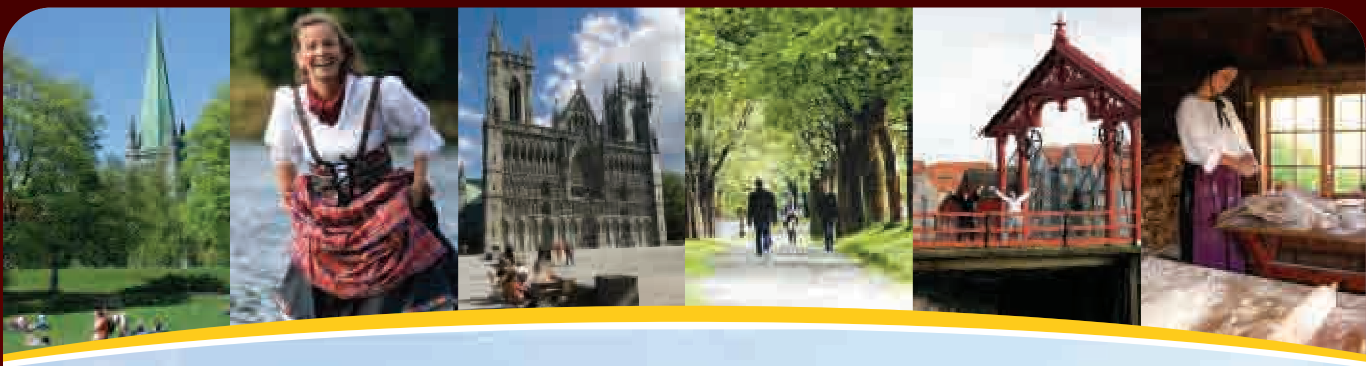
FROM BENCH TO BEDSIDE



ISPGR / GAIT & MENTAL FUNCTION
1st Joint World Congress

International Society for Posture & Gait Research

Gait and Mental Function

Symposia, Oral and Posters Sessions
Authors, Titles, Affiliations & Abstracts

Clarion Hotel and Congress Centre

Trondheim, Norway | June 24–28, 2012

Symposia

S.1 UPDATE ON NEUROLOGICAL GAIT DISORDERS: A STEP INTO THE FUTURE, *Cosmos 2*

Speakers: B. Bloem[1] (organizer), F.B. Horak[2], J. Close[3], E. Moro[4]

[1]Radboud University Nijmegen Medical Center, Department of Neurology, Nijmegen, Netherlands: [2]OHSU, Portland, US: [3]Neuroscience Research Australia, Sydney, Australia: [4]Toronto Western Research Institute, Toronto, Canada

- Bas Bloem, Nijmegen: “Phenomenology and clinical implications”
- Fay Horak: “Pathophysiology of freezing of gait”
- Jacqueline Close, Sydney: “Walking problems? Check your cognition!”
- Elena Moro, Toronto: “Treatment of gait problems: from cortex to spinal cord”

S.2 ARM MOVEMENTS AND GAIT, *Living 4*

Speakers: J. Duysens (organizer)[1], Y. Ivanenko[2], J. van Dieën[3], A. Nieuwboer[4]

[1]Dept. of Kinesiology, Faber, KU-Leuven, Belgium: [2]Dept. of Kinesiology, Faber, KU-Leuven, Belgium: [3]Fondazione Santa Lucia, Rome, Italy: [4]VU University Amsterdam, Amsterdam, The Netherlands

Why do we use arm swing during bipedal gait? During recent years, growing evidence has suggested that bipedal locomotion is a remnant of quadrupedal limb coordination. Furthermore, interlimb coordination during human locomotion shares features with other primates and non-primate quadrupeds, and it has been proposed that this is due to a similar organization of the locomotor pattern generators. Strong arguments for this view have recently emerged from detailed studies of the development of gait. The movement of the upper limbs during upright human locomotion may be due to preserved evolutionary neural circuitry. On the other hand it has been argued that arm swing is primarily a passive phenomenon, which needs to be controlled by muscle activations so as to optimize coordination. Either way, it is important to understand the role of arm swing in gait as this has consequences for our understanding of both normal and pathological gait. For example, the quadrupedal model predicts that freezing in Parkinson’s’ disease should not only be seen in legs but also in arms, provided that rhythmic locomotor-like movements are made. There are also consequences with respect to rehabilitation since there is some evidence that arm swing can assist leg movements in locomotor behavior. Finally the role of arm movements following a balance perturbation during gait needs to be clarified since this could provide insights into fall prevention. The speakers will illustrate and address different important aspects of human arm-leg coordination during gait, its neural control and implications for pathology and rehabilitation.

- Yuri Ivanenko : Coordination of spinal cord motoneurons in crawling
- Jaap van Dieën: Using arms for balance control during gait perturbations
- Alice Nieuwboer: Freezing of arm movements in Parkinson's disease
- Jacques Duysens: Using arms to assist legs and concluding remarks

S.3 AXIAL DISABILITY AND COMPENSATORY STRATEGIES IN PARKINSON'S DISEASE*, Cosmos 3A*

Speakers: E. Ruzicka[1] (organizer), B. Bloem[2], A. Nieuwboer[3]

[1]Department of Neurology and Center of Clinical Neuroscience, 1st Medical Faculty, Charles University, Prague, Czech Republic: [2]Parkinson Center Nijmegen (ParC), Radboud University Nijmegen Medical Center, Department of Neurology, Nijmegen, The Netherlands: [3]Department of Rehabilitation Sciences, Faculty of Kinesiology and Rehabilitation Sciences, Katholieke Universiteit Leuven, Belgium

- Evzen Ruzicka: Pathophysiology of axial impairment in Parkinson's disease
- Bastiaan R. Bloem: Medical and surgical treatment of axial disability in Parkinson's disease
- Alice Nieuwboer: Rehabilitation of axial disability in Parkinson's disease
- Ruzicka E / Bloem BR / Nieuwboer A: Spontaneous compensation for axial disability in Parkinson's disease

S.4 PHYSICAL AND NEUROPSYCHOLOGICAL RISK FACTORS FOR FALLS IN OLDER PEOPLE WITH NO, MILD AND MODERATE COGNITIVE IMPAIRMENT*, Cosmos 2*

Speakers: S.R. Lord[1] (organizer), K. Delbaere[1], M.E. Taylor[1,2], J.C.T. Close[1,2,3]

[1]Falls and Balance Research Group, Neuroscience Research Australia, Sydney, Australia: [2]Prince of Wales Clinical Schools, University of New South Wales, Sydney, Australia: [3]Falls and Injury Prevention Group, Neuroscience Research Australia

Approximately one third of cognitively intact older people suffer a fall each year and the incidence of falls in their cognitively impaired peers is in excess of 60%. Cognitive decline has been associated with many established risk factors for falls including balance and gait disorders. However, there is limited evidence on the relative contribution of different risk factors for falls in people with cognitive impairment and dementia. Impairment in executive function has been suggested as an important cognitive domain and several studies have demonstrated that even routine walking is not automated and requires higher-level cognitive control. With ageing, cognitive functioning can: remain normal, decline to a state of mild cognitive impairment (MCI) or progress to dementia. This symposium will outline the complex role of cognitive and physical functioning in relation to falls in older people with no, mild and moderate to severe cognitive impairment.

The first presentation will outline associations between white matter hyperintensities, physical performance and falls in people with a range of cognitive abilities from normal through to MCI and dementia. The second presentation will highlight the importance of attention, executive function, information processing speed and memory in the prediction of falls in community-dwelling older people with MCI. The third presentation will present findings on the effects of secondary tasks on gait in relation to falls in people with dementia. The fourth presentation will discuss the inter-relationships between physical and cognitive decline and falls in people with moderate to severe levels of cognitive impairment and include data from a pilot fall prevention trial for this group. With this outline, we aim to provide a better understanding of the role of cognition in maintaining balance and avoiding falls in older people across a range of cognitive abilities.

- Stephen R Lord: The relationships between physiological and cognitive function and structural brain changes across the continuum of cognitive performance in older people
- Kim Delbaere: Mild cognitive impairment as a predictor of falls in community-dwelling older people
- Morag E Taylor: Gait parameter risk factors for falls under functional and cognitive dual task conditions in cognitively impaired older people.
- Jacqueline CT Close: Understanding risk factors for falls in people with dementia and interventions to prevent falls.

S.5 AMBULATORY ASSESSMENT OF POSTURE AND GAIT IN PARKINSON'S: WHY AND HOW? *Cosmos 3C*

Speakers: W. Maetzler[1] (organizer), A. Snijders[2], J.M. Hausdorff[3], A. Salarian[4]

[1]Tuebingen University, Germany: [2]Radboud University Nijmegen Medical Center, the Netherlands: [3]Tel Aviv University, Israel: [4]EPFL Lausanne, Switzerland:

This symposium will define the value of quantitative ambulatory motor assessments for the detection of posture and gait abnormalities in Parkinson's disease. Besides, it will discuss future directions to implement such assessments in scientific projects, clinical trials and routine diagnostics. Both clinicians experienced with these aspects of Parkinson's disease (and working with ambulatory devices) and movement scientists who have experience with studies on Parkinson's disease will contribute. The speakers will present an overview of ambulatory assessment strategies in preclinical parkinsonism and in patients with clinically overt Parkinson's disease, and will report on new findings. Thus, it will bring clinicians and movement scientists closely together to develop new options for standardized assessments. In addition, this symposium will attempt to address two highly relevant challenges that are not adequately solved: the definition of preclinical markers for Parkinson's disease, and the definition of reliable markers for the progression of this disorder. The discussion promises to move this field a small step forward.

- Anke H. Snijders: Why do we need ambulatory assessments in Parkinson's disease?
- Jeffrey M. Hausdorff: Ambulatory assessments strategies for detecting preclinical Parkinson's disease
- Arash Salarian: Ambulatory assessments strategies for quantifying clinically manifest Parkinson's disease
- Walter Maetzler: Use of ambulatory assessments strategies in the clinical management of Parkinson's disease

S.6 HOW MODELING CONTRIBUTES TO UNDERSTANDING POSTURAL CONTROL*, Cosmos 3C*

Speakers: R.J. Peterka[1] (organizer), I.D. Loram[2], T. Mergner[3], S. Park[4], H. van der Kooij[5]

[1]Department of Biomedical Engineering,Oregon Health & Science University, Portland, Oregon, USA: [2]Institute for Biomedical Research into Human Movement and Health, Manchester Metropolitan: University, Manchester, United Kingdom: [3]Department of Neurology, University of Freiburg, Freiburg, Germany: [4]Department of Mechanical Engineering, Korea Advanced Institute of Science and Technology

(KAIST), Republic of Korea: [5]Departments of Biomechanical Engineering, University of Twente and Delft University of Technology, the Netherlands

ISPGR members will appreciate that the task of maintaining upright stance and compensating for postural perturbations is a complex process that is only partially understood. In this symposium we will demonstrate that there are multiple ways that modeling can facilitate a greater understanding of balance control. Specifically, we will demonstrate how modeling can (1) contribute to understanding how the nervous system integrates multiple sources of sensory orientation information and how this sensory integration process is dynamically regulated for the purpose of controlling balance and responding to perturbations (Mergner, Park), (2) be used to develop and investigate alternative hypotheses regarding mechanisms used to generate the corrective torque required for stance control (Loram), (3) be applied to robotic systems both to verify hypothesized balance control mechanisms and to create naturally behaving bipedal robots that can more easily interact with humans (Mergner), (4) be used to quantify responses to perturbations in a manner that can reveal how neurological deficits, specifically Parkinson's disease, influence balance control (Park), and (5) reveal that erroneous conclusions can be (and have been) reached by applying analysis methods that may seem to be intuitively reasonable, but which are in fact inappropriate when applied to a system operating with feedback control (van der Kooij).

S.7 PHYSICAL ACTIVITY MONITORING IN DAILY LIFE: VALIDITY AND VALIDATION ISSUES*, Living 4*

Speakers: K. Aminian[1] (organizer), U. Lindemann[2], H. Bussmann[3], W. Zijlstra[4]

[1]Ecole Polytechnique Fédéarale de Lausanne: [2]University Medical Center Groningen: [3]Erasmus MC University Medical Centre Rotterdam: [4]Robert Bosch Krankenhaus, Klinik für Geriatrische Rehabilitation, Stuttgart

Physical activity (PA) is monitored since more than 30 years through different ambulatory techniques involving mainly body worn sensors such as accelerometers. During these decades the opportunities to assess physical activity has improved considerably by the technical progress in motion sensors and methods for assessment and monitoring of spatio-temporal measures of mobility. Objective outcomes are available based on these techniques, however, the validity and clinical relevance of motion sensor based measures of the performance of physical activities in daily life must be addressed with appropriate validation procedures. This symposium aims to provide answers and future direction with regard to this validation and discuss standardization issues with regard to monitoring PA. Several topics such as protocol for PA validation, technical validation in real-word configuration, unsupervised vs. supervised and controlled monitoring, minimal sensor configuration, duration of monitoring and relevant and valid outcome measures needed for clinical evaluation are among the topics of the symposium.

This symposium is related to "Standardization in clinical assessment of physical activity, posture and gait". With this symposium, the conference can provide a multidisciplinary approach needed to overcome the current validation and standardization issues of PA monitoring.

- Ulrich Lindemann: Development of a comprehensive protocol to assess validity of sensor-based activity monitors for older people
- Hans Bussmann: Extracting valid measures from objectively measured movement behaviour
- Wiebren Zijlstra: Mobility assessment and monitoring; do data tell the same story?
- Kamiar Aminian: Activity monitoring using single inertial sensors: real-world validation vs. controlled condition validation

S.8 EXERGAMING TO INFLUENCE WALKING*, Cosmos 3A*

Speakers: E. de Bruin[1] (organizer), J. Fung[2], A. Mirelman[3]

[1]Institute of Human Movement Science and Sport, ETH, Zürich, Switzerland: [2]School of Physical & Occupational Therapy, McGill University, Canada: [3]Tel Aviv Sourasky Medical Center, Israel

The health and well-being of a person depends on the complex interactions in physical, cognitive and social domains [cf. International Classification of Functioning (ICF) by the World Health Organization, Geneva (see http://www.who.int/classification/icf)]. Even in the absence of overt pathology, motor functioning can deteriorate, as evidenced by the incidence and impact of falls in aging populations. Falls are one of the most common reasons for medical intervention in older people and their occurrence might initiate a vicious cycle of decline leading to fear of falling, nursing home admittance and loss of independence. Falls among older adult populations often occur during walking, and gait dysfunction is included among the many risk factors for falls.

Although more traditional training programmes are able to increase muscle strength and improve balance and, therefore, positively influence some measures of gait, they often do not impact on spatial and temporal characteristics of gait that are associated with distinct brain networks, e.g. gait assessed under dual task conditions. Because these gait characteristics are associated with distinct brain networks, it can be hypothesised that addressing neuronal losses in these networks may be an important strategy to prevent mobility disability in older adults.

A way to bring in a cognitive element into an exercise program is the use of virtual reality techniques. There are some reports on the use and effects of virtual reality exergaming-training in various populations. Methods using immersive computer technologies resulted in improved motor functions of upper extremities and a cortical activation after virtual reality intervention in patients with chronic stroke. Older adults benefited from training in terms of improved functional abilities, postural control and simple auditory reaction times under dual task conditions. This symposium will focus on the relation between the use of exergames and their influence on walking in various populations.

- Eling D. de Bruin: Ageing and gait disorders: “Should we let the (Exer-)games begin”?
- Anat Mirelman: The use of VR for improving gait and reducing fall risk in neurodegenerative conditions
- Joyce Fung: A Mixed Reality System for sensorimotor enhancement in neurorehabilitation

S.9 WHAT CAN WE DETECT BY VESTIBULAR FUNCTION TEST? *Living 4*

Speakers: K. Ishikawa[1] (organizer), K.S. Kim[2], S.H. Kim[3], T. Murofushi[4], A. Mitsuhiro[5]

[1]*Akita University, Japan:* [2]*Inha University, Korea:* [3]*Yonsei University Korea:* [4]*Gifu University, Japan:* [5]*Teikyo University, Japan*

The vestibular system has a crucial role in the maintenance of equilibrium functions, and some lesions in this system can cause space disorientation, decreased mental function, nystagmus, postural abnormality, gait instability and so on. These are abnormalities which appear in the output system. Vestibular function tests are indispensable in locating the lesion sites, measuring its degree and evaluating the effect of treatments. They include detailed vestibulo-ocular reflex tests such as the caloric test, the visual suppression test, the positional and positioning nystagmus tests, along with the cervical and ocular VEMP (Vestibular Evoked Myogenic Potential) which have been introduced recently. In addition, it is also important to examine visually induced eye movements, subjective visual vertical, movement of body center of gravity, locomotion and so on. Among these vestibular function tests, in this symposium, the following five clinical examinations will be focused upon, based upon the recent developments in this field. Each speaker will talk about its physiological background, clinical experience, its significance and limitations including future development. These tests will give us some important information in understanding patients' pathophysiologal status, which then will make it possible for us to prescribe the most pertinent treatment policy.

- Kyu-Sung Kim: Cervical Vestibular Evoked Myogenic Potential (cVEMP)
- Toshihisa Murofushi: Ocular Vestibular Evoked Myogenic Potential (oVEMP)
- Sung-Huhn Kim: Subjective Visual Vertical (SVV)
- Mitsuhiro Aoki: Autonomic nervous function

S.10 NEUROIMAGING OF GAIT*, Cosmos 2*

Speakers: J. Klaus[1], M. Muller[2] (co-organizers), S. Vercruysse[3], C. Rosano[4]

[1]*München, Germany:* [2] *Michigan, USA:* [3] *Leuven, Belgium:* [4] *Pittsburgh, US*

In vivo neuroimaging can provide insights in the neuroanatomical and neurophysiological mechanisms underlying normal- and/or pathological gait and balance functions. These functions involve (sub-)cortical brain regions (including brainstem locomotor regions), multiple neurotransmitter systems, and are affected by both white- and gray matter pathology. Nuclear (PET/SPECT) and anatomical MR imaging allows for *in vivo* visualization of this, while functional MR provides insight in the brain mechanisms involved. In this symposium, the latest neuroimaging findings will be presented and the relevance of multimodality neuroimaging for balance and gait research will be highlighted.

- Martijn Muller: PET imaging of balance and gait impairment in Parkinson disease
- Jahn Klaus: Observing the walking brain: Supraspinal locomotor control in PET and fMRI
- Sarah Vercruysse: fMRI of upper limbs freezing of gait
- Catarina Rosano: Update on neuroimaging of gait in aging: from observation to mechanisms.

S.11 COGNITIVE THERAPY AS A COMPLEMENTARY WAY TO IMPROVE GAIT AND REDUCE FALL RISK*, Cosmos 2*

Speakers: M.M. Odasso[1] (organizer), O. Beauchet[2], A.F. Ambrose[3], J.M. Hausdorff[4]

[1]Gait and Brain Lab, Western University, in London, Ontario Canada: [2]Geneva University Hospital, Geneva, Switzerland: [3]Department of Rehabilitation Medicine, Mount Sinai Hospital, New York, USA: [4]Laboratory for the Analysis of Gait and Neurodynamics, Tel-Aviv Sourasky Medical Center

Until recently, both clinicians and researchers treating older adults have performed gait and cognitive assessments separately. However, increasing evidence demonstrates that gait and cognition are quite interrelated. This symposium will review the significance of this gait-cognition interrelationship and present a complementary approach to reducing falls risk by improving cognition via non-pharmacological and pharmacological treatments.

Specifically, this symposium will:

1. Summarize the evidence linking attention, memory, and executive problems with gait disturbances and risk of falling in older people.
2. Propose that a cognitive approach (i.e.; dual-tasking) is a sensitive means of assessing higher levels of gait control in older adults.
3. Appraise and judge non-pharmacologic and pharmacological interventions for improving cognition and gait and reducing gait instability and the risk of falls.
    - Manuel Montero Odasso: Do we need a new approach to improve gait and reduce the risk of falling in older adults?

Falls are double among people with cognitive problems and dementia, as compared with cognitively intact older adults. The classic multi-factorial fall risk intervention is not effective in reducing fall risk in these patients. We will discuss possible mechanisms accounting for this failure and suggest that a different approach may be needed to optimally reduce fall risk. In addition will review the evidence to appraise the value of gait analysis while dual-tasking as an instrument for assessing the risk of falls in older adults.

- Anne Felicia Ambrose: Emerging Neurorehabilitation Techniques To Improve Gait and Reduce Falls

  She will review recent techniques and technologies used in rehabilitation of patients with strokes and gait impairments including constraint induced therapy, body weight supported treadmill, robotics and cognitive remediation.

- Jeffrey Hausdorff: Interventions to improve cognition and reduce fall risk: Should we pay more attention to attentional deficits?

  His presentation will review recent provocative studies that have demonstrated that non pharmacological (e.g., dual task training, treadmill training with virtual reality) and pharmacologic treatment (e.g., methylphenidate, donepezil, rivastigmine) improves attention and executive function among older adults and patients with neurodegenerative disease, and further, that these gains are associated with enhanced gait and balance as well as a reduced risk of falls.

S.12 THE USE OF WEARABLE INERTIAL SENSORS TO IDENTIFY FALLS AND ESTIMATE THE RISK OF FUTURE FALL EVENTS*, Living 4*

M. Pijnappels[1] (organizer), S. Redmond[2], N. Lovell[2], S. Rispens[1], A. Bourke[3], J. Nelson[3], V. Cionca[3], A. Weiss[4]

[1]VU University Amsterdam, the Netherlands: [2]University of New South Wales Sydney, Australia: [3]University of Limerick, Ireland: [4]Tel Aviv University / Tel Aviv Medical Center, Israel

Assessment of individual fall risk can form an important contribution to prevention of falls in older adults. Most of the currently used assessments are either questionnaires, based on associations from epidemiological studies, or physical performance tests. Although these assessments can provide valid fall risk profiles, these profiles are usually obtained in a clinical setting and lacking valuable information on the person's behavior in daily life.

Technological developments of miniaturized, body-fixed inertial sensors allow three-dimensional, high resolution, ambulatory measurements of body accelerations in daily life situations. These techniques can be used to add information of normal behavior in home based situations to fall risk assessments. Ambulatory accelerometry can provide information on the types, intensities and quality of daily activities, but also on the number of actual falls or the number of near-falls in daily life. In addition, they can provide additional information on the outcome of certain guided routines, such as physical performance tests. These approaches, based on daily situations outside the lab or clinic, are promising for the improvement of fall risk assessment. In this symposium, we will highlight the possibilities for improvement of fall risk assessment based on ambulatory monitoring, and we will also discuss the validation and implementation of these techniques in practice.

- Stephen Redmond/Nigel Lovell: Instrumented and guided routines for physical performance assessments
- Mirjam Pijnappels/Sietse Rispens: Physical activity and stability measurements in daily life
- V. Cionca/Alan Bourke /John Nelson: Fall-detection
- A. Weiss: Near falls detection

S.13 WHY INSTRUMENT THE TUG TEST? *Cosmos 3A*

Speakers: F.B. Horak[1], L. Chiari[2] (co-organizers), B. Greene[3], B. Mariani[4]

[1]OHSU, Portland, OR, USA: [2]University of Bologna, Italy: [3]Health Research and Innovation Europe, Intel lab, Ireland: [4]EPFL, Lausanne, Switzerland

The Timed Up and Go Test (TUG) is a popular clinical test of mobility and fall risk among older adults that is typically scored using a stopwatch. However, recently, several groups have used body worn sensors to enhance the ability of the TUG to obtain objective measures of postural transitions and gait, without sacrificing simplicity of testing. This symposium will compare different technological approaches to instrumenting the TUG and summarize the added benefits of these instrumentations. The presenters will compare the traditional stopwatch TUG with the instrumented versions (ITUG) for fall risk detection and measurement of balance and gait. New studies showing the sensitivity, specificity, validity, responsiveness to intervention as well as the feasibility of performing the ITUG in clinical and home settings will also be demonstrated.

S.14 FALLS AFTER STROKE – UNDERLYING MECHANISMS AND NOVEL OPTIONS FOR INTERVENTION*, Cosmos 2*

Speakers: V. Weerdesteyn[1] (organizer), A. Ashburn[2], A. Mansfield[3], M. Roerdink[4]

[1]Radboud University Nijmegen Medical Centre, Department of Rehabilitation, Nijmegen, The Netherlands: [2]University of Southampton, Rehabilitation Research Unit, Southampton, UK: [3]Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada: [4]Research Institute MOVE, Faculty of Human Movement Sciences, VU University Amsterdam, The Netherlands

Falls are the number one medical complication after acute stroke and they remain a considerable health issue during the entire post-stroke life span. The fall risk of people after stroke is up to ten times greater compared to their healthy peers. Balance and gait problems, as common residual deficits after stroke, have been identified as an important risk factor. The consequences of falls can be particularly devastating in this group of people due to the high prevalence of (hemi) osteoporosis and their inclination to fall to the side, which increases the risk of hip fractures. Many people also develop a fear of falling, which is associated with anxiety, depression and low quality of life. Although the importance of the problem is widely acknowledged, there is still a lack of evidence on effective intervention strategies to help prevent falls after stroke. As yet, exercise interventions have largely failed to reduce the number of falls. Insight into the pathophysiological mechanisms underlying these falls may give rise to the design of new and potentially more successful interventions. In this symposium we present fall-related mechanisms after stroke as identified by experimental balance and gait studies. In addition, we will introduce novel intervention strategies informed by these studies.

- Ann Ashburn: Falls after stroke – an overview of the problem
- Vivian Weerdesteyn: Postural control after stroke
- Avril Mansfield: Compensatory stepping post-stroke: control problems, rehabilitation strategies, and link to falls
- M. Roerdink: Gait adaptability training after stroke using a treadmill with visual context

Oral Sessions

O.1 TOOLS AND METHODS I, *Cosmos 3C*

O.1.1 Motor imagery of balance: a quantitative approach

Murielle U Ferraye[1], Bas R Bloem[2], Lieke Heil[1], Bettina Debû[3], Ivan Toni[1]

[1]Donders Institute for Brain Cognition and Behaviour, [2]Department of Neurology, [3]Grenoble Institut des Neurosciences

BACKGROUND AND AIM: Pedunculopontine nucleus stimulation in patients with Parkinson's Disease (PD) can lead to improved freezing without consistent effects on postural stability (Ferraye et al., 2010). This finding raises the issue of whether gait and balance disturbances in PD reflect two aspects of the same pathological process, as commonly believed. To date, addressing this issue in humans has proven to be technically difficult (Bakker et al., 2007). The current study describes a new experimental protocol that might provide a tool to disentangle the neurophysiological bases of balance and gait in humans. The approach combines motor imagery (MI) and functional magnetic resonance imaging (fMRI). Previous work has shown how this approach can be used to investigate the neurophysiology of gait in both healthy subjects and PD patients (Bakker et al., 2007, 2008; Snijders et al., 2011). Here we elaborate on that approach, extending it to balance control. We exploit Fitt's law (Fitts, 1954) to quantify MI performance during a dynamic balance task, distinguishing it from visual imagery (VI) and showing its temporal correspondence with actual balance (AB). METHODS: Fifteen healthy subjects performed a dynamic balance task and two imagery tasks. This task used a forward/backward moving balance board to the front of which was attached a laser pointer. The pointer projected a red dot on a whiteboard placed in front of the subject. The AB task was to make the laser dot reach circle targets placed by pairs on the whiteboard by physically swaying on the board. During both imagery tasks, the subjects were laying supine and faced a computer screen that presented photographs of the setup with the whiteboard. During one task (MI), subjects had to imagine swaying on the balance board as they did during the AB task. During the other task (VI), subjects had to imagine seeing the laser dot moving from one target to the other. We manipulated the length of the dot trajectory by placing the target pairs at two different distances from each other (80% and 60% of subjects' maximal forward and backward sway), and the difficulty of the task by having two different target widths (8 and 2 cm) (Figure). Subjects reported onsets and offsets of both actual and imagined tasks with a button press. The time between the two button presses was taken as the actual or imagined movement duration. RESULTS: Movement durations increased with increasing trajectory length and decreasing target width in all three tasks ($F(1,14)=93.58$; $p<0.05$). Crucially, the effect of target width on movement durations was significantly stronger during MI and AB than during VI ($F(2,28)=23.09$; $p<0.05$), suggesting that target width imposes similar constraints on both actual performance and MI of balance, but not on VI of a moving dot. CONCLUSIONS: These results open the possibility of using this experimental protocol for exploring neurophysiological correlates of dynamic balance control in humans.

O.1.2 The effects of virtual heights on static and dynamic postural control

Taylor Cleworth[1], Mark G Carpenter[1]

[1]University of British Columbia

BACKGROUND AND AIM: Postural threat influences both static and dynamic posture in young healthy adults. For example, when standing at elevated heights, centre of pressure (COP) frequency increases, amplitude decreases, and mean position shifts away from the edge [1]. During support-surface rotations at height, amplitude of balance correcting responses (120-220ms post-perturbation) increase and shoulder muscle response latencies decrease [2]. While these results have been clearly demonstrated in young healthy adults, it is important to also examine the relationship between fear, anxiety and balance in populations with greater fall risk. Given the ethical and feasibility constraints of placing such populations at elevated heights, virtual reality has been proposed as an alternative method of manipulating fear and anxiety in these individuals. Therefore, the purpose of this research is to validate virtual heights as an effective means of inducing threat related changes in static and dynamic postural control. METHODS: Two studies were performed. In Study 1, 17 subjects performed four 120s quiet standing trials at the edge of a platform. Two trials were in a real environment located at ground level and 3.2 meters above ground and two trials were performed while immersed in a similar virtual environment using a head mounted display. The virtual environment closely matched the real environment in visual detail and scale, and included haptic and auditory cues to help increase the sense of presence within the virtual scene. Real and virtual conditions were counterbalanced, while height conditions were presented in ascending order after an initial practice trial. In Study 2, 4 subjects responded to 20 randomly presented forward and backward support-surface translations (0.75m amplitude) under 2 virtual heights. Subjects stood on a moving platform located at the same virtual heights as described in Study 1. Height conditions were presented in ascending order to maximize height effects. EMG was collected from right leg, trunk and arm muscles. RESULTS: In Study 1, there was a significant decrease in amplitude and increase in frequency of COP displacement, independent of environment. Significant interactions revealed greater height-related changes in the mean position of COP displacements in the real, compared to virtual conditions. In Study 2, preliminary evidence indicated an increase in amplitude for balance correcting responses (i.e., tibialis anterior for forward perturbations) and decreased shoulder muscle response latencies when standing at virtual height. CONCLUSIONS: Virtual heights elicit similar postural changes to those observed when standing at physical height, and thus may be a useful method for studying the effects of fear and anxiety on postural control in populations with greater fall risk.

ACKNOWLEDGEMENTS: This project was supported by NSERC.

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[1] Davis et al. (2009) Gait Posture;
[2] Carpenter et al. (2004) J. Neurophysiol.

O.1.4 Use of exploratory factor analysis to describe a model of gait

Lynn Rochester[1], *Sue Lord*[1], Brook Galna[1], David J Burn[1]

[1]Newcastle University

BACKGROUND AND AIM: Gait is a complex entity to quantify. Recent evidence suggests that gait is comprised of distinct features that are associated with selective but overlapping neural and cognitive mechanisms. Further understanding of these features may help refine gait analysis, identify underlying neural substrates and guide treatment. We aimed to identify distinct features of gait through exploratory factor analysis using two cohorts. METHODS: One hundred people with PD and 158 age matched controls were assessed for 10 spatio-temporal gait variables using a 7m instrumented walkway (GAITRite) whilst walking for 2 minutes under single task and dual task conditions (normalised Digit Span Task). Principal Components Analysis (PCA) and Factor Analysis (FA) 'varimax' procedure were used to examine relationships between variables. Data were analysed with reference to earlier work that provisionally identified 3 separate components of gait: gait speed, gait variability and step width. The model was therefore not limited to including variables with eigenvalues greater than 1. RESULTS: Mean (SD) age for controls was 69.8 (7.8) and 66.6 (10.4) for PD. Four factors emerged from the FA with similar cross-loadings for PD and controls: Factor 1 'timing', Factor 2 'variability', Factor 3 'forward progression' and Factor 4 'postural control'. These factors explained 90.2 % of common variance for controls and 91.0 of variance for PDs. Cross loading for all variables was below 0.5. The model held for dual task gait with the same amount of total variance explained (data not shown here). However, variability characteristics loaded onto the variability factor as well as the timing factor. CONCLUSIONS: A four factor model may be useful for conceptualizing gait in older adults and people with PD especially under single task gait. Under dual task conditions variability reflects temporality as well as stride to stride fluctuation.

Table 1 Item loadings for the four-factor rotated solution and communalities (Varimax Rotation)

	Item	Timing	Variability	Forward progression	Postural control
Controls (n = 158)	Stride time (secs)	**.936**	.239	-.212	.093
	Swing time(secs)	**.925**	.158	.164	-.027
	Stance time(secs)	**.846**	.251	-.357	.136
	Stride length SD	.062	**.873**	.039	.144
	Stride time SD	.381	**.724**	-.445	.107
	Swing time SD	.354	**.701**	-.384	.101
	Stance time SD	.330	**.691**	-.488	.140
	Stride velocity (m/sec)	-.438	-.205	**.848**	-.087
	Stride length (m)	.122	-.180	**.958**	-.047
	Step width (cm)	.078	.204	-.085	**.970**
	Eigenvalue	5.6	1.6	.943	.811
	% Variance	30.2	25.1	24.2	10.4
PD (N = 100)	Stride time (secs)	**.934**	.183	.233	.130
	Swing time(secs)	**.888**	.181	-.219	-.034
	Stance time(secs)	**.832**	.160	.398	.183
	Stride length SD	.009	**.904**	.144	.022
	Stride time SD	.475	**.730**	.337	.125
	Swing time SD	.429	**.613**	.485	.163
	Stance time SD	.471	**.678**	.393	.141
	Stride velocity (m/sec)	-.345	-.288	**-.876**	-.095
	Stride length (m)	.087	-.276	**-.937**	-.089
	Step width (cm)	.114	.104	.111	**.979**
	Eigenvalue	5.6	1.6	.94	.81
	% Variance	31.2	24.4	24.4	10.9

O.2 DEVELOPMENT OF POSTURE AND GAIT I, *Living 4*

O.2.1 The construction of space for navigation: how children develop spatial memory and path planning for locomotion, in comparison with reaching movements.

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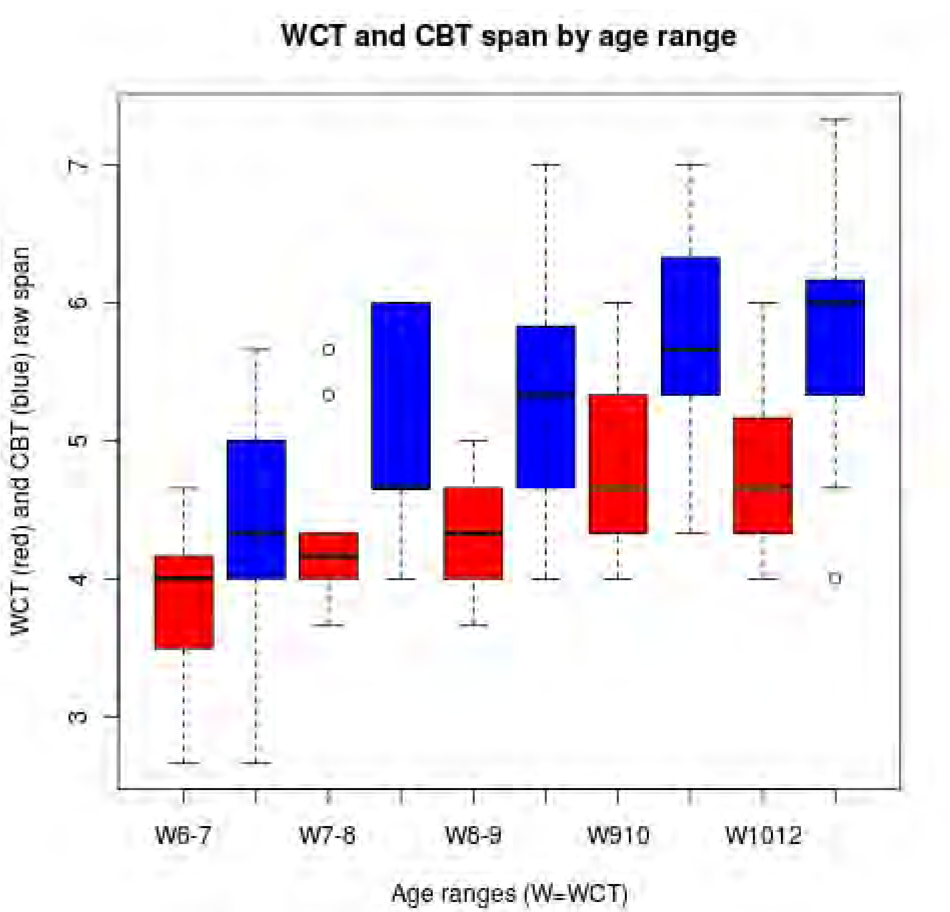
BACKGROUND AND AIM: Gait control has to be coupled with cognitive processes to control direction, retrieve spatial locations, and plan routes (Wiener et al, 2009), referred to as 'navigation' abilities. So, though walking and reaching require different motor synergies, the two tasks share the need for a mental construction of space. Recently, a widely used test for visual-spatial memory in the reaching space, the Corsi Block-tapping Task (CBT), has been transferred to the locomotor space as the Walking Corsi Test (WCT) (Piccardi et al, 2008). Adult males, but not females, score higher at the WCT than at the CBT, while little is known on early development. Aims: 1) to assess navigation skills in typically developing children at school age by means of an electronic version of the WCT; 2) to compare WCT with CBT scores, with the hypothesis that the reaching space is better managed by children than the locomotor one, before the onset of advanced strategies of spatial encoding and abstraction (see Bullens et al, 2010); to establish when gender differences set in. METHODS: The CBT requires subjects to retrieve a previously viewed sequence of two or more, out of a total of nine, wooden blocks attached to

a board, by simply tapping them (Berch et al. 1998). The electronic WCT is a room-scale version of the CBT, with luminous tiles instead of blocks, requiring the subject to retrieve sequences by walking on the tiles. A span score is obtained for both tests, corresponding to the maximum sequence length fully achieved. Ninety healthy children aged 6-12 years have been enrolled (48 males). All subjects have undergone the WCT, the CBT, the Digit span (a test for short-term verbal memory), and Raven's Coloured Progressive Matrices (CPM), a test for general non-verbal intelligence. RESULTS: Both WCT and CBT scores are related to age. Linear regression analysis (age determining scores) gives for both: $R^2=0.22$, $p<0.0001$. The two tests expectedly correlate with each other (Pearson's P, confidence interval=[0.479,0.734]). After sorting subjects into five age ranges (one per year), CBT scores prove consistently higher than WCT scores at any age (T-test for paired samples: $p<0.01$). There are no statistically significant gender differences, except for CBT scores between 7 and 8 years (females better). In the eldest group, males seem to perform slightly better than females at the WCT. CONCLUSIONS: The WCT has proved an effective means of assessing navigation skills in children at school age. Children up to 12 yrs perform better at the classic CBT than at the WCT, contrary to adults. This confirms the hypothesis that navigation requires the development of more abstract spatial constructs than reaching, employing allocentric as well as egocentric and combined reference frames, not yet full-blown until adolescence. Extending the sample to elder subjects, we shall try to establish when this gap disappears and when gender differences set in.



Acknowledgements:
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O.2.2 Determinants for direction of obstacle avoidance in children.

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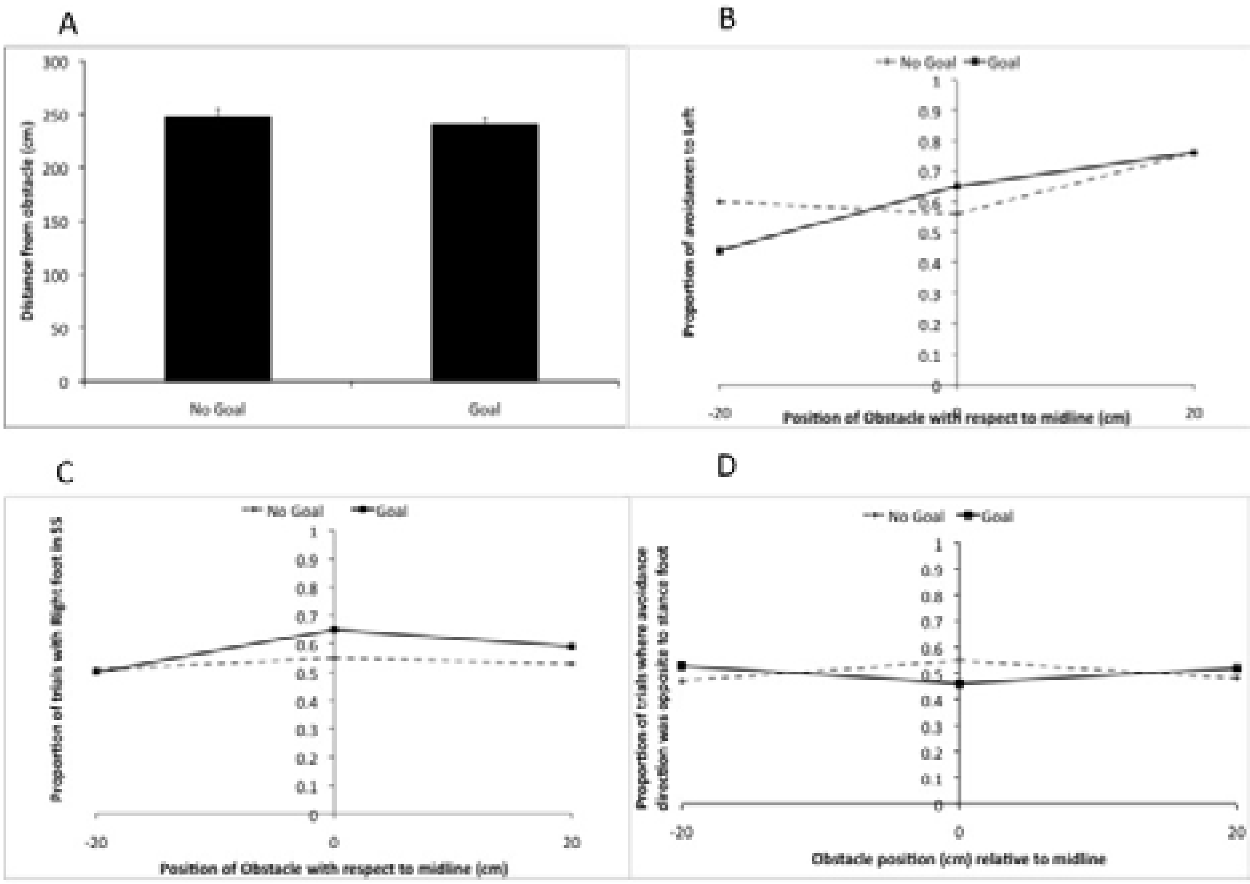
[1]Wilfrid Laurier University

BACKGROUND AND AIM: What determines the direction an individual will circumvent an obstacle? Previous research has suggested that the perception of more space is a major contributor [1]. When space is equal on both sides, young adults avoid an obstacle in the direction that is opposite to the limb in single support (i.e. step wide) [2]. The objective of this study was to determine if young children act similar to young adults when circumventing an obstacle. METHODS: 9 children (7-8 years) participated in the study. Prior to testing all children performed functional tasks to determine foot dominance. Children were instrumented with NDI Optotrak Smart Markers on their head, trunk and feet. Data was collected at 60Hz. Children walked towards a goal located 9m from the start while avoiding an obstacle (pole) placed 5m from the start. The obstacle was placed either in-line with the goal or 20cm to the right or left of the mid-line and the goal was either visible (pole) or not (spot on floor) from the starting position. RESULTS: Regardless of whether a goal was present or not, obstacles were avoided when the children were ~2.5m from them. The perception of more space only slightly influenced the direction of avoidance when a goal was present. Even though 8 of the children were right foot dominant, this did not lead to more avoidances towards the left (i.e. right foot push off) nor were there more trials where the Right foot was in single support at the time of avoidance. Children also did not always avoid the obstacle in the direction opposite to the stance foot. CONCLUSIONS: Unlike young adults, it is difficult to determine which factors determine the direction that a child will avoid an obstacle. It seems that the presence of a goal helped to perceive the side with the most space and this influenced the direction of avoidance. It appears that children's obstacle avoidance strategies are variable and not based on foot dominance or stability (i.e. step wide). This is may be related to the dynamics of a developing perception-action system [3].



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O.2.3 Bimanual gait: The development of human brachiation

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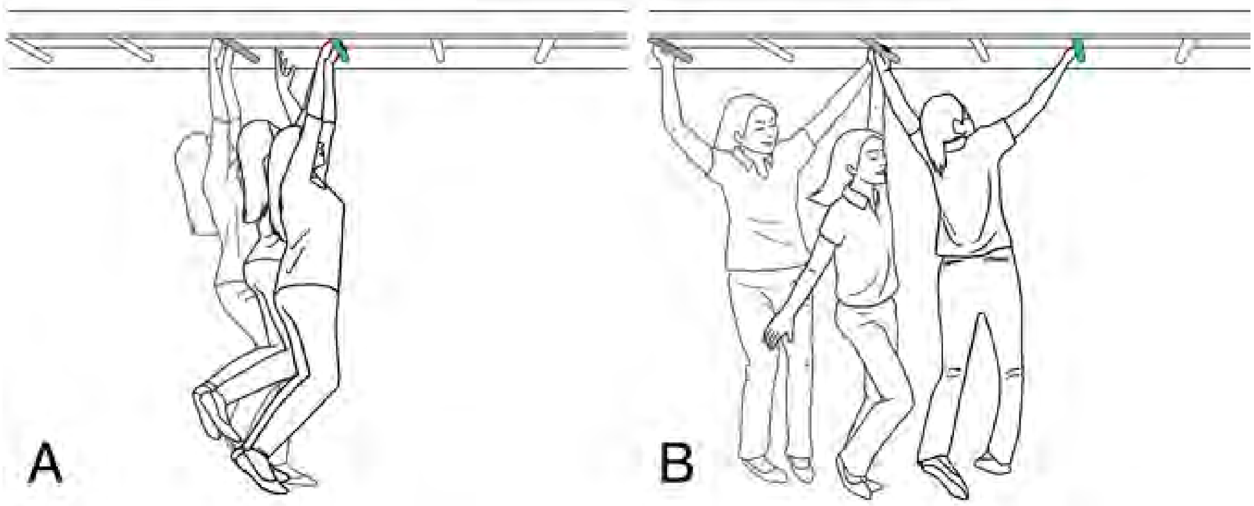
BACKGROUND AND AIM: Humans can locomote by walking over a substrate with their legs or brachiating under a superstrate with their arms (e.g., children swinging along playground monkey bars). In contrast to bipedal walking gaits, bimanual brachiation gaits have been studied only in non-human primates. The current study is the first to examine the development of human brachiation. METHODS: Six children and 22 adults brachiated across a set of adjustable monkey bars in our lab during weekly sessions over the course of 5 months. An additional 39 children and 11 adults were observed only once.

The timing and position of hand contacts with the bars were coded frame-by-frame from video. RESULTS: As in bipedal locomotion, we observed a variety of bimanual gaits, each a unique solution to the problem of locomotion beneath a superstrate. The selection of bimanual gaits roughly paralleled the course of bipedal gait development, with the most demanding and complicated gaits appearing last. Two gait varieties accounted for roughly 80% of all trials: Marking time, where each bar is grasped by both hands in succession, and alternation, where each bar is grasped only once (see Figure 1). Alternation requires the swinging arm to travel the longest distance with each step. CONCLUSIONS: As in bipedal gait, bimanual gait selection may be influenced by differing biomechanical demands. A critical factor in brachiation appears to be how long one can support the body with only one limb. Whereas alternation may be more energy efficient, it also requires the swinging arm to spend the longest time in motion while the body is supported by the contact arm alone.

Fig.1 Marking-time (A) and alternating (B) bimanual gaits.



O.2.4 Postural Control in Children: The Influence of Head Movement Propensity during Natural Gaze Behaviour

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BACKGROUND AND AIM: The development of the visual system is thought to be an important determinant of postural control development. Although the effect of crude visual occlusion on postural control has been studied in different stages of development, the more subtle effect of head movements - as an extension of the oculomotor system [1] - on postural control in children is unclear. We aimed to shed light on this matter by exploring head movement and postural sway during natural gaze behaviour in children aged 5 to 12 years. METHODS: Time series of centre of pressure (COP) data and three-dimensional head motion were obtained in three groups of children (aged around 6 years (n=14), 9 years (n=20) and 12 years (n=15), respectively) and in one group of young adults between 18 and 35 years (n=18). Participants completed two experimental conditions: (1) quiet stance with gaze fixed on a dot on eye level and (2) quiet stance while watching an animation movie on a large projection screen (2.2 x 1.3 metres) 1.1 metres away from the participants. Head movement was unrestricted. In order to characterise postural control, standard deviations of anterior-posterior (AP) and medio-lateral (ML) COP displacement were calculated. In order to characterise gaze behaviour, maximal range-of-motion (ROM) of head yaw, roll, and pitch was determined. RESULTS: COP displacement in both AP and ML directions as well as head ROM in all directions significantly decreased with increasing age in both conditions (.001<p<.019). Compared to quiet stance, the condition movie watching showed a significantly larger deterioration of COP in AP direction and larger head ROM values in yaw, roll, and pitch in all age groups (.001<p<.012). CONCLUSIONS: In line with Murray et al. [2], head movement propensity decreased with increasing age. This finding is important when describing postural control development. The inability to stabilise the head (described earlier by [3]) even during quiet stance with a fixed gaze in young children might be one of the reasons for the ample reported lower postural stability in this group. Moreover, a development from a head-movement to an eye-movement strategy seems to take place during childhood. The achievement of the latter seems an important developmental milestone. After all, excessive head movement during gaze shifts implies excessive energy expenditure and seems to render lower postural stability. The latter effect might be explained mechanically (i.e., the head as a large mass on top of an inverted pendulum) or sensory (i.e., movement noise in the information flow to the vestibular and visual systems).

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O.3 ACTIVITY MONITORING, *Cosmos 3A*

O.3.1 Moving outdoor in older people: assessment based on accelerometer data

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BACKGROUND AND AIM: In older people, the ability to move outdoor may indicate functional independence, participation to social activities and capacity for independent living in community. Outdoor activity, in particular walking is a key factor for the maintenance of physical capacity and quality of life therefore the objective and reliable assessment are important issues in geriatric research. The monitoring systems based on accelerometers usually report daily-life physical activity (PA) in terms of body postures and walking pattern without distinction about where activity is performed. The objective of the present study was to develop an algorithm that allows distinguishing indoor from outdoor activity on the basis of the trunk accelerometer data. METHODS: The study included 100 older persons that were living independently in the community. PA was monitored during 24 hours with a Physilog device attached on the chest. On the second day the participants were asked whether they had left home and, if so, for how long (how many times). This information (partition of participants in two groups, 'true indoor' and 'true outdoor') was used as reference to quantify the performance of the algorithm. The algorithm used the chest acceleration signals and was based on the following stages: Stage 1: exploratory analysis of the database to detect and characterize each walking episode by estimating the duration (d) , the number of steps (ns), and the occurrence time during monitoring, plot the cumulative probability distribution (cpd) of d and ns using the pooled data in each group ('true indoor', 'true outdoor') and from cpd determine the maximum number of steps characteristic to indoor walking episodes (max_step_indoor) Stage 2: analysis of individual data, select the walking episodes that contain a number of steps superior to max_step_indoor and define them as estimated outdoor walking

episodes, merge the estimated outdoor walking episodes that succeed at less than 5 minutes and define the cumulated time as cumulated estimated outdoor activity episodes (activity= walking and standing), classify the subjects as 'estimated indoor' or 'estimated outdoor' bases on the results of preceding step Stage 3: quantify algorithm's performances. The accuracy (A), sensitivity (Sen), specificity (Spec), positive predictive value (PPV) and negative predictive value (NPV) were calculated with 'true indoor'/'true outdoor' (reference) against 'estimated indoor'/ 'estimated outdoor' RESULTS: From the participants' responses it resulted that: 'true indoor' = 16 subjects and 'true outdoor'= 84. The cdf plot indicated that max_step_indoor ≈ 60 steps. The performances of the algorithm to classified the 100 subjects as 'indoor' or 'outdoor' were: A=94%, Sen=75%, Spec=97%, PPV=85% and NPV=95% CONCLUSION: The results of this study showed that outdoor activity in older adults can be reliably assessed using one accelerometer fixed on the chest and appropriate analysis of walking episodes.

O.3.2 Quantifying Fall Risk in Daily Life using 3-day long Continuous Accelerometer Recordings

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BACKGROUND AND AIM: Many approaches are used to evaluate fall risk. While their properties and ability to successfully quantify fall risk vary widely, most share common features: a) they reflect the performance at a specific moment in the lab or clinic; and/or b) they are based on subjective self-report. Unfortunately, however, because of problems of recall, transient changes, or white coat syndrome, such measures may not represent actual fall risk. We recently proposed a method for quantifying activity in complex, daily living settings1; the potential utility in assessing fall risk was not yet tested. The aim of this work was to evaluate the possibility of using a body-fixed sensor worn continuously for 3 days to quantify fall risk as subjects carry out their routine daily life activities. METHODS: Community-living older adults (ages 70-90 yrs of age) were studied. Fall risk was assessed using traditional performance-based tests of balance and gait in the lab (e.g., Timed Up and Go). Usual-walking was also quantified1. Afterwards, subjects were asked to wear an accelerometer on their lower back for 3 consecutive days (except during activities like showering or swimming). A filter was first applied to identify the locomotion parts and activity segments of the 3 day recordings1. In these segments, the dominant frequency of the power spectral density (psd) provided a reflection of the average step cycle. The amplitude, width and slope of the dominant frequency were also determined. These features reflect gait variability and walking consistency in daily life. RESULTS: Based on fall history, subjects were classified as fallers or non-fallers (Table 1). As expected, the fallers scored significantly worse on performance-based measures of gait and balance., fallers also walked more slowly and the amplitude, slope and step regularity were lower in the fallers, indicative of a less consistent gait pattern (Table 1). Based on the 3 day recordings, the fallers and non-fallers had similar amounts of activity and similar number of steps. However, the amplitude, slope and width differed in the fallers (e.g., Slope non-fallers: 0.35±0.26; fallers: 0.19±0.13; p=0.01). Mild correlations were observed between the at-home and in-lab measures (r=0.35-0.55, p<0.04). The total number of falls per year was correlated with the 3 day estimates of the dominant frequency (r=0.47, p=0.002) and the width (r=0.31, p=0.04). CONCLUSIONS: These initial findings suggest that a body-fixed sensor worn for 3 days can be used to evaluate fall risk as older adults carry out routine activities of daily living in their natural settings.

Table 1: Subject characteristics and lab-based assessments of gait and fall risk.

		Non-Fallers	Fallers	P-value
Demographics and Traditional Tests of Fall Risk	**Age (yrs)**	77.99±4.73	77.49±4.87	0.73
	Gender (% women)	55	74	0.08
	Falls in past 6 months	0±0	2.4±2.7	<0.001
	Frontal Assessment Battery	16.05±1.26	15.35±2.49	0.27
	Mini Mental Status Exam	28.47±1.41	27.94±1.81	0.35
	Montreal Cognitive Assessment	24.68±2.21	23.60±3.91	0.29
	Dynamic Gait Index	22.25±1.55	20.14±3.38	0.01
	Berg Balance Scale	54.16±1.68	49.90±4.94	0.001
	Timed Up and Go (sec)	9.83±2.46	12.29±2.76	0.006
	Four Square Step Test (sec)	11.31±2.51	16.64±5.12	<0.001
	Activities-specific Balance Confidence (%)	90.8±8.4	70.7±17.5	< 0.001
Laboratory Measures of Gait	**Time to complete 50 meter walk (sec)**	41.43±7.11	53.12±8.79	<0.001
	Dominant Frequency [Hz]	1.89±0.18	1.79±0.12	0.057
	Amplitude of dominant frequency [psd]	0.94±0.13	0.63±0.24	<0.001
	Width of dominant frequency [Hz]	0.63±0.01	0.65±0.04	0.2
	Slope [psd/Hz]	1.40±0.19	0.95±0.39	<0.001
	Step Regularity	0.75±0.08	0.63±0.20	0.02

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O.3.3 Can the ActivPAL accurately measure walking under challenging conditions in people with PD?

Robyn M Lamont[1], Meg E Morris[2], Marjorie H Woollacott[3], *Sandra Brauer*[1]

[1]University of Queensland, [2]University of Melbourne, [3]University of Oregon

BACKGROUND AND AIM: Maintaining walking ability is an important health goal for people with PD and therefore important to assess. Current methods of walking in the community are either time consuming (observation) or unreliable (self report). The ActivPAL (Pal Technologies, Glasgow, UK) is a small lightweight uniaxial accelerometer which has been used to measure stepping time, number of steps, position changes and sedentary activity in older people and people with PD. The purpose of this study was to assess the accuracy and test-retest reliability of the ActivPAL to measure time spent stepping and the number of steps taken while walking for shorter and longer durations and with a variety of walking challenges. METHODS: Walking was assessed in 62 people with PD while walking at a comfortable pace over 10 metres, for 3 minutes and 6 minutes. Ten metre and 6 minute walks were conducted with minimal distractions and while performing no other tasks. During the 3 minute walk, participants walked in a busy public area while conducting a conversation and negotiating doorways, obstacles and surface changes. Time spent stepping and number steps taken was measured using the activPAL, a stop watch (time) and manual counting (steps). Participants attended a second assessment 4-7days later where the 10 metre and 6 minute walks were repeated. RESULTS: The activPAL showed excellent accuracy when

measuring time spent stepping across all three walking conditions with ICC's ranging from r=0.92-0.99. When measuring number of steps, the activPAL was accurate across all three walking conditions being most accurate for the 6 minute walk (ICC r=0.99) and least for the 10 metre walk (ICC r= 0.88). Test retest reliability was also good with ICC's ranging from r=0.63 to 0.76 for time and r=0.76 to 0.84 for steps. CONCLUSIONS: The activPAL is an accurate way of assessing time spent stepping and number of steps across short and longer duration walks and in a variety of environments and thus may be a promising tool for measuring volume of walking in the community. This study was supported by NHMRC project grant ID#5121170, CIA Brauer.

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O.3.4 Comparing activity levels between people with Charcot-Marie-Tooth disease and healthy controls: an Exploratory Study

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BACKGROUND AND AIM: This study compares physical activity levels, recorded using the SenseWear activity monitor (SAM), in people with Charcot-Marie-Tooth disease (CMT) and healthy matched controls. There is an indication from small, early studies that people with CMT are less active than the general population. This has implications for deconditioning and prevention of co-morbidities. Twenty people with CMT (11 male; aged 46 ±15 years) and 20 healthy matched controls participated. METHODS: The SAM was worn for the waking hours of 7 days. Primary comparisons of body mass index (BMI), calorie expenditure, energy expenditure (METs), step count, time spent performing sedentary (<3 METs) and moderately vigorous (≥3 METs) activities were measured using the SAM. Secondary measures of people with CMT included reported activity levels (Phone-FITT questionnaire), muscle strength, sensory impairment, fatigue severity (FSS questionnaire) and disease severity using the CMT Examination Score (CMTES). Analysis: Unpaired T-Tests were performed to explore between group differences. Linear regression was used to explore relationships between activity variables and clinical measures in the CMT group. Patterns of sedentary behaviour were assessed by power law analyses of the lengths of sedentary bouts fitted from raw sedentary data. Activity patterns were also assessed by assessing transitions from being inactive to active and normalized by the length of the recording, termed ''Sedentary to Active Transitions''. These data were presented as a percentage of the activity data per day. RESULTS: There were no significant group differences between calorie expenditure, energy expenditure, or time in sedentary or moderate activities. However, people with CMT took significantly fewer steps each day than the control group (6814 ±2587 and 11218 ±2846 respectively; T=2.024, P<0.00001). Numbers of sedentary to active transitions were significantly higher in patients with CMT compared with controls. Disease severity, self-reported activity, muscle strength, sensory impairment and fatigue did not correlate with any of the SAM measures in people with CMT. No difference was seen in BMI between groups (people with CMT mean BMI 24.5 ±3.4; Controls mean BMI 24.7 ±3.4). Increased time in sedentary activities predicted an increase in BMI (P=0.006). CONCLUSIONS: People with CMT have comparable levels of energy expenditure to controls, but take fewer steps per day suggesting

increased effort during walking. No subjects with CMT reached 10,000 steps per day. However, fewer target daily steps may be recommended due to their increased energy expenditure per step. They also have more sedentary to active transitions than controls so may have more frequent periods of activity but for shorter duration. This could relate to factors such as fatigue or pain. High BMI has been implicated as a cause of poor general health so a targeted intervention to reduce BMI would be desirable e.g. reducing duration of sedentary periods

O.4 NEUROLOGICAL DISEASES I, *Cosmos 2*

O.4.1 Delayed postural responses are associated with gait and postural sway abnormalities in multiple sclerosis

Jessie Huisinga[1], Rebecca St. George[2], Rebecca Spain[2], Dennis Bourdette[2], Fay Horak[2]

[1]University of Kansas Medical Center, [2]Oregon Health and Science University

BACKGROUND AND AIM: Up to 85% of those diagnosed with Multiple Sclerosis (MS) report gait and balance disturbance as their main symptom, yet the specific neural control mechanisms that contribute to these problems in patients with MS are not well understood. This study examined the relationship between postural response latencies and gait and balance variables since this laboratory has already shown that somatosensory evoked potentials reveal slowed conduction of spinal cord somatosensory pathways in patients with MS. METHODS: Forty persons with MS [20 mild disability; 20 moderate disability] and 20 healthy controls participated. Postural response latencies were measured as subjects stood on a forward translating force platform (4 cm at 15 cm/s). MS subjects performed a quiet standing task (30 sec, eyes open) on the force platform and a 2-minute walk while wearing inertial sensors on bilateral wrists, ankles, trunk, and sacrum. Postural response latency differences across groups (MS mild, MS moderate, control) were assessed with a one-way ANOVA and the relationship between postural latencies and balance or gait parameters in MS subjects were assessed with Spearman correlations. RESULTS: There was a significant group effect ($F=10.187$; $p<0.001$) for postural latencies, where latencies for the mild and moderate groups were significantly longer compared to the control group ($p=0.024$; $p<0.001$, respectively). For MS subjects, there were significant correlations between postural latencies and quiet standing measures including: center of pressure root mean square ($p=0.04$), range ($p=0.01$), and sway area ($p=0.01$). There were also significant correlations between postural latencies and trunk motion during the two-minute walk including: lateral range of motion ($p=0.05$), standard deviation of lateral range of motion ($p=0.01$), range of peak lateral angular velocity ($p=0.04$), and standard deviation of peak lateral angular velocity ($p=0.006$). CONCLUSIONS: The results show patients with MS have significantly longer postural response latencies compared to healthy controls and these latencies are significantly related to both balance and gait variables. Longer postural response latencies in MS patients were associated with increased amounts of postural sway during quiet stance. During gait, longer latencies were associated with an increased amount of lateral trunk movement and decreased variability (range, standard deviation) of lateral trunk angular velocity. Excessive lateral trunk motion during walking has been associated with falls in the elderly and walking balance requires step-by-step, integrative control for balance mainly in the lateral direction. Thus, it appears that slowed somatosensory conduction up the spinal cord, critical for timely postural responses to external perturbations, also reflects MS patients' difficulty in maintaining postural control during standing and walking.

O.4.2 Effects of wearing an ankle orthosis while walking on fatigue and postural sway in people with Multiple Sclerosis: a randomised crossover trial

James McLoughlin[1], *Christopher Barr*[1], Daina Sturnieks[2], Stephen Lord[2], Maria Crotty[1]

[1]Flinders University, [2]Neuroscience Research Australia

BACKGROUND AND AIM: Motor fatigue is a major problem in people with multiple sclerosis (MS) and can exacerbate disturbances in balance and gait leading to an increased risk of falls [1]. Fatigue related weakness of the lower limb muscles (ankle dorsiflexors) is common and may limit functional mobility. The aim of this study was to evaluate the effect of wearing a dynamic dorsiflexion assist orthosis (DAO) on fatigue and postural sway of people with MS before and after a bout of walking. METHODS: Twelve subjects (7 females, mean age 51 years) with moderate disability due to MS (EDSS score 3-6) participated in 3 assessment sessions performed over a 10-day period. Each session involved one of three 6 minute tasks: (1) seated rest, (2) walking with a DAO (Foot-Up, Ossur) worn on the most affected ankle, and (3) walking without a DAO. The 6 min walk test has been shown to correlate with fatigue and functional mobility in people with MS [3]. The order of the tasks was mixed across subjects. Postural sway was measured before and after each 6 min task and was characterised by the trajectory of a reflective marker on the C7 vertebra and centre of pressure under the feet measured using an 8 camera motion capture system (Vicon, UK) and 2 force platforms (AMTI, USA), respectively. Subjects performed two 30 sec balance trials standing with eyes closed and feet together. Differences between mean sway parameters for the 3 assessment sessions were tested using a repeated measures ANOVA ($p < 0.05$). RESULTS: There was no significant difference in distance walked (383 ± 130m vs 374 ± 133m) or perceived exertion for the 6 min walk tests performed with and without the DAO, respectively. However, postural sway (C7 path length) was greater after walking without the DAO, and was significantly different ($p = 0.019$) to postural sway measured after walking with the DAO or seated rest (Fig 1). This suggests the DAO did not afford any functional benefit in terms of distance walked but may have minimised motor fatigue of the ankle dorsiflexors aiding in the maintenance of postural control after the fatiguing walk. CONCLUSIONS: This preliminary data shows that postural sway in people with MS can increase following a short bout of walking, and such changes in postural control may be minimised by use of a DAO. The benefits to gait require investigation.

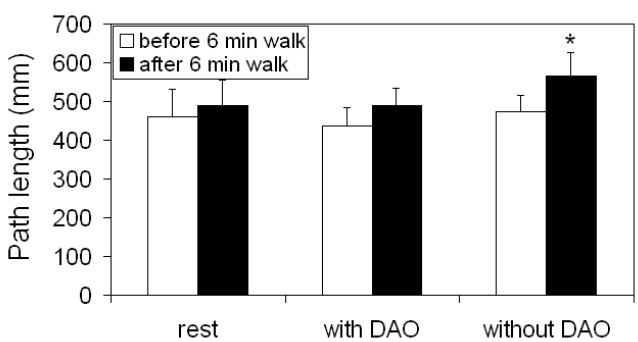

Fig.1 Mean (+SE) postural sway (C7 path length) before and after 6 min walk (*p = 0.019).

ACKNOWLEDGEMENTS:
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O.4.3 Effect of a Standardized Motor Training on Physical Activity Status in Patients with Dementia: Results of a RCT

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BACKGROUND AND AIM: Effect of a Standardized Motor Training on Physical Activity Status in Patients with Dementia.: results of a RCT Background and aim of study: Motor behaviour interacts with cognitive status in many aspects. However, there is a lack of controlled randomized intervention studies on the effect of physical training on habitual and intervention-related physical activity (PA) in patients with dementia. The aim of the study was to determine the effect of a standardized training program on physical activity in these patients. METHODS: Physical activity (PAQE) was documented at baseline (T1), after a 3-month- training (T2) and a 3-months-follow-up (T3) in sedentary patients with mild to moderate dementia (n=111). An intensive strength and functional training (intervention) was compared to a low-intensity group training (control). RESULTS: Repeated measure ANOVA show significant effect of time (p<0.001, partial eta square (eta2):0.574) and time*group effects (p<0.001;eta2:0.380) for differences between the intervention (T1:5.36(5.07); T2:13.20 (5.71); T3:6.62(5.01) and the control group (T1:4.08(3,76); T2:6.36(4.78); T3:6.21(5.22). Increase was mainly induced by training activities including leisure walking (Time effects: p<0.0001;eta2::0.655; time*group effects: p<0.0001; eta square:0.421) but partly sustained during follow-up. ADL activities increased in both groups inducing time (p=0.001, eta2:0.133) but no time*group effects (p=0.556, eta2=0.012). Habitual activity level (comparison T1 vs. T3) could be increased in both groups resulting in time (p<0.0001;eta2: 0.152) not in time x group effects (p=0.310; eta2: 0.010). CONCLUSION: Study results document a significant behavioural change in a patient group at high risk for insufficient physical activity.

O.4.4 Self-selected walking speed predicts ability to run following traumatic brain injury.

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BACKGROUND AND AIMS: High-level mobility limitations, such as the inability to run, are prevalent following traumatic brain injury (TBI). The aim of this study was to identify factors that predict running ability following TBI, and to quantify performance thresholds for these predictors. METHODS: One hundred and fourteen people with TBI were required to undergo three-dimensional quantitative gait analysis (3DGA) in order to quantify postural stability (lateral centre of mass displacement), ankle power generation at push-off and quality of gait performance (Gait Profile Score). Self-selected walking speed, the ability to run, and High Level Mobility Assessment Tool (HiMAT) scores were also measured for each participant. RESULTS: All predictor variables were all strongly associated with the ability to run. When considered together, the regression model was statistically significant, ÷2 (4, N = 94) = 53.83, p < .001; however, only self-selected walking speed contributed significantly to the final result. Investigation of performance thresholds for self-selected walking speed indicated that following TBI, people who walk at

speeds of 1.0 m/sec or higher are 16.9 times more likely of being able to run than for those who walk at speeds of less than 1.0 m/sec. CONCLUSIONS: Self-selected walking speeds higher than 1.0 m/s greatly increase the likelihood of running following brain injury. The 1.0 m/s threshold, although slower than able-bodied self-selected walking speeds, may be an important indicator of the ability to run in this population.

O.5 MODELING, ROBOTICS AND BIOMECHANICS I, *Cosmos 3C*

O.5.1 Individual recognition from motion data using 2 IMU sensors

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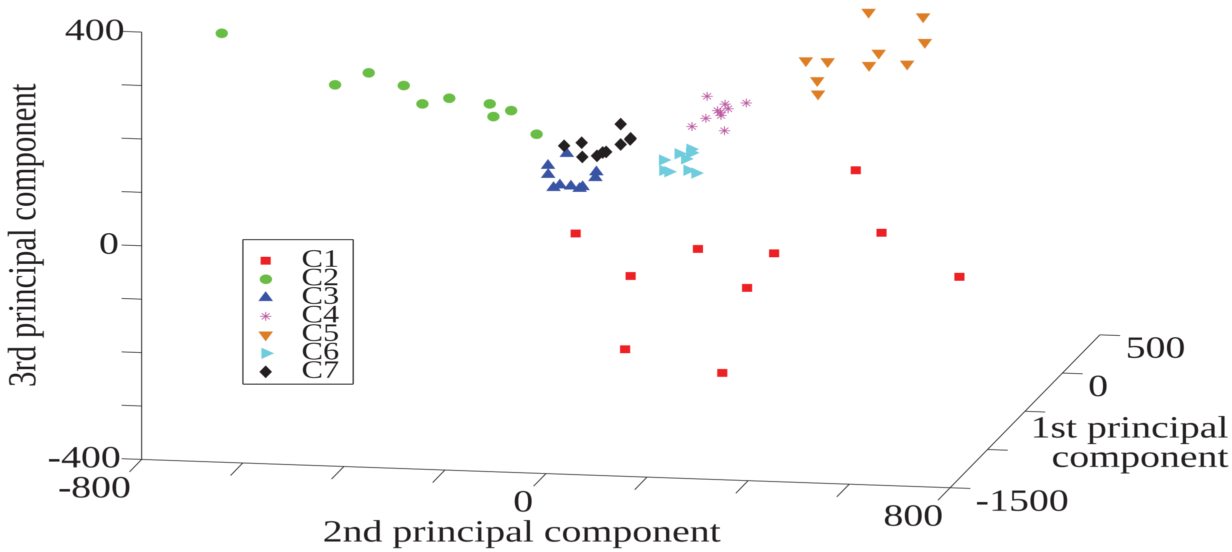
BACKGROUND AND AIM: To improve intelligent systems ability, it is necessary to develop technology to recognize humans from their motions since non-verbal communication plays a major role in our life. We propose to recognize individuals from gait. We collected 3D walk data from 7 persons, using 2 IMU sensors. Then we developed an algorithm based on Principal Component Analysis on feature vectors calculated from motion data to recognize candidate. EXPERIMENTS: 7 candidates (C1~C7) (6 males 1 female) are equipped with 2 IMU sensors. One is fixed on the lower torso (pelvis, centered) and the other on the upper torso (sternum). We get the 3D motion data from each IMU sensor. A 6DOF model was constituted. Candidates walk about 6 steps, the experiment is repeated 10 times. Thus a total of 70 angular velocity time-series data of the 6 DOF is recorded simultaneously. METHOD: The feature vector of a motion i is obtained by computing the auto-correlation matrix of the vector of DOF considered as presented in [1]. PCA of these vectors gives information of the clustering possibility of the data. PCA results are given in the figure. A clear cluster structure for each candidate is obtained. We introduce an algorithm based on PCA of feature vectors for all candidates. First, we find the barycenter of PCA results for database cluster j (j=1~7) in the 3D orthogonal coordinate system configured by the first three principal components and calculate the distance between any data point i on the PCA. Second, we calculate the Euclidian distance from i to j's least-square approximation for each candidate. Finally, "Feature Value" of data point i to database cluster j, which presents the closeness between them, is defined as the sum of these two parameters. If a minimum is found by utilizing new data i, we conclude that this data point fits candidate j. By definition both the candidate that has a high degree of concentration and the candidate whose has a clear linear distribution are considered at the same time. Further, according to the shapes of the clusters, we can balance the order of priority by adding weight coefficient. RESULTS: In order to verify the validity of the recognition algorithm, we substituted each feature vector of 70 feature vectors into i, and other 69 data into database to ensure that the test data is different from the training data. We were surprised to find that All experimental results matched the truth, namely, for each data i the rate is 100%. CONCLUSIONS: We proposed and validate experimentally a method to recognize individuals from gait with only 2 IMU sensors. The results are encouraging; and of great importance for both gait analysis and intelligent system development. We schedule to extend our database and to take into account external parameters that can affect gait.



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O.5.2 UPMOVE: a system for automatic classification of gait patterns

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BACKGROUND AND AIM: For humans, recognizing running, walking, shuffling or limping appears quite easy. By contrast, automatic classification of such patterns is much more difficult, but also necessary for objective assessment of gait. Because simple measures like step length and frequency are often not useful for classification, we developed a classifier system that integrates analyses of multivariate time series and state-of-the-art techniques for pattern recognition. The system is entitled UPMOVE: Unraveling Patterns of human MOVEments. METHODS: UPMOVE has been developed in Matlab. The main workflow consists of a feature extraction phase and a classifier phase. Feature extractors are methods that extract relevant measures from the data. From each data set, multiple features are extracted. Features can be simple measures such as step length and velocity, but also more complex measures like Lyapunov exponents, scaling exponents, and the eigenvalues of a principal component analysis are included. These features are then fed into a classifier, which assigns each data set to one of several classes, e.g., male vs. female or normal vs. specific pathologies. The classifier will be based on pattern recognition techniques and artificial neural networks. All methods are implemented as separate modules rendering the system flexible, easy to use and easily extendable.

To test UPMOVE, we employed various gait data, as diverse as multivariate recordings from amputees and CVA patients, and data containing walking-running transitions from experienced runners. These data sets contain different data modalities like force plate data, accelerometer data, 3D kinematics and respiration data. RESULTS: UPMOVE provides classification rates typically larger than 90%. These rates can be achieved even if only a limited amount of features and a simple classifier are implemented. We are confident that by adding more feature extractors and using more advanced classifiers, classification success rate will approach 100%, also for other types of gait data. CONCLUSIONS: UPMOVE has potential as a system for automatic classification of gait patterns. As a next step, input to the classifier can be varied in order to pinpoint information on which differences in gait are judged. UPMOVE is available open source via www.upmove.org. By choosing for an open source environment, we stimulate collaboration and future development. UPMOVE is easy to adapt and to be tailored for various demands by which it is very suitable for use in both the lab and the clinic.

O.5.3 Modifying human balancing response to support surface tilt by stroboscopic illumination

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BACKGROUND AND AIM: Stroboscopic illumination has been shown to enlarge spontaneous sway during quiet stance [1,2]. This effect has been attributed mainly to withdrawal of velocity information of visual self-motion perception. We now ask to what extent stroboscopic illumination affects the balancing response of healthy human adults during perturbed stance. This project is related to a recently published stance control model [3] that hypothesizes that humans use vestibular velocity information to compensate for support surface tilt. We now extend this hypothesis by postulating that visual velocity information improves this vestibular signal under normal illumination conditions (in terms of a better signal-to-noise ratio). This postulate predicts that the tilt response deteriorates in a graded way with stroboscopic illumination. METHODS: Six healthy subjects (3 males, 3 females; mean age 28 ± 3 yrs) were presented with pseudorandom tilts of the support surface in the sagittal plane (frequency range, 0.016-2.2 Hz). Motion of trunk in space (TS) and legs in space (LS) were measured opto-electronically (Optotrak® 3020). Center of mass (COM) was calculated thereof. The spectral characteristics of stimulus and responses (LS, TS, and COM; in addition COP) were analyzed in terms of Bode histograms. Subjects were tested twice in each of the following three conditions: "eyes open" (E-OPEN), "eyes closed" (E-CLOSED) and "eyes open with stroboscopic illumination" (STROB; 4, 8, 12, and 25 Hz; 100 µs pulse width). Model simulations were performed using Simulink/Matlab. RESULTS: E-CLOSED compared to the E-OPEN increased LS and COM excursions considerably (factor ≈1.5 in mid-frequency-range). In STROB at 4 Hz, LS and COM gain and phase curves resembled closely those of the E-CLOSED condition. Increasing STROB frequency improved the balancing, almost to the E-OPEN values at 25 Hz. These findings could be mimicked in the model simulations by modifying the scaling of the velocity dependent support surface estimate (factor 0.67 for E-CLOSED to 0.92 for E-OPEN). STROB effects on TS were qualitatively similar, but smaller. In addition, a phase reversal in E-OPEN compared to E-CLOSED was noted (mid- to lower frequency range of tilts). Modeling the findings requires an additional, unpredicted tendency to maintain a stable head position in space. CONCLUSIONS: The body COM findings support our hypothesis that visual velocity information improves vestibular velocity information in the estimation and compensation of support surface tilt. Balancing of upper body appears to include rejection of head rotation and translation as an additional control aim.

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O.5.4 Neuromechanics: understanding neural and muscular interaction determining physical performance in specific pathology and ageing

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BACKGROUND AND AIM: In ageing, the role of muscle in functional impairments, cognitive decline and mortality is increasingly being acknowledged. However, while loss of muscle strength was found to be up to about 30-50% by the age of 80 years (1), muscle mass seems to be relatively preserved (2). Muscle function is largely determined by the neural controller. The interaction between muscle/motor and nervous system/controller, i.e. neuromechanics, is constantly being shaped by daily life physical activity. Novel control engineering techniques allow for identification of causalities in aforementioned closed loop interrelations. METHODS: Neuromechanical properties can be identified from a system's reaction to precise force and torque perturbations applied by powerful haptic robot manipulators. System identification and neuromuscular modeling allow for quantification of the contribution of either motor and controller to system's performance. Application of different combinations of environmental condition and task allow for assessment of adaptive capacity and identification of controller involvement from low spinal to higher brain levels. RESULTS: Modulation of neuromechanical characteristics to provoking environmental conditions and tasks have been demonstrated. In patients with various pathology, diagnosis specific neuromechanical characteristics have been established. Muscular and neural interaction have been found to change with age CONCLUSION: Understanding the neuro-muscular interaction, i.e. neuromechanics is of vital importance to understand causal relations between neural and muscle function and actual physical performance in specific pathology, shaped by ageing. Insight in primary lesions and secondary compensation is the basis for understanding clinical implications of sarcopenia and goal directed therapy to improve disorders of posture and movement.

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O.5.5 Enhanced locomotor adaptation in the "broken escalator" after-effect using anodal tDCS.

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BACKGROUND AND AIM: The everyday experience of stepping onto a stationary escalator causes a stumble, despite our full awareness that the escalator is broken. In the laboratory, this 'broken escalator' phenomenon is reproduced when subjects step onto an obviously stationary platform (AFTER trials) having previously stepped onto a moving platform (MOVING trials), and attests to a process of motor adaptation. Given the critical role of M1 in upper limb motor adaptation, and the potential for

transcranial direct current stimulation (tDCS) to increase cortical excitability, our aim was to would increase the size and duration of the locomotor after-effect using anodal tDCS over M1 and premotor cortex. METHODS: Thirty healthy volunteers received either sham or real tDCS (anodal bihemispheric tDCS; 2mA for 15 minutes to induce excitatory effects over the primary motor and premotor cortex) at rest and prior to walking onto the moving platform. We used transcranial magnetic stimulation (TMS) to probe changes in cortical leg excitability before and after tDCS to M1 using different electrode montages, and simulated the current flow of tDCS on the human brain using a finite element computational model in these different tDCS montages. RESULTS: The real tDCS group (compared to sham) displayed larger trunk sway, and increased gait velocity in the 1st AFTER trial and a persistence of the trunk sway after-effect into the 2nd AFTER trial. Our TMS data show that tDCS induces excitability changes in lower limb motor cortex, with resultant enhancement of locomotor adaptation. Our computational model correctly predicted these neurophysiological changes in excitability. CONCLUSIONS: These TMS and locomotor findings support the use of direct current stimulation over motor and premotor regions to improve locomotor adaptation in patients with neurological gait disorders.

O.6 AGING I - COGNITIVE FACTORS, *Cosmos 3A*

O.6.1 Ageing of ankle proprioceptive control

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BACKGROUND AND AIM: Ankle proprioception is crucial for postural stability. This fact has recently been evidenced in a study showing that brain activity during ankle proprioceptive stimulation predicts balance performance in young and older adults. However, it is still not clear whether ankle proprioception is altered in older adults. We hypothesized the strong and unexplained discrepancies in the literature were related to different attentional costs associated to ankle proprioceptive control in young and older adults. We also hypothesized that the presumed age-related alteration of proprioceptive control was associated to an alteration of internal models. METHODS: To test the attentional hypothesis, one group of young adults and one group of older adults performed an ankle position matching task in single and dual-task paradigms with different difficulty levels of the secondary task to assess attentional costs associated to proprioceptive control in these populations. To identify the central mechanisms involved in the proprioceptive control, we proposed to assess the effects of ageing on internal models. To this aim, one group of young adults and one group of older adults performed the ankle matching task in two speed conditions (self-selected and fast). Error, temporal, and kinematic variables were used to assess the matching performance. RESULTS: Results showed that proprioceptive control was as accurate and as consistent in older as in young adults for a single proprioceptive task at a self-selected speed. However, performing a secondary cognitive task and increasing the difficulty of this task evidenced both a decreased matching performance and/or an increased attentional cost of proprioceptive control in older adults as compared to young ones. The results also demonstrated that internal models of proprioceptive control were altered in adult ageing. Behavioural expressions of these alterations were dependent upon the considered condition of speed. In the self-selected speed condition, this alteration was expressed through an increased number of corrective sub-movements in older adults as compared to young ones. This strategy enabled them to reach a level of end-point performance comparable to young adults. In the fast speed condition, older adults were no more able to compensate for their impaired internal

models through additional corrective sub-movements and therefore decreased their proprioceptive control performance. CONCLUSIONS: These results advocated for an increased attentional cost for proprioceptive control in older adults as compared to young adults which would presumably impact the postural stability. The present age-related alterations of ankle proprioceptive control also suggested a decreased resistance to attentional and speed stressors in adult ageing and supported the fact that proprioceptive control is involved in the frailty syndrome, i.e., a decreased resistance to stressors, which characterizes older adults.

O.6.2 Age, but not sit or stance, affects rapid reaching movement time to virtual objects in response to a simple or choice cue

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BACKGROUND AND AIM: Virtual reality (VR) technology is being used increasingly by clinicians for the assessment and treatment of sensori-motor and cognitive functions. Although off-the-shelf commercial VR environments aimed at the general population can be used for rehabilitation purposes, these systems are often not well suited to the specific needs of individuals with a variety of impairments. With recent advances in technology, affordable VR hardware and software that are more adaptable to the needs of different patient populations are becoming more readily available. The objectives of the present study were to investigate the reliability and validity of a novel VR environment - SeeMe. The specific aims of this study were to determine: 1. Test-retest reliability; 2. Age effect; 3. Effect of standing versus sitting in elderly adults. METHODS: The SeeMe system, which is based on portable video capture technology, was developed for the rehabilitation of subjects with a variety of impairments related to motor and balance control. The tasks involved reaching to virtual balls appearing in random order on the left and right side of a TV screen, connected to a computer, placed in front of the participant. The tasks were simple (SMT) and choice (CMT) upper extremity movement-time paradigms. In the SMT task, subjects were asked to touch each ball as soon as it appeared. In the CMT task, the participants were to touch only the smooth looking balls and avoid balls with spines. Total duration of each task was one minute. For the reliability study, 19 young, healthy male and female adults (age ± SD: 24.6±2.9 years) performed the tasks twice while standing, with one week between sessions. To determine age effect, 18 young female subjects (age ± SD: 24.9±2.7 years) and 16 older female subjects (age ± SD: 72.2±5.8 years) performed the same tasks as in the previous study. In the third study, a group of 22 elderly participants (age ± SD: 76.6±5.2 years), performed both the SMT and CMT tasks while sitting or while standing in a comfortable stance. RESULTS: The interclass correlation coefficients (ICC) for SMT and CMT were 0.717 and 0.564, respectively. ANOVA showed significant age, task, and interaction effects, indicating that not only are older subjects slower than younger adults in both simple and complex choice times, but the difference between SMT and CMT is greater in the older subjects. While CMT was longer than SMT in the third study as well, no differences were noted in older subjects between performance while sitting or standing. CONCLUSIONS: The studied VR environment is user friendly for both the operator and older adults, and demonstrates moderate to high test-retest reliability. While older adults respond more slowly, particularly when faced with a choice reaction, the need to maintain upward posture while maintaining a comfortable stance position does not challenge the older subjects sufficiently to affect movement time during stance.

O.6.3 Gait variability: the role of physical and cognitive functioning

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BACKGROUND AND AIM: The causes and consequences of gait variability in the elderly population are still unclear, since studies on this topic have yielded inconsistent results. For instance, some studies show that an increase in gait variability is related to an increased fall risk[1], while other studies interpret variability as a compensatory mechanism which reduces the fall risk [2]. One limitation of previous research on gait variability is that it mainly focused on the role of cognitive impairment, largely ignoring the possible influence of physical impairments. Our aim was to identify the role of cognitive and physical functioning on gait variability in three carefully selected subgroups of community-dwelling older persons. METHODS: Three groups were identified from an ongoing cohort study (TOS: Two step Older Screening) among community dwelling elderly (n=594, mean age 76.9 (SD=4.9); 43.7% male). The division in groups was motivated on cognitive and physical functioning. Cognitive functioning was measured with the Mini Mental State Exam (MMSE) and Frontal Assessment Battery (FAB). Physical functioning was measured with the Timed Up and Go Test (TUG), Short Physical Performance Battery (SPPB) and handgrip strength. Group I (n=12) was determined by participants who scored in the lowest quartile of all physical tests, but had no cognitive problems, as indicated by scores in the best half of the cognitive tests. Group II (n=9) scored in the lowest quartile of the cognitive tests and the best half of the physical tests. For comparison, Group III (n=79) consisted of participants whose scores on all cognitive and physical tests were in the best half of the cohort. All these participants underwent gait analysis at preferred walking speed on an 6.1m electronic walkway (GAITrite). Outcomes were coefficients of variation of step length, step width and step time (CV= 100*standard deviation/mean) and walking speed. Statistical analysis was conducted with MANOVA for variability measures with post hoc t-tests and independent-samples t-tests for walking speed (alpha=0.05). RESULTS: The groups differed significantly on variability measures ($p<0.001$), with larger variability for group I compared to II and III (step length, $p=0.016$ and $p=0.004$; step width, $p=0.016$ and $p=0.002$; step time, $p=0.045$ and $p=0.005$). There were no differences in gait variability between group II and III. Walking speed was significantly lower in group I compared to II and III ($p<0.001$) and in group II compared to group III ($p=0.009$). CONCLUSION: Our results demonstrate that increased gait variability is more evident in persons with poorer physical functioning than in those with cognitive problems. This highlights the need for further research on the causes and consequences of gait variability and, in turn, its role in the risk of falling.

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O.6.4 Thinking, gripping and standing: Multitasking in young and older adults depends on ecological validity of the performed tasks

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BACKGROUND AND AIM: Multitasking is a ubiquitous aspect of human behaviour essential for everyday function. In the present study we investigated the way young and older adults achieve multitasking of a task with high cognitive demands (working memory) and two sensorimotor tasks, one with low and one with high ecological validity, finger force control and postural control respectively. METHODS:

Participants performed the three tasks in single, dual (memory-force, memory-posture) and triple task (memory-force-posture) contexts. Results showed that working memory accuracy was reduced in dual-task performance with both sensorimotor tasks, suggesting that both force and posture performance require cognitive resources. RESULTS: However when cognitive and sensorimotor task demands were increased in the triple task context older adults prioritized postural control over force control and cognition presumable because of its higher ecological validity acquired in the context of preventing falls. CONCLUSION: Our results identify ecological validity as a key aspect of multitasking performance in older adults.

O.6.5 Poor trail making test performance is directly associated with altered dual task prioritization in 686 elderly

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BACKGROUND AND AIM: Deterioration of executive functions in elderly subjects is associated with changes in walking performance. This may be caused by limited cognitive flexibility and working memory, but also by altered prioritization of simultaneously performed tasks. To disentangle these options we investigated the associations between Trail Making Test performance - which specifically measures working memory and cognitive flexibility - and prioritization as measured with dual task costs. METHODS: Of the TREND study, 686 neurodegeneratively healthy elderly subjects (median age 64 years) were classified according to TMT performance [1]. Subjects with delta TMT values >58s were defined as poor performers (lowest tertile, N=233), with 36-58s as intermediate performers (N=226), and with<36s as good performers (highest tertile, N=227). The subjects performed a fast pace 20m walk under single task and dual task conditions (checking boxes [2], subtracting serial 7s [3]). Dual task costs (DTC, %) were calculated using the formula: (see file 'Formula for methods'). RESULTS: Compared to good (median 17%; range -16 to 43%; p<0.001) and intermediate TMT performers (17%; -38 to 58%; p=0.0006), poor TMT performers had higher DTC in the walking condition when subtracting serial 7s (20%; -6 to 59%). Interestingly, the proportion of the poor TMT performance group that made calculation errors under the dual tasking situation was lower than under the single task situation, but higher in the good TMT performance group (change of proportion in poor performers, -1.6%; in good performers, +3%; p=0.035). Box checking condition did not add relevant information. CONCLUSIONS: Under most challenging conditions, elderly subjects with poor TMT performance prioritize the cognitive task at the expense of walking velocity. This indicates that poor cognitive flexibility and working memory are directly associated with altered prioritization.

$$DTC = \left(1 - \frac{\textit{dual task speed}}{\textit{single task speed}}\right) * 100$$

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O.6.6 Are you paying attention? What walking and counting can tell us about ageing.

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BACKGROUND AND AIM: Walking, an apparently automatic physical activity appears to be directly linked to older adults' underlying cognitive function, such that less steady gait is associated with poorer cognitive ability. When a secondary cognitive task is performed while walking, the relationship is even more obvious. Most research into dual task (DT) gait and cognition focuses on walking outcomes for fall-prediction and fall-prevention. By contrast, the present study focuses on the cognitive aspects of the DT, firstly, by examining the impact on gait and cognition of increasing the attentional demands of the secondary cognitive task (counting backwards). Secondly, the study investigates older adult's ability to allocate attention, by instructing them to prioritise either walking or counting during the DTs. These aims will provide information about the availability of attentional resources and the flexibility in allocating attention between gait and cognition tasks. METHODS: Seventy-two older adults aged between 65 to 91 years (average age 73) performed a single walking (ST) task (15m) and two single counting tasks (counting backwards in 3s & 7s). These measures were compared with dual-task (DT) performance of walking and counting backwards in 3s and 7s (DT3s and DT7s) respectively. Separate conditions examined prioritising walking and counting during DT3s and DT7s: no prioritisation (NP), prioritising walking (PW) and prioritising counting (PC). The 'cost' of walking and counting simultaneously was examined by comparing ST and DT gait and cognition measures of gait variability (CV), gait velocity, correct cognitive responses and number of steps per response. The results of the gait and cognition measures were also compared with standardised tests of cognitive function, including working memory and attention. RESULTS: In this experiment, 2 independent variables of cognitive load and prioritising attention were manipulated and 4 dependent variables of gait and cognition were measured. Both increase in cognitive load plus instructions to prioritise had significant effects on walking and counting measures. When the cognitive load was greater (DT7s), and participants were instructed to prioritise walking, not only did gait improve but, unexpectedly, the number of correct cognitive responses increased. EF measures associated with DT cognitive responses and with DT gait measures. In addition, EF, particularly working memory/attention, significantly correlated with participants' ability to prioritise walking and counting. CONCLUSIONS: The findings suggest that, with older adults, increasing cognitive load reduces attentional capacity and that prioritising either gait or cognition provides a sensitive measure of flexibility in allocating attention. In the DT condition (PW), gait steadied and cognitive performance improved suggesting that an intervention strategy could be adopted to maximise older adults' gait and cognition.

O.7 COORDINATION OF POSTURE AND GAIT, *Living 4*

O.7.1 Coordination of the head with respect to the trunk and pelvis in the roll and pitch planes during quiet stance

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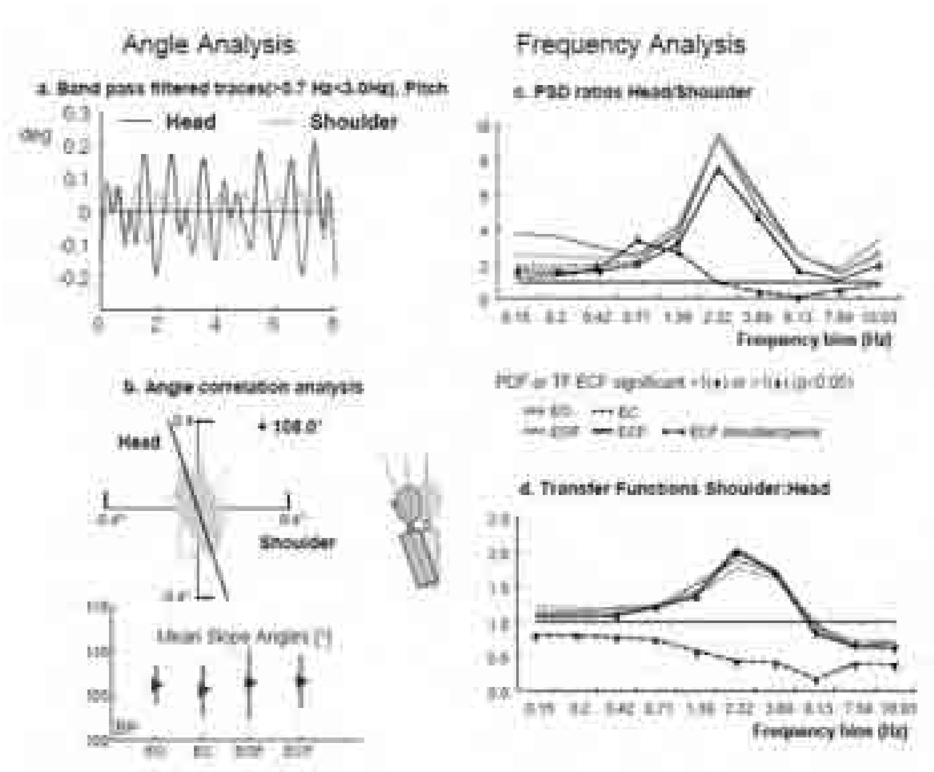
BACKGROUND AND AIM: The aim of this study was to examine the relationship between head and trunk sway of normal subjects during different sensory conditions of quiet stance and to compare this relationship with that of the pelvis to the trunk. METHODS: Sixteen younger and 14 elderly healthy subjects participated, performing four tasks: standing quietly on a firm or foam support surface, with eyes open or closed with feet shoulder width apart. Data was recorded with 6 body-worn gyroscopes; a set of 2 mounted at the upper trunk (SwayStar) and an identical set at the hips, and another lighter but less accurate set (XSens) on a head band. The roll and pitch angular velocities recorded with each set were spectrally analysed and integrated for angle correlation analysis in three frequency bands: below 0.7Hz (LP), above 3 Hz (HP) and in between (BP). RESULTS: Across sensory conditions, greater head than trunk motion was observed in angle correlations, power spectral density (PSD) ratios, and transfer functions (TFs), except for frequencies below 0.7Hz (see figure). Low frequency (<1Hz) head motion was supra-threshold for perception of linear accelerations by the otolith system, and head motion above 0.7Hz supra-threshold for perception of angular accelerations by the semi-circular canal system. The amplitude of head motion varied little across sensory conditions, pelvis motion considerably. Head on trunk angle correlations revealed a low-frequency (<0.7Hz) in-phase mode, an anti-phasic mid-frequency resonant mode (see figure a&b), and a head motion on fixed trunk high-frequency (>3Hz) mode. Head motion relative to the shoulders peaked at ca. 3.7 Hz for roll, 2.3 Hz for pitch in PSD ratios and TFs, and increased again for high frequency roll above 8 Hz. Pelvis to head coherence was less than that of the trunk to head coherence, particularly in roll. Low frequency pelvis to shoulder TFs were less than 1 and even less for high frequencies consistent with previously reported in-phase and anti-phase movements between these two segments. No statistically significant between-group differences were found in trunk to head movement strategies. CONCLUSIONS: This data indicates that during quiet stance body motion increases in order of pelvis, trunk, head, with head motion supra-threshold for the vestibular system. These findings suggest that regulation of quiet stance involves control of at least 2 separate links: trunk on pelvis, head on trunk, and possibly head biomechanical resonance. Each link has two modes of movement, in phase and anti-phase. Based on angular velocity criteria described here, the head is only locked to the trunk for low frequency motion. It is not stabilised in space during stance, rather the pelvis is.



O.7.2 Are postural responses to backward and forward perturbations processed by different neural circuits?

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BACKGROUND AND AIM: Reaction times can be accelerated when a startling acoustic stimulus (SAS) is delivered at the same time as the imperative cue in a simple reaction time task. This so-called 'StartReact' phenomenon has been demonstrated for tasks involving trans-cortical circuits; it has been explained by the SAS directly releasing a prepared motor program at subcortical level[1]. In contrast, automatic postural responses presumably arise from the brainstem, which raises the question whether the StartReact phenomenon also applies to postural responses. To investigate the role of a SAS on postural responses we formulated four questions: (1) can a SAS expedite automatic postural responses; (2) is the effect different between forward and backward perturbations; (3) when the perturbation direction is known in advance or not; (4) for low and high magnitude perturbations? METHODS: Eleven healthy young participants stood on a support-surface platform that was suddenly translated forward or backward, resulting in a balance perturbation. Perturbations trials were applied in blocks either with or without advance knowledge of perturbation direction. These blocks of perturbations were delivered both at low (0.5 m/s2) and at high (1.75 m/s2) perturbation magnitude, thereby evoking feet-in-place and stepping responses, respectively. In 25% of balance perturbations the perturbation was combined with a SAS. RESULTS: Combined with a SAS, anterior tibial responses to backward perturbations were expedited by on average 13 ms ($p<0.001$), irrespective of perturbation magnitude and prior knowledge

of the perturbation direction. This acceleration coincided with a 15% smaller backward trunk displacement (p = 0.002) in feet-in-place responses. SAS did not shorten gastroc latencies during forward perturbations. Participants responded faster in high than in low-magnitude perturbations (p<0.001), but this effect was larger for anterior tibial responses in backward perturbations than for gastroc responses in forward perturbations (differences of 13 and 4 ms, respectively, p = 0.002). CONCLUSIONS: This study demonstrates that a SAS accelerates postural responses to backward perturbations in parallel with an improvement in postural stability. These results may be explained by the SAS directly releasing a stored motor program for backward perturbations, or, by the SAS increasing the excitatory drive in the involved neural circuits. Interestingly, the effect of the SAS was not observed in forward perturbations and the effect of perturbation magnitude was also different between perturbation directions. Therefore, we raise the question whether postural responses to backward and forward perturbations are being processed by different neural circuits, with an involvement of startle pathways in postural responses to backward perturbations.

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O.7.3 Posture during relaxed standing is controlled intermittently rather than continuously

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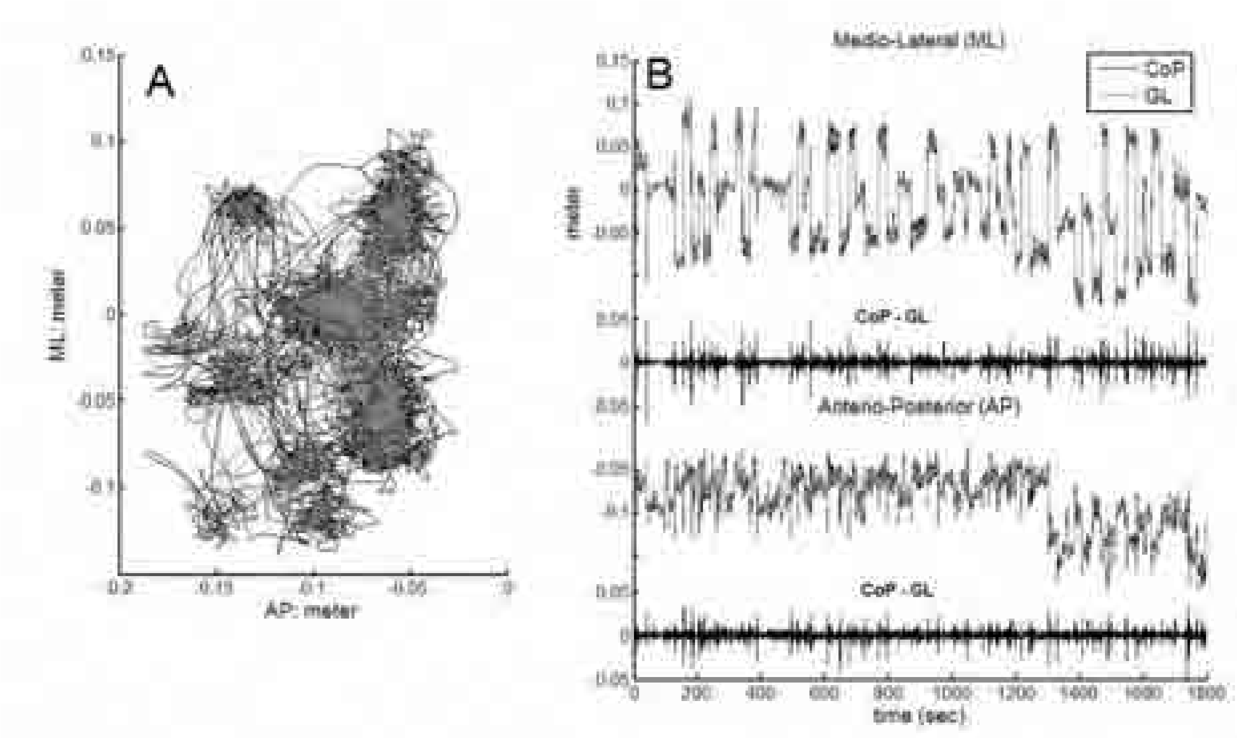
BACKGROUND AND AIM: In most research on postural sway, subjects are instructed to stand as still as possible while center of pressure data are collected over a short time interval, typically shorter than 1 minute. Relatively little is known about postural sway during relaxed standing over longer time intervals. The aim of this study was to quantify temporal change in the Center of Pressure (CoP) and vertical projection of Center of Mass (GL) during relaxed standing by analyzing their structure of variability [1]. METHODS: Nine healthy young adults stood for 30 minutes on an AMTI force platform in a relaxed position. 3D force and moment data were collected at 50 Hz and used to calculate CoP and GL traces. Multifractal detrended fluctuation analyses were applied to both the GL and the residual CoP-GL traces. RESULTS: Most subjects displayed multi-region standing (see Figure 1A) with frequent shifts in GL traces (i.e., shifts in posture). Furthermore, intermittent variation in the residual CoP-GL traces coincided with shifts in posture (see Figure 1B) and was defined by interactions across temporal scales (i.e., multifractal variations in both GL and CoP-GL traces). CONCLUSIONS: The alignment of the intermittent variation in CoP-GL traces and the shifts in posture (i.e., GL trace) indicates that these variables are not independent concepts of postural control as assumed in previous reports. Furthermore, these results indicate that posture during relaxed standing is controlled intermittently rather than continuously through interactions across temporal scales. Fig.1 Representative example of CoP (black) and GL (grey) stabilograms (A) and time series (B). The residual CoP-GL traces are displayed below the CoP and GL traces.



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O.7.4 Abdominal muscle weakness is the key determinant of postural instability in patients with Facioscapulohumeral muscular Dystrophy

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BACKGROUND AND AIM: Facioscapulohumeral muscular dystrophy (FSHD) affects approximately 350.000 people worldwide and thereby represents the third most common inherited neuromuscular disorder. It is a slowly progressive myopathy that primarily affects the facial muscles and the muscles of the shoulder girdle (1). If the trunk and lower extremity become involved, patients develop postural instability, which has a great impact on overall functioning, as reflected in a tremendously increased fall rates (2). This pilot study was conducted to identify the key determinants of postural instability in patients with FSHD. METHODS: Ten patients in different stages of disease severity (Ricci 3 - 4,5) participated in the current study as well as ten age and gender matched controls. Muscle involvement of the trunk and lower extremity was assessed with T1 based MRI images. Fatty infiltration was scored for all muscles of the trunk and lower extremities on a semi-quantitative scale. Postural stability was assessed on a moveable platform. Forward and backward perturbations were applied by platform translations in a random order. The acceleration was increased in steps of 0,125 m/s² until the subject could no longer withstand the perturbation without stepping or grabbing. A maximum of three attempts were allowed at each level. The stepping threshold was determined as the maximum acceleration intensity that was sustained without changing the base of support. RESULTS: Stepping thresholds were significantly lower in patients with FSHD compared to the controls for both forward and backward

perturbations (table 1). Linear regression analysis revealed that the degree of fatty infiltration of the rectus abdominus (RA) and tibial anterior muscles (TA) was inversely related to the stepping threshold in backward perturbations (R=.94, p=.001). The beta value for the contribution of RA was almost three times higher than for TA (RA, â= -0.194; TA, â = -0.067). In the forward direction, the degree of fatty infiltration of the back extensors and the abdominals combined was associated with the stepping threshold (R=.67, p=.035). CONCLUSION: The present results suggest that trunk muscle weakness, particularly of the RA, plays a key role in sagittal-plane postural instability in FSHD. The distinct, but variable contribution of this muscle to the synergy recruited during anterior/posterior perturbations has previously been demonstrated (3-5), but this study provides direct evidence for the debilitating consequences of severe loss of RA strength. As a clinical implication, FSHD patients may benefit from external trunk support to help them maintain upright balance.

Table 1.

Stepping thresholds	Controls	FSHD	Sign.
Forward	**1,33** ± 0,25	**0,86** ± 0,35	p<0,01
Backward	**0,85** ± 0,16	**0,50** ± 0,27	p<0,01

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O.7.5 Proximal lower limb muscle energetics and the adaptation of segment elevation angle phasing for obstacle avoidance

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BACKGROUND AND AIM: Using the planar law of intersegmental coordination [1], results have shown increases in the phase difference between the thigh and shank segments as well as increases in elevation angle ranges when stepping over higher obstacles [2]. However, little attention has been given to the relationships between such intersegmental coordination and joint energetics. The purpose of this study was to gain a better understanding of segmental phase shifting for obstacle avoidance and the role of mechanical muscle power to the reorganization of segment elevation angle trajectories during adapted locomotion. METHODS: Ten healthy young adults stepped over obstacles in which the height (level walking, 10 or 20% of leg length) was adjusted. A Fourier series was used to represent segment elevation angle trajectories and further used to quantify segment phase shifting with respect to heel contact. The mechanical work done by the knee (K5), and hip (H3 and H3D in the trailing limb) flexors were estimated using a linked segment model. RESULTS: The phase lead of the thigh fundamental harmonic increased with obstacle height in the leading limb while the phase lag of the shank fundamental harmonic increased in the trailing limb. A strong correlation was shown between H3 power burst onset and the initiation of thigh elevation angle forward motion in the leading but not the trailing limb. As well, similar relationships between K5 power burst and the initiation of shank elevation angle

forward motion were shown in the leading and trailing limbs. CONCLUSIONS: The fact that thigh-shank elevation angle phase difference is due to different strategies for the leading and trailing limbs provides further evidence that each limb may be controlled by separate neural oscillators as previously suggested [3]. The strong correlation between the timings of elevation angle peaks and muscle power onsets suggest that such muscle powers may be specifically important to the temporal organization of leading limb segment elevation angle trajectories. However, these relationships were not as strong in the trailing limb, which may indicate that intersegmental forces crossing the knee play a greater role in determining the temporal changes in segment elevation angle trajectories. The results here suggest drastically different roles for joint energetic patterns between leading and trailing limbs while there is a simple, organized pattern of phase shifting between the thigh and shank segments. It thus appears more logical that the CNS may control limb trajectory based on segment elevation angle movement with muscle energetics subservient to the required phase shifting between segment trajectories.

ACKNOWLEDGEMENTS:
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O.7.6 Intra- and inter-personal postural coordination during rhythmic sway: Effects of haptic contact and dance expertise

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BACKGROUND AND AIM: Humans coordinate their rhythmic actions with those of others in an intuitive way when maintaining visual contact [1]. Spontaneous interpersonal synchrony is also mediated by fingertip contact during rhythmic sway in the sagittal plane [2]. In this study we asked how haptic contact and the emergent interpersonal synchrony affect the ankle-hip coordination of expert dancers and novice participants swaying in pairs under self and externally paced conditions. METHODS: Eighteen expert dancers (n = 18, age: 24.5±3.43 years, height: 175.8cm) and 18 novice participants (n=18, age: 24.9±6.6 years, height: 175.6cm) stood on adjacent force plates swaying rhythmically under two task conditions: a) no contact b) light fingertip contact between partners. Sway was either Self-Paced (SP) or externally paced by a metronome (MP, 0.25 Hz). The ankle and hip kinematics of the two partners were recorded using a 6 DoF magnetic tracking system (Nest of Birds). Intra- (ankle-hip) and inter-personal (hip - hip) coordination was assessed in the frequency domain using cross-spectral analysis to determine the degree of coherence and phase spectra of the two signals. The effect of group, fingertip contact and pacing on the ankle-hip and hip-hip coherence was evaluated using a 2(Group) x 2(Contact) x 2 (Pacing) RM ANOVA. A 2(Group) x 2(Contact) x 2(Pacing) x 9 (RP region) RM ANOVA was used to assess changes in the distribution of the Relative Phase (RP) angles across nine 20o phase regions (from 0o to 180o). RESULTS: The analysis revealed that in SP sway, fingertip contact induced a significant increase in the degree of coherence ($F(1,16) = 16.668, p<.001$) and the concentration of relative phase angles in the 0o to 20o phase region ($F(2,128) = 30.113, p<.001$) indicative of in-phase entrainment between the hip-hip sway signals. Analysis also revealed a consistent in-phase ankle-hip relationship that was not affected by contact or the pacing stimulus. However expert dancers showed a higher degree of ankle-hip coherence than novices (F(1,16) =7.71,p<.001). CONCLUSIONS: These results confirm and extend our previous findings that tactile contact at the fingertip can stabilize the spontaneous interpersonal coordination of two individuals swaying rhythmically in the sagittal plane. The robust ankle-hip in phase coupling suggests a force feedback mechanism in which the fingertip acts as a communication link for the sway changes produced by the feet-support surface interaction. Dance expertise contributes to a more stable intra-personal postural organization.

ACKNOWLEDGEMENTS:
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O.8 FALLS & FALLS PREVENTION I – PREDICTION, *Cosmos 2*

O.8.1 Association of executive function impairment, history of falls and physical performance: A cross-sectional elderly population-based study in Eastern France

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BACKGROUND AND AIM: Falls in older adults are a major public health concern and an emerging area of interest is the role of impaired cognition that disturbs higher levels of control of balance and gait on fall risk. Postural stability is a complex skill involving the coordination of motor and sensory systems in perceiving environmental stimuli and responding to perturbations to control body movement. Executive function (EF) is required for planning movements, divided attention and responding to changes within the environment. The objectives of this study were to estimate: 1) the prevalence of impaired EF evaluated using the Clock Drawing Test (CDT), 2) the association between impaired EF and falls, and 3) the association of impaired EF and physical function performance measures used in the evaluation of fall risk. METHODS: Cross-sectional study of 5097 older adults without dementia who received a comprehensive geriatric assessment between July 2008 and December 2010. The geriatric assessment included cognitive testing, physical performance testing (Timed Up & Go Test (TUGT) and grip strength), and self-report of a history of falls in the previous 12 months. A modified Poisson regression was used to evaluate the association between impaired EF and falls (any fall, recurrent falls, serious fall-related event). Multivariable linear regression was used to evaluate the association between impaired EF and each of the physical function measures of the TUGT and grip strength. RESULTS: Using the CDT, 25% of the sample was identified as having impaired EF. The prevalence of a history of falls in the previous year was 29% for the whole sample, but 27% and 35% among those with and without abnormal EF respectively. People with impaired EF also reported a greater number of recurrent falls (12 % vs. 8%). In the adjusted modified Poisson analysis, impaired EF was associated with any fall [RR=1.13, 95%CI (1.03, 1.25)], serious fall-related events [RR=1.30, 95%CI (1.02, 1.66)], but recurrent falls was not significant [RR=1.13, 95%CI (0.93, 1.37)]. In the adjusted linear regression, impaired EF was associated with a longer time to complete the TUG, indicating a worse performance, and diminished grip strength compared to people with normal EF. CONCLUSIONS: Impaired EF in the absence of dementia was

prevalent, one quarter of studied sample of community-dwelling older adults, and has a strong association to falls, fall-related injuries and decreased ability on physical performance testing. The use of the clock drawing test is a reliable and easy to administer EF test that can be used routinely in comprehensive fall risk evaluations.

O.8.2 Poor executive function predicts future falls among healthy older adults: Findings from a 5 year prospective study

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BACKGROUND AND AIM: Executive function (EF) plays a critical role in the regulation of gait, especially under complex and challenging conditions. However, it is not yet fully clear if EF can be used to augment fall risk stratification and whether EF changes precede and hence predict falls in older adults. The purpose of this study was to evaluate if reduced EF is a risk factor for future falls. METHODS: 256 community-living, healthy older adults (mean age: 76.4±4.5 yrs; 61% women) participated in a prospective study designed to follow the subjects for at least 5 years. At baseline, subjects were cognitively intact and had good mobility. A computerized cognitive battery generated an index of EF, attention, a closely related construct, and other cognitive domains. Gait was assessed during single and dual task conditions. Falls data were collected using monthly calendars. Negative binomial regression quantified risk ratios (RR). RESULTS: The median follow-up was 53 months. Performance-based tests of mobility and gait predicted future falls. After adjusting for age, gender and a previous history of falls, only the EF index (RR: 0.85; CI: 0.74-0.98, P=0.021), the attention index (RR: 0.84; CI: 0.75-0.94, P=0.002) and dual tasking gait variability (RR: 1.11; CI: 1.01-1.23; P=0.027) were significantly associated with future falls. Other cognitive function measures were not related to falls. Survival analyses indicated that subjects in the worst EF quartile were more likely to fall sooner and more likely to experience multiple falls during the 66 months of follow-up (P=0.017). CONCLUSIONS: Poorer EF and attention increase the risk for future falls, even as much as 4 years later. Screening and, perhaps, treatment of EF and attention apparently have the potential to reduce the risk of falls among older adults.

O.8.3 Response to unexpected balance perturbations under dual-task conditions is predictive of falls in older people

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BACKGROUND AND AIM: Appropriate stepping responses to unexpected balance perturbations are important to control balance and prevent falls. Inappropriate stepping is more prevalent in older people and those at risk of falling. The ability to respond to balance disturbances is likely to rely not only on sensory and motor systems, but psychological factors including central processing speed and executive functioning. This study examined physiological and neuropsychological factors in relation to reactive stepping and falls in older people. METHODS: Participants comprised 242 older adults (average age 80.0±4.4 years, 46% female). Unexpected pull perturbations of controlled force were delivered at the level of the pelvis for 0.5sec with varying magnitude and direction. A dual-task condition involved a backwards-by-7 counting task. Sensorimotor (strength, balance, reaction time, proprioception and vision) and neuropsychological assessments (Digit Symbol Substitution and Trail Making A and B tests) were conducted. Prospective falls data were collected for 12 months. RESULTS: Force thresholds for stepping were related to postural sway, strength and reaction time performance and were predictive of future falls ($p>0.048$). Participants who responded with multiple steps to anterior perturbations were nearly twice as likely to fall than those who responded with a single step (RR=1.89 95%CI=1.09-3.28). Participants whose stepping thresholds were reduced in the dual-task condition (affected) were over 4 times more likely to have an injurious fall in the following 12 months (RR=4.13, 95%CI=1.50-11.41) than those who were unaffected. The affected group had poorer postural sway ($F_{1,147}=4.43$, $p=0.037$) and scored worse in Digit Symbol Substitution ($F_{1,139}=4.08$, $p=0.045$), Trail Making B-A ($F_{1,149}=5.84$, $p=0.017$) tests compared to unaffected participants while controlling for age, gender and education. CONCLUSIONS: Older adults whose stepping thresholds to unexpected balance perturbations were affected in the dual-task condition were more likely to fall. The role of neuropsychological functioning appears important in maintaining balance while attention is divided.

O.8.4 How to prevent falling in an unstable environment: Gait adaptations in response to balance perturbations

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BACKGROUND AND AIM: It has frequently been proposed that lowering walking speed is a strategy to decrease the probability of falling [1]. However, studies on the margins of stability (MoS) during gait predict that a decrease in walking speed would decrease the MoS in backward and sideward directions [2-4], as a result the probability of falling in these directions will increase. Besides, studies that investigated the effect of decreased walking speed on local dynamic stability (LDS) found inconsistent results [1, 5]. These findings question whether slowing down is really a strategy employed to reduce the risk of falling. Therefore, the purpose of this study was to investigate whether and how healthy people adapt walking speed in response to a balance perturbation, and assessed the effect of changes in walking speed and underlying step parameters on local dynamic stability and margins of stability. METHODS: Nine healthy subjects walked in a Computer Assisted Rehabilitation ENvironment (CAREN), while continuous quasi-random medio-lateral (ML) translations of the walking surface at four different intensities were imposed. The self-paced option of the system was used, which enabled subjects to regulate their walking speed throughout the trials. Besides walking speed, the effect of the perturbations on step length, step frequency, and step width, was measured. To quantify the probability of falling, LDS in terms of the short-term Lyapunov exponent (?s), and MoS in sideward and backward direction were calculated. MoS were computed as the distance between the edge of the base of support (defined by the lateral malleolus of the leading foot) and the extrapolated centre of mass (XCoM) at initial contact[2]. RESULTS: No significant change in walking speed in response to the balance perturbations ($p=0.118$) was found. But, subjects made shorter, faster, and wider steps ($p<0.01$) with increasing perturbation intensity. Subjects became locally less stable ($p<0.01$) in response to the perturbations, but increased their MoS in sideward ($p<0.01$) and backward ($p<0.01$) direction. CONCLUSIONS: In conclusion, the results of the present study indicate that the strategy of choice to cope with ML balance perturbations is not a reduction of walking speed, but rather a combination of decreased step length and increased step frequency and step width. The adaptations in step parameters

did not prevent LDS to decrease, with increasing perturbation intensity, but did cause a significant increase in MoS in backward and sideward direction. Because no falls occurred, the results suggest that subjects created a sufficiently wide margin within which LDS can decrease, without leading to an actual fall.

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O.8.5 Falls in Australians living with Parkinson's disease: When, where and how?

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BACKGROUND AND AIM: Falls occur in over 50% of people with Parkinson's disease (PD), with important physical and psychosocial sequelae. Less is known about the circumstances of falls. This study aimed to report the profile and characteristics of falls over a 14 month period in 210 people with Parkinson's disease. This knowledge may be useful to inform falls risk interventions. METHODS: 210 ambulant people with idiopathic PD were recruited into a clinical trial of physiotherapy [1]. Baseline clinical assessment recorded age, disease duration, disease severity (modified Hoehn & Yahr stage, Unified Parkinson's Disease Rating Scale), freezing of gait (Freezing of Gait Questionnaire) and falls self-efficacy (Falls Efficacy Scale-International) for a 14 month period. Falls data were captured via a standard monthly Falls Calendar and a dedicated falls telephone line. When a fall occurred, participants marked the calendar and called the telephone hotline for a structured interview, to identify falls time, location, likely mechanism, fall direction, current medication status and consequence. RESULTS: The participants were 140 men, 70 women, with a mean (SD) age of 67.9 (9.6) years, with mild to moderately severe PD, (median mHY stage of 2.5) and mean (SD) disease duration of 6.7 (5.6) years. 125 participants (60%) fell, with 90 people falling 2 or more times. 1838 fall incidents were reported, with detailed descriptions available for approximately 45% of falls. Of the falls with known circumstances, 62% occurred indoors, with 85% occurring at home (either indoors or on the home property). Most falls occurred in the morning or afternoon (42%, 37% respectively), with few occurring in the evening (18%) or overnight (3%). Fall direction varied, with 51% of falls occurring forward and 28% backwards. The most frequently self reported causes were loss of balance, tripping or freezing of gait, accounting for 70% of the detailed falls. On 80% of fall occasions, participants reported their medication status as "ON, with medication working well". Significant between-group differences showed that the people who fell had more severe disease, and greater motor impairment (UPDRS III) and activity limitations (UPDRS II). The falls group experienced greater difficulty with freezing of gait, and were more concerned about falling. Age and disease duration did not differ between groups. CONCLUSIONS: Falls occurred commonly in this group of ambulant people with PD. A greater understanding of typical falls and contributing factors may guide falls risk interventions. Given the high number of falls at home, consideration of home-based interventions may be appropriate.

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O.8.6 The descent phase of falls: neuromuscular and mechanical factors

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BACKGROUND AND AIM: A better understanding of what happens during an unintentional fall is relevant in preventing their occurrence. A fall is due to a failure of compensatory reactions to recover from postural perturbations during the descent phase, which starts at the subject loss of balance point and lasts for 700-1000 milliseconds. The aim of this study was to compare the biomechanical and muscular behavior during the pre-impact phase of non-recoverable falls and successful recovery trials. In such a challenging task, we hypothesized that the constraints imposed by the biomechanical properties ultimately determine the ability to trigger efficient muscle activities. METHODS: Full body 3D kinematics and associated muscle activities were collected in 20 young healthy subjects during fast and slow unpredictable multidirectional support-surface translations. The perturbation velocities were selected so that successful recovery occured in milder trials whereas fast trials were sufficiently challenging to trigger non-recoverable falls. Analyses focused on the spatial and temporal characteristics of the CoM, angle variations, EMG onset latencies and amplitudes across each trial and muscle. Moreover, a 17-segment personalized model was created, based on stereoradiographic images to assess subject-specific geometry and inertial parameters. The simulated falls allowed to discard the contributions of the inertia-induced vs. neuromuscular components of the response. RESULTS: The fall could be divided in 3 phases. For 200ms following perturbation onset, the head remained stable versus space. Then, despite the fact that automated postural responses(APR) started at 80ms after perturbation, the body trajectory appeared to be driven by its biomechanical properties. Later, muscle activities influenced the body trajectory, which consequently differed on a trial-to-trial basis. The simulation was in good agreement with the experimental results. Besides, a larger muscle coactivation could be responsible for the stiffening behavior observed in falling subjects whereas subjects rather coordinated multi-segmental movements in successful stabilization CONCLUSION: During a fall, the subjects prepared to the impact on the basis of sensory information that were not redundant but available in a sequential order: proprioceptive afferents being first as the vestibular and visual information continued to signal a stabilized head in space. It contributes to explain the detrimental effect of age-related declines in proprioception. Our results also suggest that a 300ms inertial passive phase does not allow a large spatiotemporal window for compensatory reactions to occur. These time delays permit voluntary reactions to play an important role very early in the fall. Indeed, the subject's recovery could not only depend on the APR occuring in the first~80-140ms. This quantitative description of the pre-impact phase of fall may help in designing more effective strategies to prevent their occurance.

O.9 NEUROLOGICAL DISEASES II – STROKE, *Cosmos 3A*

O.9.1 Assessing the interaction of respiratory and locomotor systems post-stroke: from physiology to rehabilitation

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BACKGROUND AND AIM: Respiratory and locomotor dysfunctions occur post-stroke as a result of neurological deficits. Whereas breathing and walking cycles are controlled in a coordinated fashion among healthy individuals, little information exists regarding the extent to which the respiratory cycle interacts with the gait cycle following a stroke. The aim of this pilot study was to investigate the interaction of deep volitional breathing on the temporal distance gait characteristics of individuals post-stroke. METHODS: Five individuals post-stroke with gait difficulties and five healthy age- and sex-matched controls performed one session of four randomized walking trials on a self-paced treadmill while viewing a virtual reality scene. For each 2 minute trials, participants were instructed to walk either at a comfortable or fast walking speed combined with either regular or deep breathing. Participants' respiratory data was captured with a pneumotachograph and trials were recorded using a 3-D gait VICON Motion Capture System. The parameters of interest were tidal volume and respiratory time along with gait velocity, cycle duration, total double limb support duration, step length and cadence. RESULTS: Post-stroke participants significantly increased gait velocity of paretic limbs (p=0.045) and step length of non-paretic limbs (p=0.047) in response to deep breathing. Although all other changes were non-significant among both groups, decreases in post-stroke participants' total double limb support durations and gait cycle durations with deep breathing were observably greater than changes among healthy controls. Tidal volumes among post-stroke participants did not significantly increase with deep breathing. CONCLUSIONS: Volitional deep breathing affects locomotor systems post-stroke. Further investigation is required to determine the mechanisms responsible for these findings and to assess the interaction between volitional deep breathing and walking balance post-stroke in order to possibly include deep breathing as an intervention in stroke rehabilitation.

O.9.2 The influence of balance support on the metabolic cost of walking in stroke patients during overground and treadmill walking

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BACKGROUND AND AIM: Stroke patients often suffer from a highly increased energy cost of walking 1. Previous research suggests that balance control, which is an essential prerequisite for safe and independent walking, and is often impaired in stroke patients, could be an important contributing factor to this increased energy cost 2-3. In this study we examined the effect of impairments in balance control on energy cost of walking, by investigating the effect of balance support on energy cost during treadmill and overground walking in stroke patients with varying degrees of walking ability. METHODS: 18 stroke patients participated in this study (mean age 50.3 years; 7 females). Of these, 6 subjects relied on a walking aid in daily life (aided walkers), whereas 12 subjects did not (unaided walkers). All subjects completed four 5-minute walking trials at preferred walking speed: (1) supported overground walking with a cane, (2) unsupported overground walking, (3) supported treadmill walking using one handrail, and (4) unsupported treadmill walking. Energy cost (J/kg/m) was calculated from oxygen consumption data, collected with a pulmonary gas exchange system. Gait and balance control parameters were obtained from force plate data (during treadmill trials) and accelerometer data. RESULTS: Treadmill walking resulted in a significantly higher energy cost than overground walking during both supported and unsupported walking. On the treadmill energy cost was on average 19% lower while walking with

handrail support compared to unsupported treadmill walking. This decrease was larger for aided walkers compared to unaided walkers (23% vs 16%). Providing support during overground walking did not result in significant changes in energy cost for the whole group. However, aided walkers showed a trend towards an 8% decrease in energy cost due to support (non-significant), whereas unaided walkers showed a slight but significant increase (5%) in energy cost during supported compared to unsupported overground walking. CONCLUSIONS: Results indicate that part of the increased energy cost observed during walking after stroke originates from impaired balance control. Subjects with a lower walking ability (aided walkers) benefit most from support, whereas unaided walkers even suffered from detrimental effects on energy cost of support during overground walking. Both the energy cost of walking and the effect of support on energy cost of walking were higher on the treadmill, implying that treadmill walking places higher demands on balance control. The correlation of differences in energy cost between conditions with measures of balance control during walking is currently under investigation.

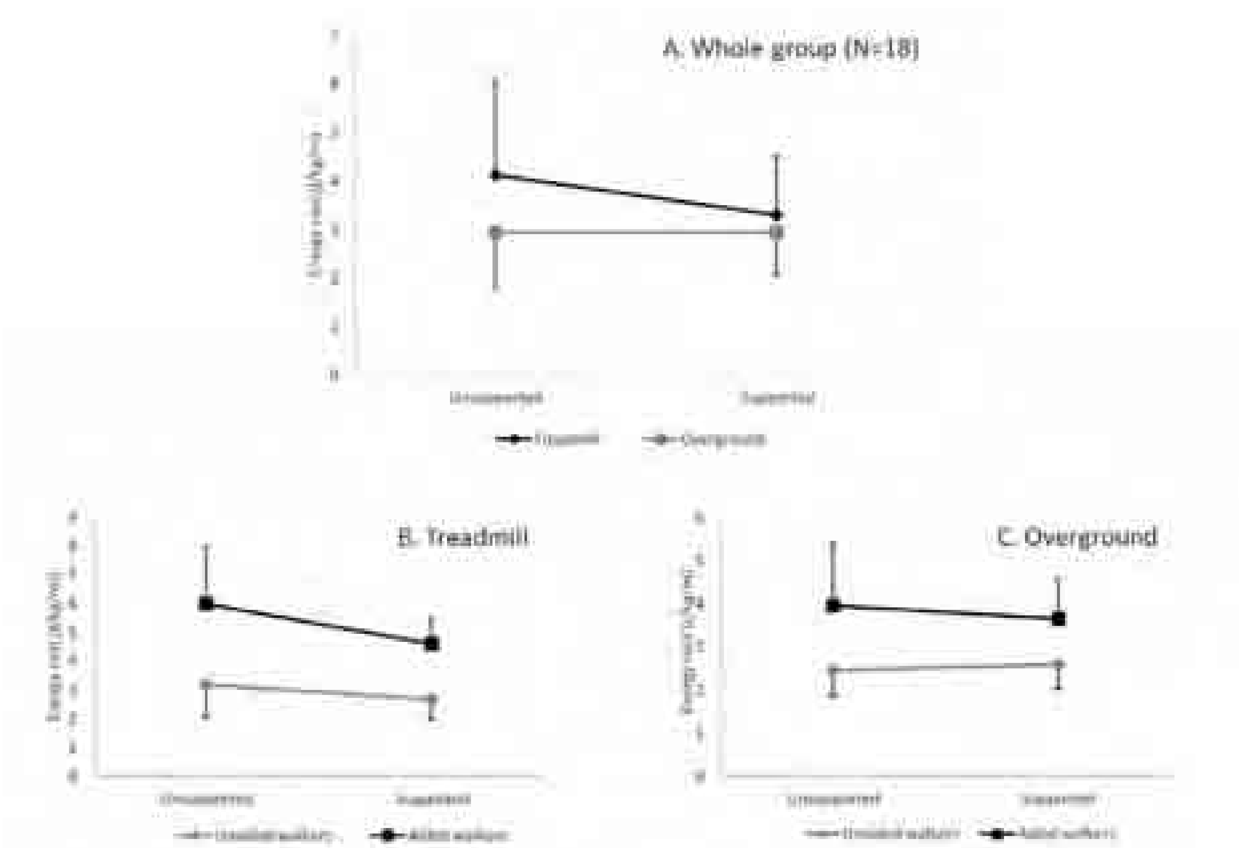

Figure 1. Effect of support on energy cost of walking (J/kg/m) for the whole group on treadmill and overground (A), differences in effect of support on energy cost for aided and unaided walkers on treadmill (B), and overground (C).

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O.9.3 Persons post stroke are faced with a reduced ability to incorporate step modifications in an ongoing gait pattern

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BACKGROUND AND AIM: The ability to adjust gait to environmental circumstances is a prerequisite for safe ambulation. In persons post stroke, an impaired ability to modify gait may contribute to their elevated risk of falling. In this study, we investigated the ability to restore normal gait after a step modification in persons post stroke. We expected that these persons require more steps to return to steady state gait than healthy controls, reflected in more persistent deviations in step length, step time, and hip kinematics in the post-crossing steps. METHODS: Twenty persons in the chronic phase (>6 months) of stroke (aged 54.1±11 years) and 20 age-matched healthy controls were included. Participants were instructed to avoid obstacles that were suddenly released in front of the paretic leg (stroke) or the left leg (control) while walking on a treadmill. Outcomes were avoidance success rates and four post-crossing gait characteristics: step length, step duration, peak hip flexion and peak hip extension, which were all normalized to steady state gait. RESULTS: Persons post stroke demonstrated lower avoidance success rates (mean ± SD = 27 ± 22%) than healthy controls (94 ± 11%). The first post-crossing step length and duration deviated more from steady state gait in persons post stroke (i.e. the non-paretic step) than in healthy controls (i.e. the right step), with lower values for persons post stroke. The same was true for peak hip excursions of the first post-crossing step with the paretic leg, with higher values for hip flexion and lower values for hip extension in persons post stroke. CONCLUSIONS: Persons post stroke are faced with impaired gait adaptability, as evidenced not only by a reduced ability to cross obstacles but also by a reduced ability to restore the gait pattern after crossing the obstacle. The shortened first post-crossing step of the non-paretic leg as well as the concomitant changes in paretic hip angles reflect that the trunk of persons post stroke does not move forward over the supporting paretic foot as well as in healthy controls. This may be attributed to a reduced propulsion of the paretic leg in persons post stroke. The impaired return to steady state gait in persons post stroke was further characterized by shorter non-paretic step durations. Given that the large crossing step may also have challenged balance after landing, persons post stroke tentatively adjusted their gait to this challenging situation by reducing the paretic single-support stance duration.

O.9.4 Functional analysis of supraspinal locomotor control in patients with progressive supranuclear palsy by PET

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BACKGROUND AND AIM: Progressive supranuclear palsy (PSP) is the most frequent atypical Parkinson syndrome, characterized by an early manifestation of gait disturbance and falls. The pathophysiology of gait dysfunction in PSP is not yet sufficiently understood. In the present study, we investigated the supraspinal locomotor network in patients with PSP during real locomotion. METHODS: Twelve patients with PSP were scanned with [18F]-FDG-PET during real locomotion and rest. In the locomotion paradigm subjects walked at constant velocity for 10 min. Then [18F]-FDG was injected intravenously while subjects continued walking for another 10 min. Results were compared to an age-matched healthy control group (N=12). RESULTS: The major results of this study were the following: 1) At rest, the

regional cerebral glucose metabolism (rCGM) in the supraspinal locomotor centers, i.e. the prefrontal cortex, the subthalamic nucleus, the pedunculopontine/cuneiform nucleus complex, was reduced in PSP. These locomotor regions are critical for the conveyance of cortical locomotor impulses to the spinal cord. 2) Severe gait impairment, measured by gait velocity, step length and PSP rating scale/gait, was associated with decreased rCGM in the prefrontal cortex and subthalamic nucleus. 3) Accordingly during real locomotion, functional activation of the prefrontal cortex, the subthalamic nucleus, the pendunculopontine/cuneiform nucleus complex and the thalamus was reduced in PSP patients compared to controls. 4) The precentral gyrus and the vermal cerebellum were activated more strongly during locomotion in PSP patients. CONCLUSIONS: Gait impairment in PSP is especially associated with dysfunction of the indirect prefrontal-subthalamic-pedunculopontine loop of locomotor control. Simultaneously, the direct locomotor loop from the primary motor cortex including input from the cerebellar locomotor center shows increased activity in PSP patients. The latter can be interpreted as an attempt of compensation.

O.9.5 The contribution of executive function and brain volume to gait speed in older adults with and without cerebral infarction

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BACKGROUND AND AIM: Gait impairment is common following cerebral infarction. Yet, the effect of lesion hemisphere on gait, as well as the compensatory role of central locomotor circuits, remains unclear. We studied these issues by examining dependence upon 1) executive function, and 2) non-infarcted regional brain tissue volumes, for the control of gait speed in individuals with right or left-hemisphere middle cerebral artery (MCA) infarcts. METHODS: Subjects with right MCA infarct (n = 19, age = 65 ± 8 years, 7 ± 6 years post-stroke), left MCA infarct (n = 20, age = 65 ± 8 years, 7 ± 6 years post-stroke) and controls (n = 55, age = 65 ± 8 years) were recruited. Gait speed was calculated from an indoor 75m walk at preferred speed. Executive function was measured with the trail making, verbal fluency, digit span and clock-in-a-box tests. Cortical gray matter volumes within non-infarcted brain regions (i.e., the cerebellum and occipital lobes) were quantified from anatomical 3T MRIs. RESULTS: The right and left infarct groups had similar infarct volumes and time since stroke. Gait speeds were slower ($p < 0.001$) in subjects with right infarct (mean ± SD = 0.8 ± 0.2m/s) as compared to those with left infarct (1.1 ± 0.1m/s) and controls (1.1 ± 0.2m/s). As compared to controls, both left and right infarct associated with worse executive function as evidenced by diminished performance on the trail making ($p = 0.02$), digit span (0.01) and verbal fluency ($p = 0.005$) tests. Gray matter volumes within regions distant to the infarct site (i.e., the occipital lobe and cerebellum) were similar between groups. Importantly, linear models revealed that in the right infarct group only, those with worse executive function (i.e., trail making test part B, $p = 0.01$) walked slower. Also within this group, those with less cerebellar gray matter volume walked slower ($p = 0.003$). Within the left infarct and control groups, on the other hand, gait speed was not related to measures of executive function or regional gray matter volumes. CONCLUSIONS: Diminished gait speed was only observed in those with right-hemisphere MCA infarct. Within these subjects, gait speed was closely associated with both executive function and gray matter volume within the (non-infarcted) cerebellum. Individuals with chronic lesion within the right MCA territory may be more dependent upon supraspinal elements of the motor control system to regulate their walking speed.

O.9.6 How does Functional Electrical Stimulation work? An fMRI study of cortical activations during ankle dorsiflexion.

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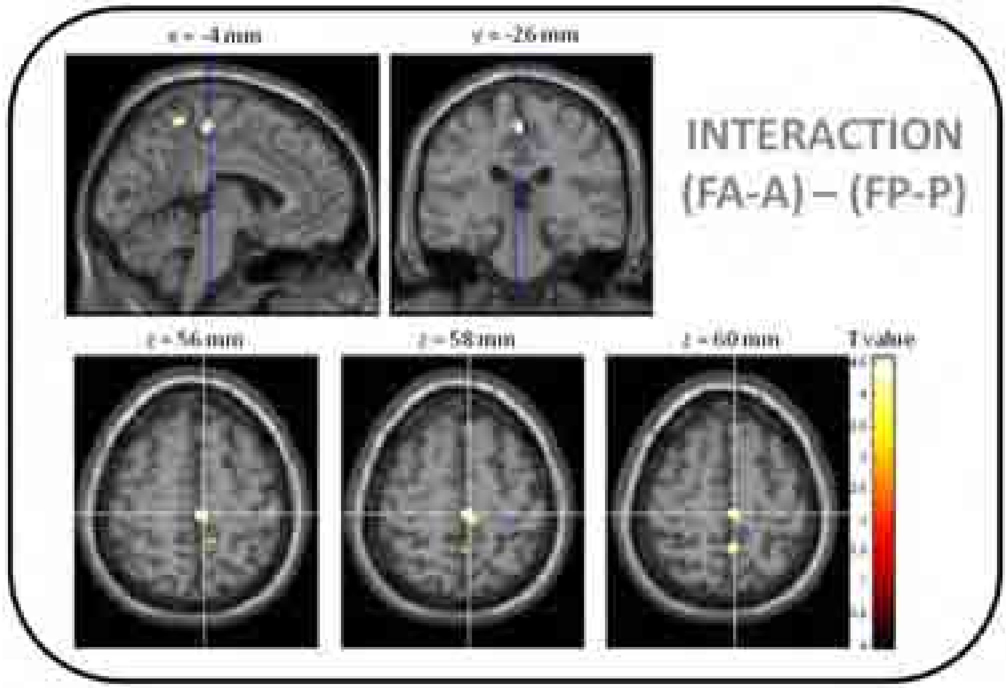
BACKGROUND AND AIM: Foot drop is one of the commonest gait impairments associated with Central Nervous System (CNS) lesions. Peripheral Functional Electrical Stimulation (FES) is used to treat foot drop as active orthosis. Some hemiplegic patients treated with FES have a beneficial effect on foot drop that outlasts the period of stimulation (the carryover effect). This suggests that FES induces some plasticity mechanisms in CNS reorganization that allows maintaining recovery of motor control, but little is known about its central mechanism of action. We hypothesise that the interaction of (i) antidromic firing induced by FES and (ii) voluntary effort could induce changes at the level of the cortex which persist beyond FES stimulation. Here we have used fMRI to study this interaction in healthy volunteers before going on to apply the paradigm to chronic stroke patients before and after an FES-based treatment for foot drop. METHODS: A 2x2 event-related fMRI study design with voluntary effort [V] and FES [F] as factors was performed with Ankle DorsiFlexion (ADF) as motor task (FV = FES-induced ADF voluntarily accompanied by the subject; FP = FES-induced ADF, subject is asked to remain relaxed; V = voluntary ADF; P = subject is asked to stay relaxed, an operator dorsiflexes his/her ankle). The experimental set-up was composed of a 1.5 T MRI scanner, a motion capture system and an electrical stimulator as previously described (Gandolla et al., 2011). 16 healthy subjects underwent the acquisition. Up to now, 4 chronic stroke patients were included in the study; patients' assessment included Medical Research Council scale index, Modified Ashworth Scale index, 6 minutes walking test, gait analysis, dynamic EMG and ankle range of motion as well. Patients are currently undergoing an FES-based treatment for one month. RESULTS: Relative increases in brain activity were seen in controlateral sensorimotor cortex (lower limb area) for all 4 conditions in healthy subjects. We were particularly interested in the interaction of our experimental factors: (FV-V)-(FP-P). Using this contrast, we were able to demonstrate that activity induced by FES-antidromic stimulation in both primary motor and sensory cortices is increased by concurrent voluntary ankle dorsiflexion (Fig. 1). We are now interested in understanding whether the presence of this positive interaction is a prerequisite for a successful carryover central effect after FES treatment in stroke patients. CONCLUSIONS: Our results demonstrate that FES can modulate activity in primary motor and sensory cortices, an effect which may undelay its clinical mechanism of action. We now hypothesise that this is the mechanism by which FES leads to a clinically meaningful carryover effect. Furthermore, presence of this interaction should predict a positive recovery of voluntary motor control. Ultimately this could help to identify best responders and open a window about new strategy to facilitate functional recovery.



O.10 EXERCISE I, *Cosmos 3A*

O.10.1 Training conditions influence walking kinematics and self selected walking speed in patients with neurologically impairments.

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BACKGROUND AND AIM :Gait training is a major focus of rehabilitation for many people with neurological conditions, yet systematic reviews have failed to identify the most effective form of gait training. The main objective of this study was to compare conditions for training gait for people with acquired brain injury (ABI). METHODS: Seventeen people who had sustained an ABI and were unable to walk without assistance were recruited as a sample of convenience. Each participant was exposed to seven alternative gait training conditions in a randomized order. These were: (a) therapist manual facilitation; (b) the use of a gait assistive device; (c) unsupported treadmill walking; and (d) four variations of body weight support treadmill training (BWSTT). Quantitative gait analysis was performed and Gait Profile Scores (GPS) were generated for each participant to determine which condition most closely resembled normal walking. RESULTS: BWSTT without additional therapist or self-support of the upper limbs was associated with more severe gait abnormality (Wilks' Lambda = .20, $F(6, 6) = 3.99$, $p = .047$). With the exception of therapist facilitation, the gait training conditions that achieved the closest approximation to normal walking (GPS) required self-support of the upper limbs. When participants held on to a stable handrail, self-selected gait speeds were up to three times higher than the speeds obtained for over-ground walking (Wilks' Lambda = 0.17, $F(6, 7) = 5.85$, $p < 0.05$). CONCLUSION: The provision of stable upper-limb support is associated with high self-selected gait speeds which are not sustained when

walking over-ground. BWSTT protocols may need to prioritize reduction in self-support of the upper-limbs, instead of increasing treadmill speed and reducing BWS, in order to improve training outcomes.

O.10.2 Video-game based intensive coordinative training improves motor performance of children with degenerative ataxia

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BACKGROUND AND AIM: Since the cerebellum is strongly involved in both motor control and motor learning, the benefit of neurorehabilitation training has been controversially debated for patients with progressive cerebellar degeneration. We have recently shown that intensive and continuous coordinative training based on physiotherapeutic exercises improves degenerative ataxia in adult patients (Ilg et al 2009, Neurology). However, such exercises have several drawbacks for children, including the problem of motivation for a continuous and high-frequent physiotherapy. Recently developed movement controlled video-game technology might present a novel treatment tool for highly interactive, motivational and playful coordinative training particularly in these children. METHODS: We examined the effectiveness of an eight-week coordinative training for 10 children (age:15.4±3.5 years) suffering from progressive ataxia due to degenerative spinocerebellar disease (baseline SARA score: 10.9±2.3). Training exercises were based on 3 Xbox® video-games which seem particularly suitable to exercise whole body coordination, goal-directed limb movements and dynamic balance, namely "table tennis", "light race", and "20.000 lecks". Training was started with a supervised lab-based 2-week training phase, followed by 6 weeks training in children's home environment. Effects were assessed by ataxia rating scales (SARA), balance scores (ABC6, dynamic gait index (DGI), and quantitative movement analysis of gait. Assessments were performed two weeks before lab-based training (E1), immediately prior to (E2) and after the lab-based training period (E3), as well as after the home training period (E4). Using an intra-individual control design, we are able to evaluate (i) the variability of test performance unrelated to the intervention (by comparing E1 and E2), and, (ii) the intervention effects (comparing E4,E3 with E2). RESULTS: Significant reduction of ataxia symptoms (decrease in SARA score,$p=0.0078$) as well as improvements in objective (DGI) and subjective balance capacities (ABC6) were observed after the intervention period (E4). Decrease of the SARA posture score between E3 and E4 score correlated significantly with training intensity at home ($r=0.67$,$p=0.035$). Quantitative gait analysis revealed a significantly reduced lateral sway ($p<0.01$), and step length variability after the training period ($p<0.13$), both correlating with changes in the SARA subscore "posture" ($p<0.03$). Children experienced feelings of success about their own movements and were highly motivated throughout the whole highly demanding training period. CONCLUSION: Our study shows for the first time that - despite cerebellar degeneration - children are able to benefit from continuous motor rehabilitation training. In particular, movement controlled video-games present a novel highly motivational, cost-efficient and home-based rehabilitation tool to train dynamic balance and interaction with dynamic environments.

O.10.3 Movement Strategy Training in Parkinson's disease: Results from a Community Based Sample

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BACKGROUND AND AIMS: Physical rehabilitation is commonly used for people with Parkinson's disease. This study aimed to explore changes in gait and activity limitations over the course of rehabilitation using movement strategy training. METHODS: The study included a sample of community dwelling participants with Parkinson's disease who were recruited as part of a larger randomized controlled trial [1]. They attended a rehabilitation centre once a week for eight consecutive weeks where physiotherapists conducted two hour group sessions of movement strategy training. The exercises included the use of visual and attentional strategies when performing functional tasks, such as standing up, activities in standing, or walking in environments of varying complexity. Participants also practised a structured exercise program of movement strategies once a week at home. Outcome measures were recorded at baseline, immediately after the intervention period (8 weeks) and three months after intervention. The Unified Parkinson's Disease Rating Scale (UPDRS) was used to quantify activity limitations (section II); gait speed from the 6 metre walk test and the Timed Up and Go Test (TUG) were used to quantify mobility. RESULTS: In this sample of 50 participants the median modified Hoehn and Yahr stage score was 2.5. There were 35 males and 15 females. There were no significant changes in gait speed over the course of the 3 tests ($F(2,44)=1.91$, $p>0.05$). Likewise there was no significant change for the TUG ($F(2,45)=1.58$, $p>0.05$). However activity limitations were seen to lessen from baseline to the 8 week test and to the 3 month follow up ($F(2,43)=5.63$, $p=.007$). The median scores for the UPDRS section II were 11 at baseline, 10 at 8 weeks and 10 at 3 months. CONCLUSIONS: Despite PD being characterised as a progressive deteriorating neurological condition, we found that activity limitations lessened over the course of rehabilitation using movement strategy training. Future analyses are needed to compare the effects of movement strategy training with other interventions and controls. Meanwhile clinicians could consider selecting movement strategy training as one of the possible rehabilitation options for people with PD.

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O.10.4 Is Strength Training Associated with Improved Activity in Parkinson’s disease?

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[1]The University of Melbourne, [2]La Trobe University, [3]Monash University, [4]Kingston Centre

BACKGROUND AND AIMS: Although progressive resistance strength training has long been used clinically to improve motor performance in people with Parkinson's disease (PD), there are few controlled evaluations of its effects in people with this debilitating and progressing condition. The aim of this investigation was to examine whether an 8 week progressive strength training program was associated with improvements in mobility and activity limitations in a community based sample of Australians living with PD. METHODS: As part of a larger trial (Morris et al 2011) a sub-sample of people with PD attended a rehabilitation centre once a week for eight consecutive weeks where physiotherapists conducted two hour group sessions of progressive resistance strength training for up to four people in each group. The exercises included the performance of functional activities such as moving from sitting to standing, heel raises, abdominals, trunk rotation, hip abductors and calf strengthening. Resistance was provided from weighted vests, Theraband® and body weight resistance. Exercises were tailored to individual needs, taking into account the level of weakness, functional ability and safety. Participants also practised a structured exercise program once a week at home. Outcome measures were recorded at baseline, immediately after the 8 week strength training period and 3 months after intervention. The UPDRS was used to quantify activity limitations (section II). The Timed Up and Go Test (TUG) and gait speed from the 6 metre walk test were used to quantify mobility. RESULTS: This sample comprised 32 males and 18 females. Participants had mild to moderate disease, with a median modified Hoehn and Yahr score of 2.5. There were no statistically significant differences in walking speed from baseline to the 8 week test or from baseline to the 3 month follow up. Performance on the TUG test deteriorated from baseline to test 2 and test 3. Activity limitations did not change significantly over the course of strength training. CONCLUSIONS: In this relatively small sample of 50 participants, strength training was not associated with improvements in gait or activity limitations. These results concur with previous trials (Goodwin 2011, Morris 2009,) and suggest that strength training may be task specific and does not always generalise to improved mobility in people with Parkinson's disease. Further analyses are required with larger samples and examining outcomes for additional variables, such as falls and quality of life.

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O.11 TOOLS AND METHODS II - SENSOR-BASED ASSESSMENT, *Cosmos 3C*

O.11.1 Sensor based assessment of standardized and daily-life gait in independent-living older adults

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BACKGROUND AND AIM: Body-fixed-sensor (BFS) methods for quantifying functional walking performance may assist in optimizing interventions for supporting independent mobility. Development and testing in different settings and populations is needed. The aim of the study was to evaluate the reproducibility of accelerometry based estimations of gait parameters for standardized walking as well as the correspondence of daily-life walking with standardized walking in independent-living older adults. METHODS: Three older men and 17 older women (70-80 years old) without pathological conditions that severely affect walking were included as well as several older persons with walking difficulties. A sensor unit containing accelerometers and gyroscopes (DynaPort Hybrid, McRoberts) was worn with a waist strap at vertebrae L2-L4. Indoor straight-line walking of 30 m trajectories at different speeds was performed twice on separate days. In addition, subjects wore the sensor unit for 12 hours during their daily-life activities on two days. Steps were identified from instants of heel-strike as determined from forward accelerations. The middle 25 m of each standardized walk was used to assess mean values for e.g. speed (V), step duration (Tstep) and step length (Lstep=V*Tstep). In addition, different step length estimations were made based on an Inverted Pendulum (IP) model of walking. To identify periods of walking in daily-life data an automatic activity detection algorithm was applied. Gait parameters were estimated for those gait trajectories that fitted criteria for straight line walks. RESULTS: The group mean speed for walking at normal, fast, slow speed was respectively 1.34, 1.58, 1.08 m/s and the group mean step length respectively 0.68, 0.73, 0.62 m (n=20). Test-retest ICCs2,1 (absolute) for walking speed ranged from 0.693-0.874 and for step length from 0.831-0.904, with an exception of 0.945 for slow walking. For one of the IP estimates of step length, ICCs ranged from 0.866-0.955. For the agreement of the IP estimate with the reference value (Lstep), ICCs3,1 (absolute) ranged from 0.924-0.976, with exceptions of 0.821 and 0.850 for fast walking. Preliminary analyses of the individual gait data obtained during daily life indicate that on average 150 walking trajectories were detected (range 87-205), with an average trajectory duration of 20.6 s (range 9.6-13.3). Mean total gait duration over the 12h period was 51.8 min (range 24.8-69.6). Only a small part of all gait trajectories complied with straight line walking characteristics. CONCLUSIONS: BFS based gait assessment yields reliable results for repeated testing under standardized conditions in independent-living older adults of 70-80 years old: estimated step length based on an IP model of walking has high test-retest reliability and high agreement with the reference method. Most of the gait data obtained during daily life differed from those obtained during standardized conditions.

O.11.2 Can accelerometer-based evaluation of postural function identify individuals with Enlarged Substantia Nigra Hyperechogenicity?

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BACKGROUND AND AIM: Enlarged Substantia Nigra hyperechogenicity (ESNH) assessed by transcranial sonography (TCS) is present in about 90% of subjects with Parkinson's Disease (PD) independent of age and disease stage [1], and may be the best risk marker for PD known to date [2]. Our hypothesis is that instrumented analysis of postural function may identify "high risk" subjects for PD (HR) characterized by ESNH. In order to preliminary test our hypothesis we searched for combinations of postural measures, extracted from acceleration signals during quiet standing (QS), which could discriminate between HR and control subjects (CTRL). This was achieved through feature selection based on classification algorithms [3]. METHODS: The subjects were 21 HR (62±5 yrs) and 15 CTRL (64±7 yrs); the accelerometer (DynaPort Hybrid, McRoberts) was worn on the lower back during QS trials performed with eyes open (EO) and with eyes open on a foam rubber support (EOF). The foot placement was semi-tandem. RESULTS: The quadratic discriminant classifier built on two measures had 83.4% accuracy evaluated with a leave-one-out cross validation (Fig.1a): the 83.4% of the subjects were assigned to their correct class (CTRL or HR). The two selected measures were frequency dispersion (FD) in the medio-lateral (ML) direction and median frequency (F50) in the antero-posterior (AP) direction, both taken in the EOF condition. The specificity was 86.7% and the sensitivity was 81%. FD ML values in HR were significantly lower than in CTRL (Fig.1b). CONCLUSIONS: Two frequency domain postural measures are able to discriminate with a good accuracy between HR and CTRL. This result suggests for the first time that instrumented posture analysis may be able to disclose preclinical signs of a high risk of developing PD.

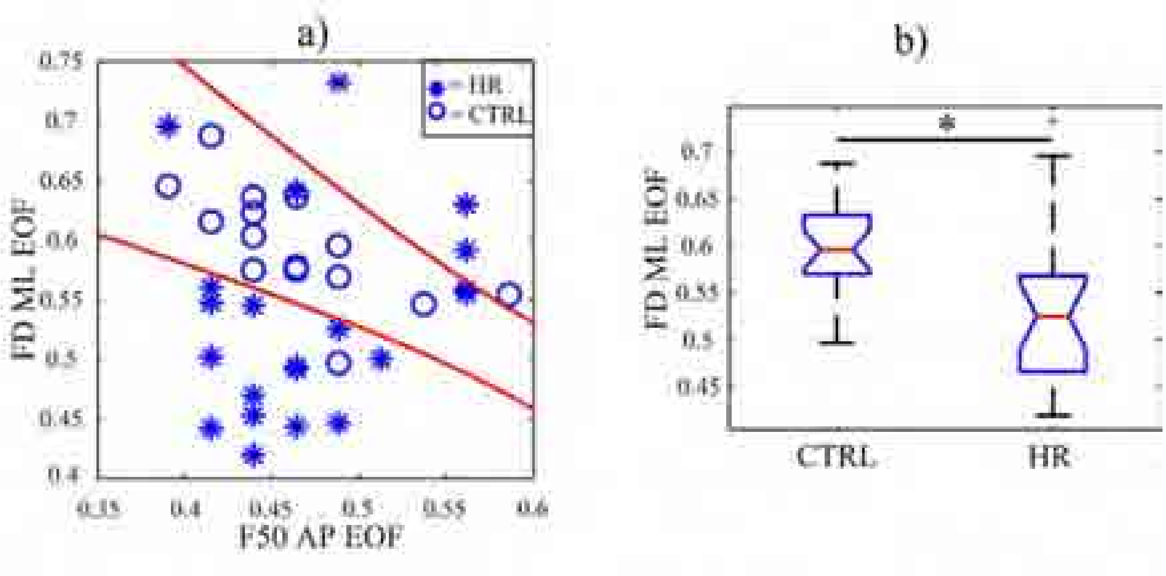

Fig.1 a) Quadratic classifier; b) T-Test results

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O.11.3 Sensor based assessment of resistance and balance training effects on peak power during the sit-to-stand transfer in older persons

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BACKGROUND AND AIM: Muscle strength and power decline during ageing. Low muscle strength and power are related to functional limitations. Studies showed that strength and especially power training can improve strength, power and functional performance in older persons. A recent study demonstrated that the power to lift the center of mass during the sit-to-stand (STS) transfer can be estimated with hybrid motion sensors [1]. These findings imply the possibility to monitor changes in leg muscle power based upon motion sensors. However, at present it is unknown whether motion sensors can be used to detect effects of resistance training on STS peak power. Therefore, this study investigated whether a hybrid motion sensor can be used to detect effects of a short resistance and balance training intervention on STS performance in older persons. METHODS: Older persons (9 males and 17 females; age: 70-84 yrs) participated in an 8-week training program which consisted of leg strength and power exercises with a balance component. Subjects performed two group training sessions per week and additional home exercises. Before and after the intervention, normal and fast STS performance was measured, as well as the performance on three standard clinical tests: left & right leg extensor strength, Berg Balance Scale (BBS) and Timed Up and Go test (TUG). STS performance was analysed using a wireless matchbox-sized hybrid motion sensor measuring 3D-accelerations (±2 g), 3D-angular velocities (±300 deg/s), and 3D-orientation in the earth-magnetic-field (±2 Gauss). Data were sampled at 50Hz. The sensor was attached to the right trochanter major femoris. Duration, peak power and maximal jerk were calculated as STS performance measures [1]. The STS performance measures were scaled to body dimensions [2]. RESULTS: Table 1. Mean and standard deviation of outcome variables before and after the intervention (n=26). P-values are based on Wilcoxon signed-rank test and standardized response mean values indicate sensitivity to change of the outcome measures. CONCLUSIONS: Results showed that a motion sensor worn on the hip can be used to detect effects of a short resistance and balance training intervention on STS performance in older persons. Of all STS performance measures, STS peak power demonstrated relatively high sensitivity to change. Compared to standard clinical tests, STS peak power showed similar sensitivity to change. This study shows the potential of motion sensors for the evaluation of exercise effects on functional performance in older persons, especially in daily life situations.

Outcome variable	Pre	Post	P-value[a]	Standardized response mean
STS measures				
Normal STS duration (s)	1.67±0.40	1.56±0.37	0.043*	-0.33
Normal STS duration°	4.06±0.96	3.79±0.85	0.043*	-0.34
Normal STS peak power°	0.83±0.17	0.97±0.31	0.006*	0.46
Normal STS maximal jerk°	0.38±0.12	0.43±0.14	0.080	0.33
Fast STS duration (s)	1.35±0.33	1.24±0.28	0.015*	-0.33
Fast STS duration°	3.28±0.82	3.02±0.65	0.012*	-0.33
Fast STS peak power°	1.09±0.25	1.29±0.46	0.003*	0.47
Fast STS maximal jerk°	0.51±0.21	0.60±0.23	0.060	0.40
Clinical tests				
TUG (s)	10.81±2.42	10.23±2.38	0.004*	-0.49
BBS (score)	51.15±3.21	52.12±3.39	0.013*	0.47
Leg extensor strength (Nm)	75.18±25.74 [b]	79.10±22.55 [b]	0.031*	0.41

° dimensionless numbers after scaling to body dimensions.

* p<0.05, indicating a significant improvement.

[a] one-tailed p-value.

[b] mean extensor strength of left and right leg at knee angle 90°.

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O.11.4 Screening for balance disorders in mildly affected multiple sclerosis patients.

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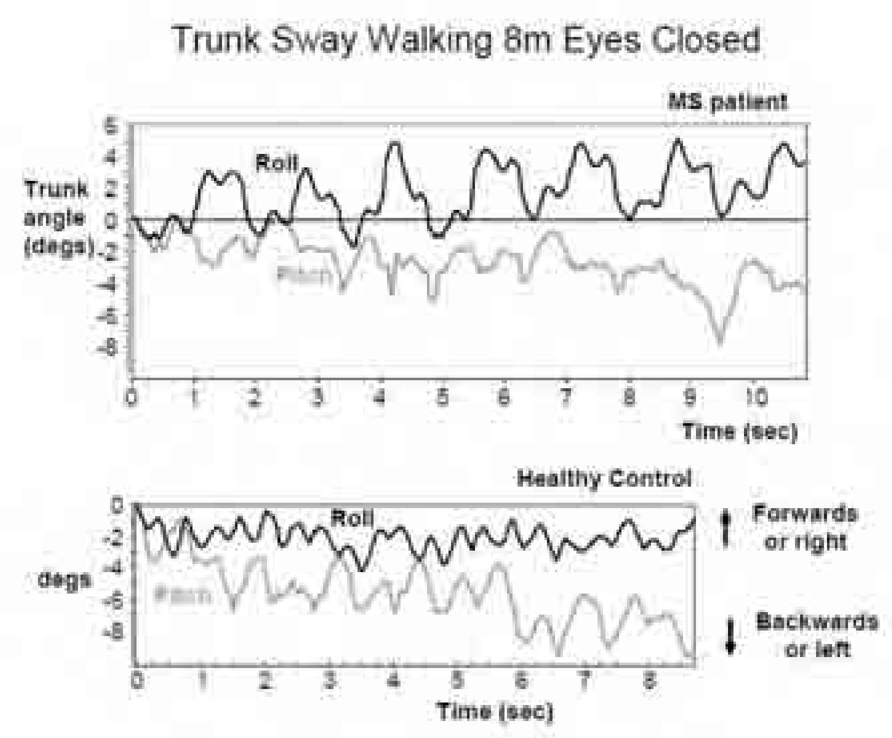
BACKGROUND AND AIM: MS patients often complain about balance problems even if the clinical neurological examination is normal. It is important to screen for balance deficits in MS patients before these lead to a major functional decline, because treatment, once started, can slow down disease progression. Therefore the aim of this study was to determine if measures of trunk sway taken during a battery of stance and gait tasks could screen for subclinical balance disorders in mildly affected MS patients and whether this detection technique was more accurate than assessment of the same tasks by two certified neurologists. METHODS: We recorded trunk sway from 20 MS patients (mean age 31 years, range 23-39); 80% female; 80% relapsing forms; mean disease duration 55 months (SD=35) with a maximum EDSS score of 2 (mean 1.4 sd 0.5). The study protocol included the Dizziness Handicap Index (DHI) and 6 stance and 6 gait balance tasks during which trunk sway angles and velocities in the roll and pitch planes were measured at L1-3 with a Sway-Star™ system (Balance International Innovations GmbH, Switzerland). 20 age- and gender-matched healthy subjects served as controls (HCs). Subjects from both groups were filmed performing the tasks. The neurologists were asked to judge each test and overall performance as pathological or not. Non-parametric Mann Whitney U tests for single variables were performed, and a step-wise discriminant analysis across significant variables was performed in order to separate the groups. For both the neurologist and the discriminant model MS and HCs classification accuracies were calculated. RESULTS: Sway measures were significantly different between patients and HCs in 8 out of 12 balance tasks. The most significant differences between MS patients and HCs were pitch angle range standing on one leg with eyes open on a firm (mean 3.13° vs. 2.09°, p=0.005), and on a foam support surface (mean 6.24° vs. 2.96°, p=0.006), pitch velocity range walking 8 m with eyes closed, examples of which are shown in the figure (mean 75.5°/sec vs. 50.2°/sec, p<0.001), and pitch velocity range walking 3 m on heels (means 85.37°/sec vs. 60.9°/sec, p=0.002). After entering all significant variables in a step-wise multivariate discriminant analysis, a model with three variables and tasks emerged which detected 84% of the MS patients and 90% of the HCs correctly. The neurologists achieved accuracies of 30% for the MS patients and 82% for the HCs. Within the patient group, 55% were classified as subjectively having a balance problem based on their DHI scores (any question answered other than "no"). CONCLUSIONS: Using trunk sway measures during stance and gait tasks is a sensitive screening method for balance problems in MS patients, and is more accurate than assessment by trained neurologists. Such a screening tool can also be used to track improvement with medication.



O.12 NEUROLOGICAL DISEASES III - PARKINSON'S DISEASE, *Cosmos 2*

O.12.1 Freezing of gait in Parkinson's disease is related to impaired set-shifting during stepping

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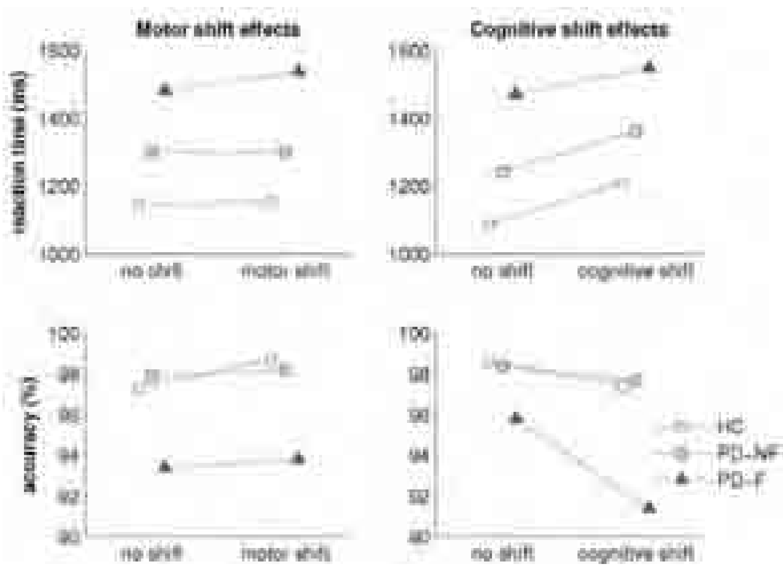
BACKGROUND AND AIM: Freezing of gait in patients with Parkinson's disease (PD) has been associated with excessive activation of the frontostriatal network, e.g. when holding multiple tasks online.1 We hypothesized that PD patients with freezing of gait (PD-F) have more problems when shifting between cognitive and motor sets during stepping than PD patients without freezing (PD-NF) and healthy controls. METHODS: 44 PD patients (age) and 22 healthy controls (age) participated in the study. 8 PD patients reported freezing of gait episodes in daily life. All subjects had to step forward or backward in response to a stimulus on a monitor in front of them. The stimulus was either a circle or a triangle, in blue or yellow. Above the stimulus the word 'shape' or 'color' was presented, indicating the dimension to respond to. This design provided us with four trial-types: no shift trials, cognitive shift trials (from shape to color), motor shift trials (from forward to backward), and combined cognitive and motor shift trials. Step response times as well as the accuracy of the response were analyzed. RESULTS: The PD-F group responded significantly more slowly (p=0.031) and made significantly more errors (p=0.021) compared with the healthy subjects. Conversely, the PD-NF group did not differ from the healthy subjects. The impairment in the PD-F group was not uniform across trial-types. In terms of reaction times, a disproportionate impairment was observed on motor shift trials relative to no shift trials (motor shift x group interaction, p=0.034). By contrast, in terms of accuracy, they exhibited a disproportionate impairment on cognitive relative to no shift trials (cognitive shift x group interaction, p=0.010). Results are presented in Figure 1. CONCLUSIONS: PD patients with freezing of gait were slower and less accurate when they had to switch between task sets compared with PD patients without freezing of gait. These findings suggest that commonly reported cognitive set-shifting deficits in PD may extend to problems with shifting between motor sets, eventually leading to freezing of gait.



O.12.2 Using ecological event-based acoustic guides to cue gait in Parkinsons Disease patients.

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BACKGROUND AND AIM: Variations in gait parameters, such as stride amplitude, yield alterations in the resulting acoustics/sounds produced. However, we currently do not know if spatial aspects of footsteps can be perceived through sound alone. The first aim of the study was to design event-based, ecological footstep sounds that convey both spatial and temporal information. The second aim was to assess if both healthy adults and people with Parkinson's Disease (PD) can perceive and adapt their gait patterns according to gait parameters conveyed in the sound samples. METHODS: Generating the sound samples: We asked a young healthy adult male to walk along an 8m walkway at a range of stride amplitudes (specified by horizontal lines on floor) at 50, 70 and 90cm intervals. We recorded the sounds of twenty footsteps on a gravel surface, in addition to twenty ground reaction force vectors (GRF) for each specified stride length parameter using a portable AMTI force plate. The changes in GRF were used to create synthesized stepping sounds using an adapted 'Pure Data' software patch [1]. Protocol: Ten healthy adults and ten PD patients (all scoring between 2 and 4 on the Hoehn and Yahr scale [2]) were asked to walk along a 10m walkway and imitate (in real time) the successive stepping actions presented in the sound samples. This was completed both when listening to real recordings of successive footsteps on gravel, and their synthesized counterparts. The gait parameters recorded during these trials were compared to trials when participants walked to alternative 'traditional' visual and auditory cues (horozontal lines on the floor and metronome sounds) RESULTS: Our results showed an impressive ability of healthy adults and PD patients to perceive relative changes (in stride length) in the acoustic displays, and adapt their gait parameters accordingly. Furthermore, PD patients also exibited significantly reduced variability in both stride length and cadence when walking to the ecological acoustic guides compared to when using visual, or intermittent acoustic guides. CONCLUSIONS: The current study demonstrates how dynamic content within acoustic guides can be utilized by listeners to inform spatial parameters of gait during a movement imitation task. Whereas traditional cueing methods for PD patients have utilized visual cues and intermittent auditory metronomes to improve the walking characteristics of PD patients, the use of continuous auditory guides provides a novel approach that has the potential to deliver the combined benefits of both visual and intermittent auditory cueing.

ACKNOWLEDGEMENTS:
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O.12.3 Attention modulation in parkinsonian freezers: consequences for step initiation postural adjustments

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BACKGROUND AND AIMS: Advanced Parkinson's disease is characterized by episodic gait disorders such as freezing of gait (FOG). The latter constitutes a major problem because of its relative insensitivity to treatment, its effect on quality of life and its relationship with the risk of falls. In view of FOG's circumstances of occurrence, attentional resources appear to be involved. However, the mechanisms leading to FOG are not well characterized. We decided to study the role of attention in gait initiation, which is particularly affected by FOG in Parkinson's disease. Gait initiation is preceded before step execution by anticipatory postural adjustments (APAs) - adjustments that are known to be impaired in parkinsonian freezers. Our main objective was to establish whether or not a change in attentional load during step initiation modulates APAs differently in patients with vs. without FOG. We assumed that modulating attentional load is partly responsible for triggering an inadequate motor program and contributing to the freezing phenomenon. We then hypothesized that lower attentional resources would prompt parkinsonian patients with FOG to display inadequate APAs more frequently. METHODS: Three groups of 15 subjects were recruited: elderly people free of Parkinson's disease and parkinsonian patients with or without FOG. Attention was modulated during postural preparation of the first step by means of an auditory oddball discrimination task and the P300 event-related potential was recorded as a marker of attention allocation. The primary endpoint was the occurrence of inadequate APAs following the attentional task, i.e. APAs not followed by a step after an intercurrent auditory stimulus. RESULTS: In parkinsonian patients with FOG, inadequate APAs were recorded in 63% of the trials and were observed more frequently than in patients without FOG (51%) and elderly controls (48%). Furthermore, inadequate APAs in freezers were longer and more ample than in parkinsonian non-freezers and controls. Lastly, postural preparation and execution of the first step were impaired in the parkinsonian patients. CONCLUSIONS: Our results indicate that allocation of attentional resources during step preparation influences the release of APAs differently in freezers (with a lack of inhibition of an undesired motor program) and non-freezers. This difficulty in focusing attention or resisting interference may contribute (at least in part) to the gait initiation failure observed in parkinsonian freezers.

O.12.4 The impact of environment on difficulty walking in the community in people with Parkinson's disease.

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BACKGROUND AND AIMS: People with Parkinson's disease (PD) have known gait impairments that are exacerbated when performing more than one task at a time, or when completing a challenging functional activity [1], but environmental challenges contributing to mobility difficulty in people with PD is unknown. This study aimed to identify environmental factors impacting community walking in people with PD and determine if there was a relationship between gait characteristics and community mobility difficulty. METHODS: Forty community-dwelling people with idiopathic PD, who scored between stage I-IV on the Hoehn and Yahr disability scale and demonstrated gait hypokinesia were recruited. Individuals with walking limitations other than from PD, dyskinesias that affected function or cognitive impairment were excluded. All participants self-reported their level of community walking difficulty as either no difficulty, no difficulty but modified their mobility, or difficulty. They completed the Environmental Aspects of Mobility Questionnaire [2] to ascertain the prevalence of encountering and avoiding a variety of environmental challenges during community mobility. Spatio-temporal gait parameters were

recorded during dual task walking using an 8m GAITrite mat. RESULTS: Over half (63%) of people with PD reported modifying their walking or having difficulty walking in the community. There was no difference in age or severity of disability between the three levels of community walking difficulty. Participants frequently encountered challenges across all environmental domains regardless of level of self-reported mobility difficulty. Those who modified their walking avoided the greatest number of environmental challenges, particularly avoiding carrying heavy items (93%), uneven terrain (71%), two flights of stairs (71%), walking long distances (71%), walking in hot weather (71%) and in crowded places (64%). When compared with the other two groups, those who had modified their walking showed a reduced step length (mean 0.47m versus 0.59m no difficulty and 0.54m difficulty, p=0.018) and velocity (mean 0.69m/s versus 0.93m/s and 0.81m/s, p=0.044) when walking under dual task conditions. CONCLUSIONS: People with PD encounter a variety of environmental dimensions when mobilising within the community, and show a pattern of avoidance of environmental challenges similar to disabled older adults [2]. Individuals who modify the way they walk show greatest changes in gait performance when dual tasking. Identification of these changes in behaviour or performance may be important in identifying those individuals at risk of limited participation due to community mobility disability. This study also highlighted that factors other than gait performance impact upon community walking.

ACKNOWLEDGEMENTS:
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O.13 SENSORIMOTOR CONTROL I, *Living 4*

O.13.1 Brain network of posture control during sensory modulation in fMRI

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BACKGROUND AND AIM: Supraspinal control of upright stance was investigated in several cerebral activation studies. Frontal lobe, medial temporal gyrus, SMA, basal ganglia, thalamus, hippocampus, cingulum, precuneus, midbrain, cerebellar vermis and hemispheres take part in this network [1,2]. In comparison, blind people showed more cerebral activations in vestibular system than sighted ones [3]. Aim of this study was to determine the supraspinal postural network within different sensoric conditions. METHODS: 22 healthy subjects practiced upright stance on firm ground (F) with eyes open (O)/closed (C) and on foam rubber (S) with eyes O/C. Subsequently they underwent a fMRI paradigm while imagining upright stance under the practiced sensoric modulations (capability of imagination was tested by VMIQ [4]). To register significant (p<0,001) changes in BOLD signal for O vs. C, F vs. S and their interactions, analysis was done by SPM 8. RESULTS: S vs. F showed an increased BOLD signal on both sides of the cerebellum, paracentral gyrus, superior (SMA) and medial frontal gyrus, superior (BA 2) and inferior parietal lobus, left medial globus pallidus and left occipital lobe. F vs. S generated activations in parietal lobe and left frontal white matter (BA 10). Visual modulation C vs. O revealed activations in superior temporal gyrus and superior parietal gyrus next to the longitudinal cerebral fissure, cuneus and cingulum. Moreover significant activations were seen in the insular cortex (right > left) when looking at contrasts of interaction FG-FO vs. SG-SO. CONCLUSIONS: Changes in cerebral activations were found

inter alia in cortical areas forming part of vestibular control. In impeded conditions (S) premotoric and sensomotoric cortex as well as parietal associative cortex were activated. The supraspinal network of posture control is appropriately modulated and can be investigated by imagiation of sensoric modulation.

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O.13.2 Sensory Integration during Human Locomotion and its Influence on Temporal Gait Variability

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BACKGROUND AND AIM: Temporal gait variability is a critical parameter in patients with balance problems. Increased magnitude of temporal gait variability corresponds to a higher risk of falls [1]. Previous studies have shown that gait abnormalities are dependent on walking speed [2,3]. Accordingly imaging studies during mental imagery of locomotion and real locomotion showed that the activity in sensory cortical regions decreased more during running than during walking [4,5]. The purpose of this study was to investigate the influences of varying levels of sensory integration at different walking speeds on temporal stride-to-stride variability. METHODS: A GAITRite® system was used to analyze the gait pattern of 42 patients with cerebellar ataxia (CA), 15 patients with bilateral vestibular failure (BVF), and 50 healthy subjects (HS) over the entire range of the individual's speed capacity (slow, preferred, maximal). The coefficient of variability (CV) of stride time was calculated for each walk. RESULTS: Temporal gait variability was increased in patients with CA and patients with BVF. The magnitude of this variability depended on walking speed in a disease-specific manner. In patients with CA, CV was increased during slow walking (10.4 ± 6.6%, $p<0.001$) and fast walking (12.7 ± 5.8%, $p<0.001$) but was normal during preferred walking speed. This resulted in a speed-related U-shaped function of stride time CV. Patients with BVF had an increased CV during slow walking (7.2 ± 2.3%, $p<0.01$) and medium walking speed (5.4 ± 1.8%, $p<0.05$) but CV normalized during fast walking. CONCLUSIONS: Minimal temporal gait variability appears to be an attractive state within the locomotion network of patients with CA, since these patients preferred to walk at a velocity associated with a minimal CV of stride time. In contrast to previous studies, patients with BVF accelerate rather than decelerate gait to achieve dynamic stability. This may be explained by reduced sensory integration during fast locomotion.

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O.13.3 Gaze anticipation during locomotion

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BACKGROUND AND AIM: Recent literature suggested a top-down organization of locomotion, with the head being the stable frame of reference and the gaze anticipating the future direction of the trajectory [1-2]. The anticipatory role of gaze has also been demonstrated in the absence of vision [2]. Why does gaze anticipate when we do not see? In order to better understand this role, we designed an experiment in which the visual environment is simplified and complex locomotor trajectories are freely generated. The goals of the present study were the following: 1- confirm the assumption of a temporal and spatial ordered relationships between gaze, head and other body segments orientation, 2- study the link between orientating mechanism of gaze, head and the other body segments with the upcoming changes in the geometry METHODS: 10 subjects without any problem of sensory, perceptual or motor disorders participated to the experiment. A Vicon motion-capture system and a video-based eye tracker system were temporally synchronized to record locomotor trajectories and gaze behavior. Participants had to perform clockwise and counter-clockwise five pre-cued trajectories. The trajectory was shown to the subject by the experimenter and then reproduced from memory by the subject without any visual cues on the ground indicating the trajectory to follow. A free walking condition (30s) was added. RESULTS: Our results indicated: 1- ordered organization of locomotion where the gaze anticipates the head orientation, and the head orientation anticipates reorientation of the other body segments, 2- temporal and spatial relationships between the gaze and the body segments depend on both the geometry of the trajectory and task constraints, 3- the role of gaze in anticipating a future segment of the trajectory when direction changes are required. CONCLUSIONS: It is well known that the head constitutes a frame of reference for guidance of locomotion [1]. Here, we further showed that the anticipation by gaze contributes to predict future locomotor aspects for this moving frame of reference.

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O.13.4 The effect of visual transitions on perception and action coupling

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BACKGROUND AND AIM: Monocular vision diminishes the influence of the moving room on body sway as compared to binocular vision [1]. In addition, monocular vision combined with increased distance from the front wall of a moving room reduces the coupling between visual information and motor response [1]. In this previous study, the monocular or binocular condition was set before each trial. Therefore, participants could adjust the weight of the different sensory systems in an anticipatory manner (i.e., feedforward control). Nevertheless, in daily situations the weight adjustment of sensory information is a dynamical process and occurs during movement execution. Then, the unexpected change in visual condition within the moving room allows the investigation of the dynamical process related to sensory information re-weighting in an online manner. The main purpose of the present study was, therefore, to examine the effect of visual transitions on the coupling between perception and action within the moving room. METHODS: Eleven young adults (22.0 SD 3.2 yrs.) participated in this study. Participants wore a pair of liquid crystal lenses goggles (Translucent Technologies Inc.), which allowed lenses transition from opaque to transparent and vice-versa independently. Participants stood as still as possible within the moving room during five minutes for each trial. They performed twelve trials combining three visual conditions (no vision [NV], monocular vision [MV], and binocular vision [BV]) and two distances from the front wall of the moving room (i.e., 75 and 150 cm). Lenses status changed every one minute within each trial in an unexpected way for the participant. Two IREDs markers were used to capture room movement and participant's sway and they were tracked by an Optotrak (Northern Digital) camera at 100 Hz. Gain, phase, and cross-correlation (including peak r values and time lag) between sensory stimulus and motor response were used as dependent variables. All dependent variables were calculated for every cycle of the moving room. For statistical analyses, two cycles before and two cycles after visual transition were used. RESULTS: The statistical results for gain and peak r showed an interaction effect between visual transition and cycles, except for the NV to MV/MV to NV for the gain variable. This interaction effect pointed out that the visual transition resulted in an abrupt change in the action-perception coupling, especially for the following transitions: BV to MV, MV to BV, BV to NV, NV to BV, and NV to MV. Interestingly, the MV to NV transition resulted in a less sharp change. CONCLUSIONS: This result suggests that sensory re-weighting due to visual transitions is a fast process, although this may take more time when the transition involves MV to NV.

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O.14 TOOLS AND METHODS III, *Cosmos 3C*

O.14.1 Using biped robots to simulate human stance control

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BACKGROUND AND AIMS: Extracting from sensorimotor research basic function principles and abstracting them into dynamic computer models became a valuable research tool over the last decades. Obtaining then, in computer simulations, stimulus responses that closely mimic the human responses is often taken to witness the descriptive and predictive power of such models. There usually exist,

however, considerable differences between the abstracted world of the model and the real world. One important aspect is that the abstraction tends to include simplifications. For example, real world sensor noise and inaccuracies are often neglected. Or, real world standing with the feet on a given support surface is often simplified as a fixed contact. The complexity of an experiment (comprising stimulus presentations in some form, data acquisition and analysis, etc.) is collapsed into few simulation steps. These considerations led us to re-embody our model of human stance control into a biped robot for 'hardware-in-the-loop' (HiL) testing [1,2]. Here we report on our experience with this extended form of modeling and simulation. METHODS: Two robots, a 1DOF robot (ankle joints) and a 2DOF robot (ankle and hip joints) were constructed for balancing in the sagittal plane using human-like anthropometric parameters (see Hettich et al. in [2]). Trunk, leg, and feet segments consist of aluminum frames interconnected by the hinged ankle and hip joints. Signals from mechatronic vestibular, joint angle, and joint torque sensor components were input to, and signals for the actuator control were output from a real time PC. The actuator signals commanded pneumatic 'muscles' (Festo, Esslingen, Germany; Type MAS20). In the PC, the model with the parts 'Disturbance Estimations' and 'Controller' was executed as a compiled Simulink model (Real-Time Windows Target; The MathWorks Inc., Natick, MA, USA). Experiments were performed in our posture control laboratory applying the same experimental methods as we use in humans. Identified human time delays were implemented. RESULTS: Results will be presented in the form of video clips and quantitative data (COM and COP responses to support surface tilt stimuli and corresponding Bode histograms). We found that our robots show human-like tilt responses. Compared to the software model, minor modifications were required such as using 'leaky' instead of ideal mathematical integration. The robot data appears more 'realistic' in that it shows spontaneous sway variation reminiscent to that of humans. CONCLUSIONS: Our HiL approach provided us not only with a 'proof of principle' of our stance control model, but in addition alerted us to some critical issues, inspired our research ideas, and improved public perception of our research. Possible applications for medical assistive and diagnostic devices will be discussed.

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O.14.2 Gait Analysis With Cane For Robot Assisted Locomotion.

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BACKGROUND AND AIM: Several methods have been investigated and realized for operating of assistive robots for human gait, such as the use of bioelectrical signals and motion intention estimation. In case of hemiplegic patients where bioelectrical are corrupted, reference trajectory for the robot assisted limb is computed. For this purpose, by observing the limb on the healthy side and utilizing the coupling of human kinesiological characteristics, reference trajectory for the impaired limb can be generated, while keeping coordination of the healthy and impaired limbs [1]. However, to grant the patient ability to adapt the generated trajectory to his personal gait pattern, and to avoid the unidirectional scheme resulting from controlling one leg via the other leg, using another correlated voluntary motion should be considered. In this study, we analyse the coupling and synergies of human gait with cane by means of Principal Component Analysis (PCA) in order to investigate the usability of cane (walking aid) for robot-assisted motor rehabilitation. We also propose an implementation with an exoskeleton robot, single leg version of HAL (Hybrid Assistive Limb) suit [2], for on-going research. METHODS: Walking patterns (with and without cane) of 4 healthy subjects were recorded for 20s each using MAC3D motion capture

system. Joint trajectories and angular velocities were extracted for the shoulder, elbow, hip, and knee joints, as well as the cane's tilting and angular velocity, all in the sagittal plane. Then, PCA was implemented to analyse the recorded trajectories and investigate the cane-limb coupling. Simulations are carried out for reference trajectory generation and gait phase detection, both utilizing the cane. RESULTS: The preliminary results showed that similar synergies (represented by principal components: PCs) were responsible for the motion of lower limbs, upper and lower limbs, and cane and lower limbs (4 PCs > 95% of 8, 20, and 10 PCs respectively), and the inter-subject variability of using the cane (measured by angle between corresponding PCs of one leg and cane) was less than 15 degrees among the subjects. Also, simulations showed the ability of generating reference trajectory and detecting gait phases (88%) using the cane, which together show a promising opportunity of utilizing a cane with an exoskeleton robot. CONCLUSIONS: The study shows that the cane is well incorporated in the coupling of human kinesiological characteristics while walking, and we thus introduce an effective interface, sensor (IMU) embedded cane, between a hemiplegic patient and assistive robot. This study was supported by the FIRST Program.

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O.14.3 Foam surfaces and standing balance testing: The balance perturbation and the contribution from rapidly adapting mechanoreceptive sensation on the plantar soles

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BACKGROUND AND AIM: Standing on a foam surface is a common technique in balance testing to distinguish patients with balance problems from those without, particularly in the case of suspected vestibular disorder. Standing on foam is believed to exaggerate balance deficits by decreasing the reliability of information from cutaneous mechanoreceptors of the plantar soles (base of the feet), though foam surfaces also alter the effectiveness of ankle torque. To fully grasp the usefulness of foam in the assessment of balance disorders, a detailed understanding of how foam perturbs standing balance is necessary. Aim: Show that the physical foam surface properties can highly influence postural control measurements. Present new insights into the contribution of rapidly adapting mechanoreceptive sensation when standing on foam METHODS: Anterior-posterior and lateral torque variance between the feet and surface was measured on three foam surfaces differing in their properties (i.e. density and elasticity modulus) and a solid surface with eyes open and closed in 30 healthy adults (mean age 22.5 years). The foam surfaces were categorised firm, medium and soft by their elasticity modulus. In addition, anterior-posterior and lateral torque variance was measured in 16 healthy adults (mean age 20.8 years), with and without decreased mechanoreceptive sensation on the plantar soles from plantar cutaneous hypothermic anaesthesia (ice-cooling), and with eyes open and closed. Tests were conducted on foam and a solid surface. Slowly and rapidly adapting plantar mechanoreceptive sensation were assessed and determined with tactile sensitivity and vibration perception respectively after balance testing. RESULTS: There was a significant correlation between the foam surface properties and standing postural control. Furthermore, the stabilising effect of vision on foam was altered by the perturbation characteristics. Rapidly adapting sensation was decreased significantly by hypothermic anaesthesia, but

not slowly adapting sensation. Hypothermic anaesthesia produced a stability change on a solid surface that was different in spectral composition, amplitude, direction and that responded differently to vision compared with standing on foam. CONCLUSIONS: Standing on foam causes a significant balance perturbation which changes the contribution from the sensory systems. This perturbation is more closely related to the foam properties than to a decrease in the reliability of rapidly adapting mechanoreceptive sensation on the plantar soles. When evaluating balance deficits with foam, the contribution from vision is different depending on the surface properties. The effect of foam on cutaneous mechanoreceptors of the plantar soles remains to be determined.

O.14.4 Development and Validation of a Questionnaire for Analyzing Real Falls Captured by Video in Long-Term Care (LTC) Facilities

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BACKGROUND AND AIM: Falls are the leading cause of injury-related deaths and hospitalization in older adults [1]. Video capture [2] can provide objective evidence of the cause and circumstances of real-life falls to guide prevention, but requires valid tools for analysis. In the current study, we developed a questionnaire for analysing the biomechanics of falls from videos, and examined the inter-rater reliability of the questionnaire. METHODS: We developed a 24-item video analysis questionnaire to probe key biomechanical aspects of fall initiation, descent, and impact from video footage (Table 1). For fall initiation, we considered the cause of imbalance, the activity at time of fall, and situational and environmental factors including the use of mobility aids and the contribution of clutter. For fall descent, we considered the direction of the fall and balance recovery responses (stepping or grasping). For fall impact, we considered the occurrence of contact to key body sites (e.g., head, hip, and hands). Two teams, each consisting of three members, used the questionnaire to independently review 15 randomly-selected fall videos captured in two LTC facilities. RESULTS: In 19 of the 24 questions, the percentage of agreement between the two teams was over 80% and the Cohen's Kappa was greater than 0.60, indicating good reliability. Over all questions, the average percentage of agreement was 87% and the average Kappa was 0.69. In terms of fall initiation, the teams agreed on the cause of falls in 87% of cases (Kappa=0.79) and on the activity at time of fall in 93% of cases (Kappa=0.91). However, there was poor reliability for held objects, footwear, and contribution of clutter. For fall descent, there was good reliability for fall direction and attempts to recover balance by stepping, but only moderate reliability for reach-to-grasp responses. For fall impact, there was good agreement for impact to specific body parts and perceived site of greatest energy absorption, but only moderate agreement on the perceived site of injury risk. CONCLUSIONS: Video capture can reveal important evidence of the cause of real-life falls, if valid analysis tools are available. Comparing responses across two independent teams, we observed good reliability for our video analysis questionnaire in 19 of the 24 questions. This establishes the basis for future use of the tool, in combination with clinical data, for revealing fall mechanisms, and guiding the selection and refinement of fall prevention strategies. Our results indicate the need for improvement in specific aspects of data collection and analysis. For example, an increase in the resolution of videos might result in better reliability for questions such as held objects or footwear. Furthermore, refinement of the questionnaire might address the challenge of accurately perceiving environmental hazards.

Table 1. Inter-rater reliability of questionnaire items.

Stage of fall	Question	Percentage of agreement	Cohen's Kappa
Initiation	Cause of fall	87%	**0.79**
	Activity at time of fall	93%	**0.91**
	Mobility aids	93%	**0.89**
	Held objects	73%	0.33
	Height of fall	100%	**1.00**
	Footwear	67%	0.21
	Floor conditions Wet/Dry	100%	...
	Floor conditions Transition	100%	...
	Lighting	93%	...
	Contribution of clutter	47%	0.14
Descent	Initial fall direction	80%	**0.70**
	Stepping responses	93%	**0.87**
	Reach-to-grasp responses	80%	0.44
Impact	Head impact	80%	**0.60**
	Pelvis impact	100%	...
	Torso impact	80%	**0.60**
	Hand/ wrist impact	93%	**0.84**
	Elbow/ forearm impact	93%	**0.84**
	Knee impact	93%	**0.86**
	Shoulder impact	87%	**0.70**
	Landing configuration (direction)	93%	**0.85**
	Floor material	100%	**1.00**
	Perceived site of greatest energy absorption	93%	**0.84**
	Perceived site of injury risk/ impact severity	67%	0.41

Note: " ... " indicates that Kappa cannot be calculated because both teams always chose the same answer

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O.14.5 A comparison of the cognitive demands of standing, cycling and walking: The contribution of bilateral coordination and postural control to the dual decrement

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BACKGROUND AND AIMS: The effects of dual tasking (DT) on gait have now been studied for several decades. Nonetheless, the mechanisms responsible for the DT cost while walking are not yet fully clear. Walking is a unique task since it requires simultaneous attention to stepping, bilateral coordination and postural control. The individual contribution of each of these three factors to walking under DT has not

been studied systematically. In this study, we tested the contribution of bilateral coordination of stepping and postural control to the DT effect on gait. By assessing the DT cost during standing (i.e., postural load without stepping or bilateral coordination of movement), cycling (i.e., bilateral coordination similar to stepping but without postural demands) and walking, we were able to dissect the individual contribution of each motor state to the cost of DT while walking. As a secondary focus of this study, we aimed to compare the effects of DT on motor performance measures and performance consistency measures (i.e., measures that reflect variability of performance). In addition, we aimed to explore how these issues are affected by aging and Parkinson's disease. METHODS: Twenty-five healthy young adults, 15 healthy older adults, and 21 patients with Parkinson's disease (PD) were assessed while walking, standing, and cycling under two conditions: single task and DT performance. DT costs of performance measures and performance consistency measures were calculated in each posture. RESULTS: For the young adults, the performance of both tasks that involve bilateral coordination deteriorated in response to the DT (as compared with single task performance), while maintaining postural control in the upright position was not negatively impacted by DT, and even improved. For example both gait speed and cycling time deteriorated in the D conditions ($p<0.021$) while measures of center of pressure (COP) displacement improved (i.e. became smaller, $p=0.014$). Similar results were observed in the older adult. In the patients with PD, however, relatively high DT costs were observed even during standing, suggesting that pathology associated with parkinsonism increases the attention demands on both upright postural control and bilateral coordination. In fact, for most motor tasks (i.e., walking, standing and cycling), DT costs were highest for patients with PD. In general, measures of the consistency of performance were more sensitive to cognitive loading as compared to performance measures. CONCLUSIONS: These results suggest that the ability to divide attention varies with the complexity of the motor task, the demands of postural control, and bilateral coordination. Bilateral coordinated movements during walking apparently have especially higher attention demands and should be a future target for intervention in order to decrease DT costs while walking and, ultimately, decrease the risk for falls.

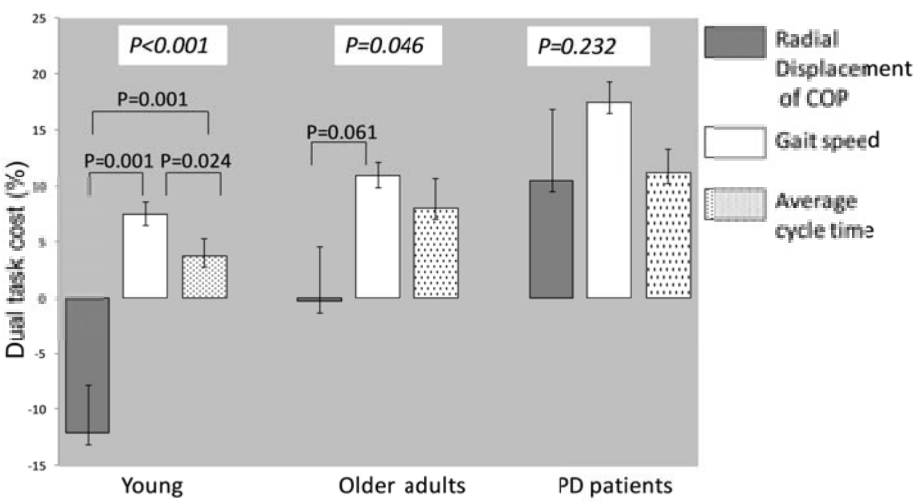

Figure 1: *A comparison of the DT cost of walking, standing, and cycling in each group. This figure illustrates the costs of measures that quantify performance (i.e. gait speed, radial displacement of COP, and average cycle time). P-values in white background refer to main effects while the p-values just above the columns refer to post hoc within group comparisons.*

O.15 ORTHOPEDIC DISEASES & INJURIES, *Cosmos 3A*

O.15.1 The Trondheim Hip Fracture Trial-Impact on mobility.

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BACKGROUND AND AIM: Hip fractures in old age have serious consequences on function, mobility and mortality. New methods within anesthesiology and surgery have reduced length of hospital stay without significant improvement of prognosis. Intervention studies applying a multidisciplinary approach have demonstrated conflicting results. The aim of the present study was to investigate if treatment of old hip fracture patients in an orthogeriatric ward during the hospital index stay has any advantage over standard care in an orthopedic ward. Primary end point is mobility evaluated after 4 months with Short Physical Performance Battery (SPPB). METHODS: A randomized clinical trial (RCT) enrolled 400 home dwelling patients aged 70 years or more, living in the county of Sør-Trøndelag. Randomization was performed while the patients were in the emergency room after a hip fracture was diagnosed. Both groups were operated by the same team of orthopedic surgeons and received the same surgical treatment according to diagnosis and procedures at our hospital. The intervention group received comprehensive geriatric assessment including a work-up by geriatricians, nurses, physiotherapists and occupational therapists. Length of stay and discharge were planned in interdisciplinary meetings. Patients randomized to the orthopedic ward received standard care for the Department of orthopedics. Information on demographic characteristics, pre-fracture use of walking aids, cognitive function, activities of daily living (ADL), instrumental ADL (IADL) and medical information was collected during index stay through interviews with patients and caregivers and review of medical records. ADL was evaluated by use of Barthel Index (0-20) and IADL by use of Nottingham extended IADL scale (0-66). Assessments at the 5th postoperative day and at 1, 4 and 12 months included mobility by use of SPPB and Timed Up and Go (TUG). SPPB measures three different modalities: standing balance, a 4 m walk, and sit to stand from a chair. Maximum score is 4 points on each task giving a total score 0-12 points. One point difference in total score is found to be substantial, while 0.5 points have a small but meaningful effect. RESULTS: Data collection will be closed in January 2012.Group allocation is therefore unknown, but preliminary analyses have been performed. The study sample has a mean age of 83±6 years, 75% are female and 10% live in sheltered housing before the injury. Prefracture median Barthel Index value was 20 points (interquartile range 17-20), and median IADL score was 45(interquartile range 28-57), indicating reduced function before the injury. The mean SPPB score at 4 months was 5.11 (SD 3,04) points, varying from 0 to 12 points. CONCLUSIONS: Preliminary data demonstrate a study sample of old hip fracture patients with restricted mobility 4 months after the fracture. Data comparing mobility in the two treatment arms will be presented at the congress.

O.15.2 Gait characteristics in hip fracture patients 4 and 12 months post fracture

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BACKGROUND AND AIM: Hip fractures are associated with increased need of assistance in activities of daily living, high socioeconomic costs, and reduced quality of life for the individual patients. This functional decline might be partly due to impaired gait function. While regaining of ADL function seems to stabilize within the first four months after the fracture, gait function seems to have a potential for improvement for at least 11 months. However, few studies have described specific gait characteristics in hip fracture patients, or how such gait characteristics change during the first year after the fracture. A better understanding of which aspects of gait are impaired after a hip fracture could help targeting rehabilitation of gait in this vulnerable patient group. The aim of the present study was to describe spatio-temporal gait characteristics in a cohort of hip fracture patients and how these characteristics change during the first year after the fracture. METHODS: Preliminary analysis of 4- and 12-months gait assessments of the first 360 patients (75% women, mean age 83.3± 6) included in an ongoing RCT, the Trondheim Hip fracture Trial2. Gait characteristics were measured by use of an electronic gaitmat (GAITRite). Patients walked back and forth the gaitmat twice in four conditions; slow, preferred, fast, and dual task condition (counting backwards while walking at preferred speed). Selected gait characteristics were walking speed, cadence, step length, and single support. We calculated within-subjects means, asymmetry ratios, and CoV. Changes in gait function were defined as an increase or decrease in gait speed larger than 0.1 m/sec, which is regarded a clinical meaningful change in hip fracture patients 3. RESULTS: 211 of the 360 included patients performed the 4-months gait assessment, of which 166 patients were assessed at both 4 and 12 months. 17% died within the first year, while gait for additional 20% could not be assessed as patients were tested in an institution or at home. Mean values show that gait in hip fracture patients is characterized by slow speed , short steps, and long double support phases in addition to high asymmetry ratios between the feet. Changes in preferred speed indicated that 40% had an improvement of gait during the period, and 5% a decline. Changes in fast speed showed that 40% had an improvement and 20% a decline. Conclusions: Gait characteristics after hip fracture reflect high risk for further functional loss and new falls. Fast speed identified a larger proportion with decline in gait function than did preferred speed and could be a better marker of change. Further analysis will explore what characterizes gait in those patients who have an improvement compared to those who experience a decline in gait function.

Mean ±SD	Speed (m/sec)		Step length (cm)		Single support %	
	4 months	12 months	4 months	12 months	4 months	12 months
Preferred	0.64±0.26	0.68(0.27)	39.1(12.5)	43.2(13.1)	30.0(4.5)	32.2(4.2)
Fast	0.89±0.33	0.94(0.35)	47.8 (14.1)	50.2(14.8)	33.9(4.6)	34.6(3.7)
Dual task	0.54±0.22	0.57(0.23)	40.8(12.6)	41.3(12.7)	31.2(5.3)	31.0(5.2)
Asymmetry │ln(affected/unaffected)│x100			12.7(20.8)	10.2(13.2)	15.2(15.4)	12.4(13.3)

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O.15.3 Do patients with vertebral fractures and/or increased thoracic kyphosis fall more often? Preliminary results of a study among geriatric patients about the relation between falling and gait variability and stability.

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BACKGROUND AND AIM: 51% of geriatric patients is diagnosed with ¡Ý1 vertebral fractures (Van der Jagt-Willems et al. Age Ageing 2011; in press), caused by osteoporosis. It was hypothesized that vertebral fractures increase thoracic kyphosis, bringing the body's centre of mass towards the limits of stability (Lynn et al. Arch Phys Med Rehabil 1997;78:273-7), and thereby increasing the likelihood that any perturbation to balance would require a greater correcting response to maintain equilibrium. This increases the risk of falling in this frail population (Huang et al. Arch Intern Med 1996;156:2469-75), and therefore the risk for further fractures. The aim of the present prospective cohort study was to examine whether the presence of vertebral fractures and the degree of the thoracic kyphosis influences the variability and stability during walking and the amount of fall events in 12-months follow-up. METHODS: So far, 43 patients (aged 80¡À5.5 years) were recruited at a geriatric outpatient clinic (inclusion of patients is ongoing until 120 patients are included). Vertebral fractures were judged with the method of Genant (Genant et al. J Bone Miner Res 1993;8:1137-48). The degree of TK was measured by Cobb angle between T2-T12 (Harrison et al. J Spinal Disord Tech 2002;15:213-20). Patients walked about 160-meter at self-selected speed, wearing a tri-axial accelerometer recording trunk accelerations. Walking speed was recorded, and foot contact moments were derived from anterior-posterior (AP) accelerations, whereof mean and coefficient of variation (CV) of stride times, and consistency of timing (Phase Variability Index; PVI) were calculated. From AP and medio-lateral (ML) trunk acceleration patterns, regularity (Sample Entropy; SEn), and local stability (Short Term Lyapunov Exponent; STE) were calculated (Lamoth et al. J Neuroeng Rehab 2011;8:2). All parameters quantify an aspect of the variability and stability of the walking pattern. Fall events and fractures were registered during 12-months follow-up with a falls-and-fracture calendar. RESULTS: Patients with vertebral fractures (n=22) had less consistent timing (higher PVI values), than patients without vertebral fractures (p=0.025). Other gait variables did not differ significantly between these patient groups. Patients with an increased thoracic kyphosis showed overall a more variable and less stable gait pattern (higher CV of stride times, p=0.015; higher PVI, p=0.008; higher SEn, p=0.030; and lower STE, p=0.030) than patients with a normal thoracic kyphosis. Regarding the fall risk, preliminary results showed that patients with an increased thoracic kyphosis have a higher risk of falling than patients with a normal thoracic kyphosis, although this effect was not significant yet. CONCLUSIONS: In this group of geriatric outpatients, the degree of thoracic kyphosis influences the variability and stability of walking, and increases the risk of falling more than the presence of vertebral fractures.

O.15.4 Introducing a new variable to quantify decoupling of the centre of mass and centre of pressure during gait inititation.

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BACKGROUND AND AIM: Gait initiation (GI) requires sufficient propulsive forces, which are generated by decoupling the centre of pressure (CoP) and centre of mass (CoM). In previous research, the distance between the CoM and CoP has been used to quantify decoupling. This variable has limitations, because it does not take the CoM velocity into account. Hof et al. introduced a new variable, the extrapolated centre of mass (XcoM), which incorporates the CoM velocity. When quantifying decoupling, it is also of

importance to correct for subjects' height, because height is positively correlated to the CoM excursion. This can be achieved by determining the inclination angle between the CoM and CoP. This exploratory trial studied the feasibility of calculating the inclination angle between the XcoM and CoP as a variable to quantify decoupling during gait initiation. METHODS: For this exploratory trial 7 able-bodied (AB) subjects and 1 patient with a transfemoral amputation (TF) were selected. Measurements included gait analysis, using a six camera Vicon system and two AMTI force plates. The Vicon full-body plug in gait model was used to determine the CoM trajectory. Data were collected at a self-selected walking speed (SSWS) and at maximal walking speed (MWS). The patient performed trials leading with the intact and amputated leg. Five trials were analyzed for each condition. Outcome measures included (1) peak inclination angle CoP-xcoM, (2) Peak CoM acceleration during first step, (3) peak CoP displacement leading leg, (4) peak CoP displacement trailing leg, (5) step length first step, (6) CoM velocity after three steps. RESULTS: In the trials of the AB subjects the inclination angle, the peak CoM acceleration during the first step, the peak posterior CoP translations of both legs, and the CoM velocity after three steps were significantly higher during the MWS trials when compared with the SSWS trials. In the SSWS trials of the TF, the inclination angle, the peak CoM acceleration during the first step and the CoM velocity after three steps were higher during the leading prosthetic leg condition. During the MWS trials, the inclination angle, the CoM acceleration during the first step and the CoM velocity after three steps were slightly higher in the leading intact leg condition. CONCLUSIONS: The results showed that the inclination angle between the Xcom and CoP is a feasible measure to quantify decoupling during gait initiation. The TF data suggest that during the MWS trials the decoupling is comparable in both leg conditions, while during the SSWS trials the decoupling is limited in the leading intact leg condition. This suggests that during the SSWS trial the subject chose for stability and safety in the leading intact leg condition and therefore minimized the decoupling. Whether this finding is applicable on a larger group of patients with an amputation should be further elucidated.

	Able-bodied (7)			**Patient with transfemoral amputation (1)**			
				Leading prosthetic leg		**Leading intact leg**	
	SSWS	**MWS**	**p-value**	**SSWS**	**MWS**	**SSWS**	**MWS**
Inclination angle XcoM – CoP (^{0})	36.36 (3.25)	47.51 (7.41)	**0.03**	27.48	37.97	20.89	39.43
Peak CoM acceleration during first step (m/s^2)	1.71 (0.37)	2.87 (0.40)	**0.02**	1.11	1.93	0.82	1.96
Peak posterior translation CoP leading leg (mm)	309.63 (21.44)	333.25 (8.22)	**0.02**	264.22	274.06	292.40	339.38
Peak posterior translation CoP trailing leg (mm)	310.41 (18.61)	324.96 (17.98)	**0.02**	292.12	331.76	261.18	262.02
Step length first step (mm)	443.78 (34.50)	542.81 (129.18)	0.09	237.87	457.40	190.25	411.52
CoM velocity after three steps (m/s)	1.27 (0.09)	1.84 (0.08)	**0.02**	0.86	1.43	0.81	1.45

O.16 NEUROLOGICAL DISEASES IV - PARKINSON`S DISEASE, *Cosmos 2*

O.16.1 Extrastriatal non-dopaminergic neuropathology is a significant modulator of gait functions in mild-to-moderate Parkinson disease

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BACKGROUND AND AIM: Parkinson disease (PD) is characterized by striatal dopaminergic denervation. Associated mobility problems can be compounded in some patients by neuropathology such as leukoaraiosis and (subthreshold) cortical beta-amyloid (Aβ) accumulation. The objective was to investigate the effect of striatal dopaminergic denervation, supratentorial leukoaraiosis, and cortical Aβ accumulation on gait in PD patients who can walk unaided and have no self-reported history or clinical evidence of freezing. METHODS: PD patients [N=77 (20F); 65.9±7.3 (50-84) yrs old; 6.0±4.2 (0.5-20) yrs motor disease duration; modified HY stage 1 (N=4), 1.5 (N=5), 2 (N=22), 2.5 (N=38), 3 (N=8)] underwent [11C]-dihydrotetrabenazine ([11C]-DTBZ) and [11C]-Pittsburgh Compound-B ([11C]-PiB) brain PET scanning to provide an estimate of striatal vesicular monoaminergic transporter type 2 binding and cortical Aβ deposition, respectively. Patients also received brain MRI for estimation of white matter hyperintensity (WMH) burden on the T2-weighted FLAIR sequence. Radiotracers were analyzed using standard non-invasive kinetic models to provide an estimate of Distribution Volume Ratio (DVR). WMH burden was calculated in a semi-automatic fashion as described previously. Normal paced gait was examined with the GAITRite® walk mat in the dopaminergic "off" state providing standard spatiotemporal gait parameters such as gait velocity and cadence. Partial correlations were calculated while correcting for motor disease duration. RESULTS: Decreased gait velocity, but not cadence, was associated with increased WMH burden ($r=-0.279$, $p=0.018$). Neither gait velocity nor cadence did correlate with [11C]-DTBZ DVR. Subgroup analysis limited to PD patients who also received a [11C]-PiB scan (N=26) showed that increased cortical [11C]-PiB DVR was associated with lower cadence ($r=-0.464$, $p=0.019$), but not gait velocity. Removal of 2 "PiB positive" (DVR > 1.3) PD patients yielded a similar result ($r=-0.529$, $p=0.009$). CONCLUSIONS: Gait in PD patients is significantly affected by comorbid supratentorial leukoaraiosis and cortical Aβ accumulation. Further research is needed to assess extrastriatal non-dopaminergic downstream effects of leukoaraiosis and cortical Aβ deposition which may negatively affect effectiveness of dopaminergic mobility treatment in PD patients.

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O.16.2 Effect of Vibrotactile Feedback on Protective Stepping Response in Parkinson's Disease Patients

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BACKGROUND AND AIM: Parkinson’s disease (PD) patients fall and this relates to difficulties with generating a protective step when facing unpredictable balance perturbations. A limitation of previous studies is that the protective step response was studied with predictable stimuli. In addition, treatment of this postural problem of PD is currently unsatisfactory. The purposes of this study are: (i) characterize the protective stepping responses in PD patients in different clinical stages; (ii) examine whether vibrotactile feedback of the impending fall enhances stepping response performance. METHODS: 20

mild PD patients, 7 advanced PD patients and 17 age-matched healthy elderly volunteers were recruited. Subjects were instructed to stand on a motorised platform, which moved unpredictably forwards or backwards, thus perturbing balance and requiring a protective step. During the perturbation, subjects wore an elastic cap which incorporated two vibrators on the forehead and the back of the head as a reminder to prompt forwards and backwards stepping response respectively. Reaction time, length and angular velocity of the first protective step, number of steps taken, total trunk displacement and trunk displacement before taking the protective step were measured in both with and without vibration conditions. RESULTS: All subjects showed significantly quicker reaction time, shorter steps, smaller total trunk displacement and smaller trunk displacement before taking the first protective step when stepping backwards than when stepping forwards. Advanced PD patients took shorter and slower protective steps and also took more steps during the perturbation. There was an overall (across groups) reduction in trunk displacement before taking the protective step with vibrotactile feedback. No feedback mediated improvement of the Parkinsonian stepping response was found. Furthermore, there was a trend for improved performance with feedback in the normal but not in the PD subjects. CONCLUSIONS: Backward protective steps are earlier, shorter and slower than forward steps in all subject groups; this is likely related to bio-mechanical features that provide smaller stability margins in the backwards direction. At initial stages PD patients display protective stepping responses which are normal for their age. However, in advanced clinical stages PD patients show abnormal stepping responses both forwards and backwards. There is no improvement of the stepping response by vibrotactile feedback in PD patients while the elderly showed a trend of improvement with feedback. This suggests that the basal ganglia facilitate the neural processes by which additional sensory feedback can be used to improve motor performance.

O.16.3 Can freezing of gait in patients with Parkinson's disease be alleviated using a motor learning based physiotherapy intervention?

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BACKGROUND AND AIM: Freezing of gait (FOG) is a paroxysmal gait disturbance commonly seen among patients with advanced Parkinson's disease (PD). FOG episodically disables the subjects from producing effective gait. To date, treatment efficacy, e.g., dopaminergic facilitation, exercise and external cueing, is limited. Aim: To test the hypothesis that an intervention that utilizes motor learning provided through intensive exercise can alleviate the symptom. METHODS: 9 subjects with PD suffering from FOG (age: 70±2.3 [SE]; Hoehn&Yahr scale: 3.2±0.3); participated in a 6 weeks progressive gait exercise program (3 training sessions per week - open trial). A training session included FOG provoking situations (e.g., tight turns). Prior to each presumed FOG provocation (e.g., just before a turn), rhythmic auditory stimulation (RAS) was elicited by the experimenter (or in the case a FOG episode). The subject was trained to pace and coordinate left-right stepping and to scale up step size, utilizing the RAS cueing. In each time, the RAS lasted for 5 s or after the FOG or FOG provocation ended, whichever came later. To achieve progressiveness, net training duration increased from week to week and secondary cognitive tasks while walking were added (to increase FOG propensity). Pre- and post- intervention a battery of evaluations was used to assess changes in the FOG symptom burden. Testing included the number and duration of FOG episodes in a given trajectory (corridor walking and curved trajectories) and the scores on subjective questionnaires (e.g., FOG- questionnaire) and the motor part of the unified Parkinson's disease rating scale (UPDRS). RESULTS: Table 1 summarizes the effects of the intervention on FOG

symptoms as measured 3 days before ('pre') and 3 days after ('post') the completion of the training program. Number of FOG episodes in corridor walking decreased from 5.6 ± 1.9 to 1.8 ± 1.3 per trial (p=0.018) when comparing pre and post testing, respectively, and the mean duration of the episodes decreased from 4.8 ± 1.8 s to 1.4 ± 0.7 s, correspondently. The corresponding reductions in curved trajectories when comparing pre to post testing were from 4.5 ± 1.9 to 2.8 ± 2.1 episodes per lap (p=0.168) and from to 4.5± 3.6 s to 1.8 ± 1.2 s (p=0.051). FOG-Q and PDQ scores did not change significantly, and marginally significantly change was seen in the UPDRS motor score (from 42.0 ± 3.5 to 34.8 ± 4.5, p=0.08). CONCLUSIONS: These preliminary results suggest that the physiotherapy based on conditional motor learning principals effectively reduces the freezing burden during typical walking conditions (corridor and curved trajectories). While subjective improvement was not reported by the subjects, objective clinical evaluation points to significant improvements.

Parameter	Pre- intervention	Post- intervention	P value*
Number of FOG episodes - corridor†	5.6 ± 1.9	1.8 ± 1.3	**0.018**
Duration of FOG episodes- corridor (s)	4.8 ± 1.8	1.4 ± 0.7	**0.028**
Number of FOG episodes - curves	4.5 ± 1.9	2.8 ± 2.1	0.168
Duration of FOG episodes- curves (s)	4.5± 3.6	1.8 ± 1.2	**0.051**
FOG-Q score	25.1 ± 1.8	21.8 ± 3.2	0.270
PDQ-score	49.1 ± 8.9	48.9 ± 7.10	0.766
UPDRS motor	42.0 ± 3.5	34.8 ± 4.5	**0.08**

Entries are means ± SE calculated across all subjects. FOG-Q- Fog questionnaire; PDQ- Parkinson's disease quality of life questionnaire; *Non-parametric statistics. † Gait data from one subject who used a different walking aid in the pre and post- evaluations was excluded.

O.16.4 Increased Gait variability of Patients with Parkinson's Disease who are carriers of the LRRK2 G2019s mutation

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BACKGROUND AND AIM: Gait in Parkinson's disease (PD) has been often characterized by impaired gait dynamic that is manifested in part as increased gait variability. The LRRK2 G2019S mutation has been associated an increased risk of developing PD. Nonetheless, previous work has also shown that the phenotype of patients with PD who carry the G2019S mutation is similar to that of patients with sporadic PD. On the other hand, we observed subtle increased in gait variability in otherwise healthy first degree relatives of patients with PD who are carriers of this mutation, compared to non-carriers (Mirelman et al., Ann Neurology, 2011). The association between the LRKK2 G2019S mutation and the ability to regulate the stride-to-stride fluctuations in walking has never been examined among patients with PD. The purpose of this study was to compare the gait of Ashkenazi PD patients who are carriers (C) of the LRRK2 G2019S mutation to that of patients who are non-carriers (NC). METHODS: 91 patients with PD participated in this study. All were Hohen and Yahr II-III. Gait speed and stride-to-stride variability (CV) were evaluated using an accelerometer placed on the lower back (McRoberts Inc.), which collected data in 3 walking conditions: usual-walk, fast walk and during dual tasking (serial 3 subtractions). The analyses of the gait data was performed while blinded to the LRKK2 G2019s mutation

status. RESULTS: 32 patients were carriers of the LRRK2 G2019s mutations and 59 were NC. No significant differences between the groups were observed in age (C: 61.9±8.7 yrs; NC: 60.5±12.2 yrs; p=0.57), gender (C: 56% F; NC:45% F; p=0.34), or disease duration (C: 4.03±5.7 yrs; NC: 2.9±3.4 yrs; p=0.21). Differences were not observed in gait speed during usual walking (gait speed: C: 1.1±0.2 m/s; NC: 1.2±0.1 m/s; p=0.15). Stride time variability (CV) was higher (worse) (p<0.001) during the self-selected pace walk (2.2±1.4%) in the C group as compared to the NC group (1.3±0.4%). These differences were even more pronounced during the challenging walks of dual tasking and fast gait (Dual task- C: 2.7±1.0; NC: 1.9±0.7; p<0.001 and fast- C: 2.2±1.3; NC: 1.5±0.5; p=0.0008). Spectral analysis results were consistent with these findings. For example, the width of the dominant frequency mode in the locomotion band (0.5-3.0 Hz) was larger (i.e., less sharp, more variable gait) for the C (0.7±0.1 Hz) vs. the NC (0.6 ±0.04 Hz) groups (p=0.0001 for dual task condition). CONCLUSIONS: The LRKK2 G2019s mutation apparently is not associated with gait speed (or stride length) in patients with PD. In contrast, differences in gait variability under different walking conditions were observed between patients with PD who are carriers and non-carriers of the LRRK2 G2019s mutation. These findings support the possibility that gait dynamics are, perhaps, related in part to the genetic composition of LRRK2 in patients with PD.

O.17 TOOLS AND METHODS IV, *Cosmos 3C*

O.17.1 A Review of Physical Performance-Related Risk Factors for Falling among Community-Dwelling Older Adults: Potential Clinical Applications of Wireless Sensor Technology

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BACKGROUND AND AIM: Fall-risk in older adults may be estimated using wireless sensor technology to analyse physical performance characteristics during specific activities (Narayanan et al. 2009). Despite its potential uses in clinical fall-risk assessment, barriers to the application of this technology in a clinical context exist. Greater communication and collaboration between developers and clinicians are needed to overcome these barriers e.g. to establish desired functionality and design features (Ní Scanaill et al. 2011). Thus, this review aims to identify which measures of physical performance are clinically-relevant risk factors for falling in this population and to discuss the potential role of wireless sensor technology in their assessment in practice. METHODS: A literature search was carried out in November 2011. Databases searched were: PubMed, Academic Search Complete, AMED, Biomedical Reference Collection: Expanded, CINAHL Plus, MEDLINE, Nursing and Allied Health Collection: Basic, SPORTDiscus, and the Cochrane Library. Key words used were 'falls', 'risk factors', 'physical', 'performance', 'community', individually or in combination. Articles were also sourced via reference lists of relevant articles. Articles were excluded if they were not available in English, did not utilise any measure of actual physical performance, did not measure falls incidence, related to disease-specific populations only or to populations other than community-dwelling adults aged 60 or over. RESULTS: Thirty-seven articles that investigated physical performance in relation to falls incidence were reviewed, dating from 1996 to 2011 inclusive. Risk factors were divided into two categories: standardised physical performance outcome measures and general physical performance measures. Standardised measures were defined as those that have been developed according to a defined test protocol, whereas general measures were those that varied between studies in the precise quantity being measured or in the measurement protocol adopted. Additionally, the current roles and potential applications of technology were explored in the

context of these measures. CONCLUSIONS: Our results confirm that a range of standardised and general physical performance measures can be used to identify community-dwelling older adults at risk of falling. The Timed Up and Go Test, Chair Stand Test and Berg Balance Scale appear to offer the most feasible, valid and reliable standardised methods for clinically assessing physical performance-related fall-risk in this population. Measures of anteroposterior and mediolateral body sway during standing balance tasks, gait speed and variability in temporal gait parameters are also associated with falls incidence. The application of wireless sensor technology to identify fall-risk related kinematic parameters during these measures has the potential to act as a valuable adjunct to current clinical assessments of fall-risk.

O.17.2 The use of the Gait Profile Score to quantify kinematic gait deviations after stroke

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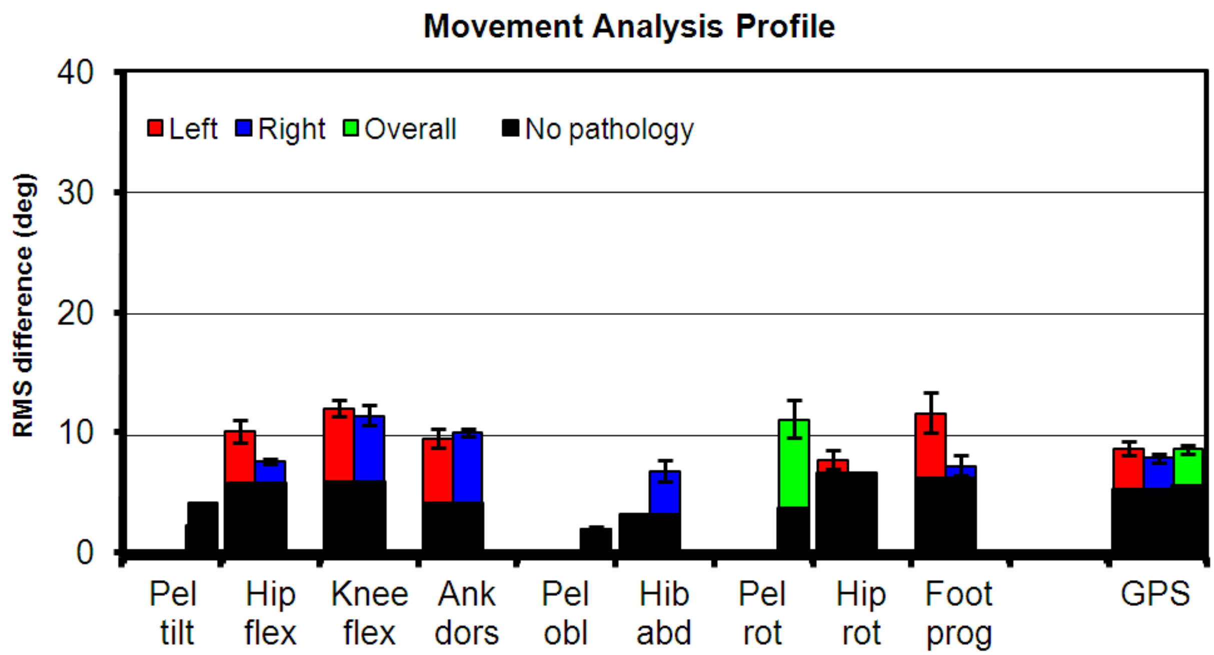
BACKGROUND AND AIM: The Gait Profile Score (GPS) is a recently developed summary index measure that reports the difference between an individual's kinematic gait pattern and reference normative data [1]. Unlike other summary indices, it is typically presented with its' 9 component kinematic variables as a Movement Analysis Profile (MAP). The GPS & MAP together quantify the degree of overall abnormality of the gait pattern, indicating the major source of gait deviations. Higher GPS or MAP scores indicate greater gait abnormality. The GPS has been introduced primarily in the context of clinical gait analysis and orthopaedic interventions in paediatric cerebral palsy. This study aims to explore the validity and utility of the GPS & MAP to describe gait in adults with hemiplegia following stroke. METHODS: Three-dimensional kinematic gait data were captured from 11 individuals aged 62.7 (SD; 13.8) years undergoing rehabilitation after hemiplegic stroke. Six walks were captured at preferred speed and a conventional biomechanical model used to calculate joint kinematics. The GPS and MAP were calculated as the Root Mean Square difference from age-matched reference kinematic data across the whole gait cycle, as previously described [1]. GPS values were obtained for each side (GPSaff, GPSunaff), and a composite overall score (GPSTotal). The magnitude and range of GPS and MAP scores were examined, along with the association of the GPS with gait speed. RESULTS: Participant walking speed varied widely from 0.22 - 1.43m/s (mean 0.76, SD 0.38), reflecting a wide range of gait disability. Overall GPS scores ranged from 4.2° to 14.0°, relative to the reference group GPS score of 4.0°. The MAP showed highest mean deviations at the knee (9.4°), hip (7.6°) and ankle (6.7°) in the sagittal plane. Inspection of the individual MAPs frequently revealed large deviations on the unaffected side, particularly at the sagittal plane hip and knee in those who walked most slowly. These deviations reflected both compensatory and speed-related gait patterns, with altered joint motion and phase duration timing relative to reference data. Individual MAPs further highlighted bilateral deviations at the pelvis and foot in the transverse plane. The GPS was moderately correlated with walking speed (rho = -.75, p = .008). A MAP from a single individual is illustrated in the Figure. CONCLUSIONS: The GPS and MAP identified and quantified common sources of deviation in hemiplegic gait, showing major gait deviations at the hip, knee and ankle in the sagittal plane. Increased GPS and MAP scores for the unaffected side reflects the bilateral nature of gait abnormality after stroke. The correlation of the GPS with gait speed reflects that this measure of overall gait pattern quality is closely associated with functional gait ability.



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O.17.3 Methodologies to Combine Objective Measures of Mobility in PD

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BACKGROUND AND AIM: We have recently introduced an objective and quick clinical test to assess important aspects of mobility including postural sway, anticipatory postural adjustments (APA), gait and turning called ISAW. While obtaining objective, reliable and sensitive outcome measures is desirable, the large number of outcomes could make clinical decision making difficult. The objective of this study was to investigate different methods to combine these objective measures into objective scores. METHODS: Sixty eight subjects with moderate Parkinson's disease (PD) (age 66.6 ± 6.3 years, UPDRS motor score was 33.3 ± 10.3) old were tested (ON state). Each subject performed 3 trials of ISAW. The ISAW analysis algorithms automatically estimated a number of objective measures related to postural sway (65), APA (10), gait (57) and turning (7). Only 24 measures with moderate or better test-retest reliability (ICC > 0.7) across the 3 trials were considered. Measures from the 3 major components of ISAW were present. Data from 75% of the subjects was used for training and the rest for validation. Postural Instability and Gait Deficiency subscore of motor UPDRS (PIGD) was selected as the gold standard. Three different model building strategies were evaluated: 1) Linear combination of the measures (LM) with AIC for model selection. We used LEAPS to evaluate all possible subsets of the measures up to 5 components. 2) Random-Forest. We used an ensemble of 1000 decision trees to build a random forest (RF). 3) Factor analysis (FA). We used exploratory factor analysis and selected 4 latent variables as the underlying factors explaining the data. These factors were linearly combined to estimate PIGD. RESULTS: FA

method found 4 factors mainly related to gait speed, range of motion of the upper limbs, stride-length and balance. Table 1 shows the correlation between the estimated and real score for each model building method. Performance of all methods on the training dataset was good while RF method showed exceptional results. On the validation dataset, however, performance was poor with RF method showing the best results and LM model showing the worst. CONCLUSIONS: Results suggest that building a predictive model to estimate a semi-subjective clinical scale is difficult. Clinical scores such as PIGD might be just too noisy to be used reliably as a gold standard to build objective scales. RF method showed the best predictive results, yet its accuracy remained low. However, RF is hard to interpret and behaves like a black box, making it a poor choice for clinical decision making. While FA results were slightly worse, it could summarize the large set of the objective measures into few, easy to understand factors. Finally, since this is a purely objective thus we believe at this stage FA method might be more practical and more useful than other methods.

Table 1. Correlations between UPDRS PIGD subscore and its objective estimates.

Method	Training set	Validation set
Linear model	0.75	0.08
Random Forest	**0.97**	**0.28**
Factor Analysis	0.70	0.14

O.17.4 Calibration and sensitivity control in the human vestibular system

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BACKGROUND AND AIM: Unlike the spatially encoded visual signal, the vestibular signal of rotation is frequency encoded. As factors other than turn influence firing rates, we presume that there is no specific firing rate that indicates zero rotation, and that a specific change in firing rate does not always represent the same change in angular velocity. METHODS: In healthy subjects, galvanic vestibular stimulation (GVS) and whole-body rotation were applied to determine effects on perception, balance and gait. RESULTS: To determine if vestibular sensitivity is modulated according to the intensity of background or preceding movement, much like auditory sensitivity, we examined perceptions of rotation evoked by GVS and real rotation before and after 20-minutes of conditioning with stochastic rotation. This conditioning attenuated perceptual responses to 1/3 of pre-stimulus levels for at least an hour. Thus, prior movement modulates perceptual sensitivity in the vestibular system. The following studies show that at some level of processing the vestibular canal signal is also "calibrated" to the reference frame provided by vision. Subjects attempted to walk straight ahead with the eyes shut to a previously seen visual target. If a per-cutaneous galvanic stimulus was delivered to bias canal afferent firing rates, subjects walked a curved trajectory, deviating from the target in the direction of the side receiving anodal current. If however, subjects were pre-conditioned by GVS delivered during a walk with the eyes open, it no longer caused them to deviate from the target when the eyes were shut. This could be explained by down-regulation (i.e. ignore the unreliable vestibular and rely on somatic signals), or by recalibration of the signal that represents zero turn. To determine which, subjects were pre-conditioned with vision and GVS, but the stimulus polarity was reversed when they shut the eyes to walk. This caused a large deviation in gait consistent with recalibration of the canal signal rather than down-

regulation of its influence on motor output. This process is akin to recalibration of the offset of the vestibular signal. To determine whether the gain of the system is calibrated, bipolar bilateral GVS was coupled to the roll angular velocity of the head to increase the response of the canals to head movement when standing. With the eyes shut, subjects were immediately unstable and could not stand for more than short periods. On opening the eyes, they regained stability as the stimulus continued. After a minute they shut the eyes again and could maintain stable balance, but now they became unstable when GVS was turned off. CONCLUSIONS: These experiments reveal three forms of rapid plasticity and modulation of vestibular responses. These effects could arise peripherally or through vestibular efferent modulation, more central but specifically vestibular processes, or non-specific central processes. The challenge is to work out what happens where.

O.18 SENSORIMOTOR CONTROL II, *Living 4*

O.18.1 Sensory reweighting of the left and right leg during human balance control

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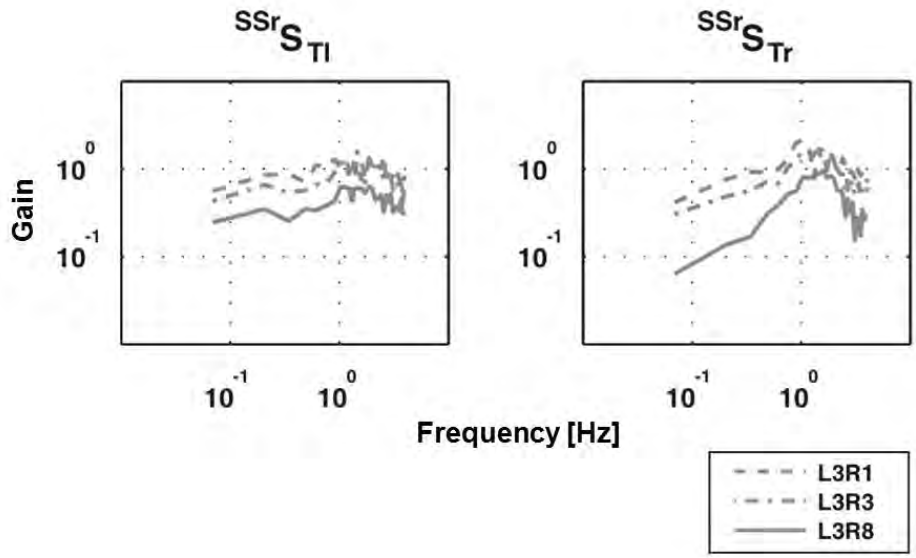
BACKGROUND AND AIM: To maintain upright stance in a gravitational field, sensory information from different complex sensory systems (i.e. visual, vestibular and proprioceptive), is combined to produce a corrective torque. It has been hypothesized that information from the most perturbed sensory system is down weighted and the more reliable information from the other systems is up weighted and thus is used more during balance control. So far, no distinction is made between the contribution of the left and right leg. However, the two legs of the human body both have their own proprioceptive information. Here, we investigated how proprioceptive information of each leg is combined to maintain upright stance. METHODS: Ten healthy subjects were asked to maintain their balance with eyes closed while proprioceptive information of each leg was perturbed independently by separate rotations of the support surfaces around the ankle axis. Two conditions were tested: the perturbation amplitude of one support surface was increased over trials, while the other support surface did not move or was perturbed with constant amplitude. Body sway and reactive ankle forces and torques were measured. Using system identification techniques, the sensitivity of the ankle torques to the perturbation amplitudes was determined. The gain gives the ratio between the perturbation amplitude and response amplitude on specific frequencies. RESULTS: Increasing amplitude of the sensory perturbation of one leg influenced the corrective torques of both legs; this resulted in saturation of both ankle torques. Hence, we found a nonlinear relation between perturbation amplitude and response amplitude. In the frequency domain, a significant decrease in gain of the sensitivity functions from the increasing perturbation to both ankle torques was found (Figure 1). The sensitivity function from the perturbation of the other leg (perturbed with constant amplitude) to both ankle torques showed no significant differences. CONCLUSIONS: Proprioceptive information from each leg is weighted independently and the weight decreases with perturbation amplitude. Weighting of proprioceptive information of one leg has no influence on the weight of the proprioceptive information of the other leg. According to the sensory reweighting hypothesis, vestibular information must be up weighted, as closing the eyes eliminated visual information. Further research will focus on the relation with asymmetry in balance control found in e.g. Parkinson 's disease. Figure 1: Gain of the sensitivity functions of the right support surface to the left (SSrSTl) and right (SSrSTr) ankle torques. The different lines indicate the different

conditions; the amplitude of the left support surface remained constant whereas the amplitude of the right support surface increased (0.1, 0.3 and 0.8 radians).



O.18.2 Proprioceptive Gain in a Balance Control Task

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INTRODUCTION: Proprioception plays an important role in the control of balance and posture. Fitzpatrick et al (1994) showed that proprioception alone was sufficient to maintain balance in a task equivalent to human standing, demonstrating that the sensory organs in the muscles, tendons and skin can detect small joint movements and provide useful feedback. Here, we investigate the consequences of changing the magnitude of proprioceptive inputs in a balance control task. METHODS: Subjects were strapped around the waist to a vertical backboard to eliminate their sway. They stood on two servo controlled footplates that could rotate around the axis of the ankle joints. With their eyes closed subjects balanced a virtual inverted pendulum that was matched to their own body characteristics. The angle of the virtual inverted pendulum was reflected in the angle of the footplates. We varied the gain between the sway of the pendulum and the rotation of the ankles. For 'physiological' gain (gain = 1), as the pendulum swayed forward by 1 degree, the subjects ankles were dorsiflexed by 1 degree. At a gain of 3, if the pendulum swayed forward by 1 degree, the subjects' ankles were dorsiflexed by 3 degrees. In all cases the torque required to stabilise the sway of the pendulum was identical: only the relationship between pendulum sway and ankle angle was changed. We varied the ‘proprioceptive gain’ between the following values: 0.3, 0.5, 1, 2 and 3. The experiment consisted of two conditions: 1) Myoelectric balancing of the virtual inverted pendulum using the lower leg muscles (soleus and tibialis anterior); 2) Myoelectic balancing of the virtual inverted pendulum using the flexor and extensors of the wrist. Control with the lower leg muscles allowed for voluntary control and local reflex control as in normal standing. Control with the wrist allowed for voluntary control only. RESULTS: In both conditions sway size and velocity of the inverted pendulum showed a systematic reduction as proprioceptive gain was increased. At equivalent gain settings sway size and velocity were smaller when myoelectric control derived from the leg muscles was used. DISCUSSION: Increasing the proprioceptive gain may mean that thresholds for detection of sway are attained more quickly permitting more rapid and effective corrective action. Control using leg muscles is superior either because myotatic reflexes are possible or because it is a more familiar task which subjects found easier to perform because sensation and the controlling muscles are co-localised. These differences are discussed.

O.18.3 The short-term effects of added mass on plantar sole sensitivity during upright standing

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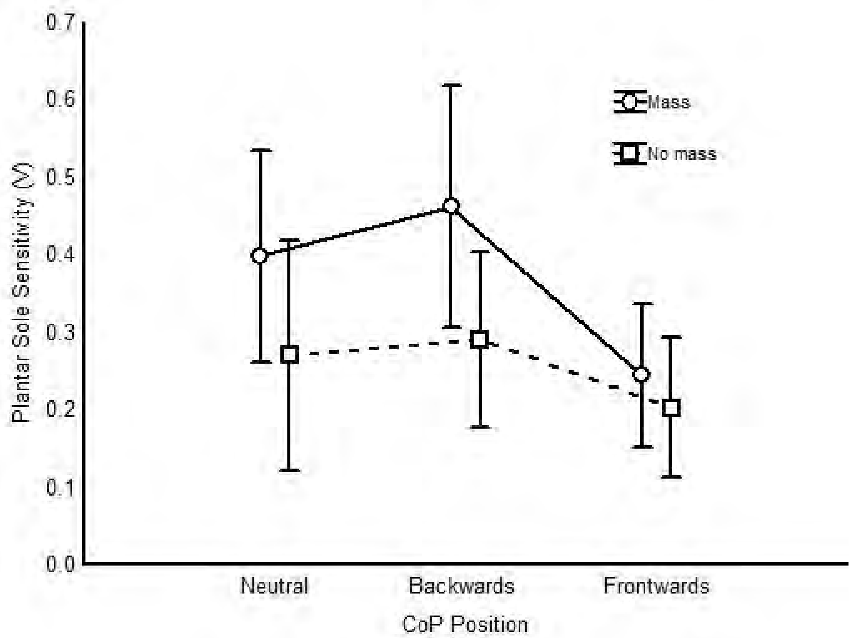
BACKGROUND AND AIM: It has been observed that obese adults and children have impaired balance control. Two possible explanations for these observations have been discussed in the literature. The first is a greater mechanical demand due to a centrally accumulated mass that requires a greater gravitational torque to control normal body oscillations. The second is a possible reduced plantar sensitivity from a hyper activation of the plantar mechanoreceptors due to the continuous pressure of supporting a large mass. Presumably, this reduces the quality of the somatosensory information that the CNS receives for balance control. The first aim of this study was to test if displacing the centre of pressure influences plantar sole sensitivity. The second aim was to test if there is a short term effect of an added mass on plantar sole sensitivity during standing balance control. METHODS: Ten males (height 178±5cm, weight 78.3±8.2kg, BMI 24.7±2.2 kg/m2, age 23.9±3.8 years) participated in this study. A custom force platform was used to measure plantar sole sensitivity and balance control. The standing surface of the platform was perforated with 15mm holes (20mm apart). Two DC motors controlled a servo actuator that moved a small pin through any of the holes in the platform. Heel plantar sole sensitivity was determined via a psychophysical approach. Briefly, once contact was established with the foot (measured with a force cell), the motor gradually increased (or decreased) the amplitude by steps of 0.05mm. Independent variables were: centre of pressure (CoP) position (back leaning, neutral position and forward leaning - each performed twice) and added mass/no added mass condition (23kg vest). In total, the experimental protocol consisted of twelve trials of six minute duration. Dependent variables were: CoP displacements and plantar sole sensitivity. RESULTS: Repeated measures analysis was performed on CoP displacements and plantar sole sensitivity. CoP displacement: There was a significant difference between the CoP anterior-posterior movements for each position ($F(2, 18)=73.57$, $p<.001$) confirming that CoP position changed for each condition. Plantar sole sensitivity: The interaction between the mass and the CoP position for plantar sole sensitivity was not significant ($F(2, 18)=2.36$, $p=.12$) (figure 1). A significant effect was present for CoP position indicating a change in plantar sole sensitivity in each condition ($F(2, 18)=8.62$, $p<.01$). Displacing the CoP from a neutral position (e.g. forwards, backwards) changes the plantar sole sensitivity of the heel. A significant weight effect was also present indicating that plantar sole sensitivity decreased between the added mass and no added mass condition ($F(1, 9)=5.99$, $p<.05$). CONCLUSION: This suggests that an added mass during upright standing reduces the plantar sole sensitivity. These results have implications for understanding the reduced balance control observed in overweight and obese individuals.



O.18.4 Adaptation during postural lean aftereffects differs in young, healthy elderly and Parkinson's Disease

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BACKGROUND AND AIM: Normal upright posture relies on sensory input about the orientation of the support surface and a combination of phasic and tonic neuromuscular processes. This study focuses on the long-term tonic responses called postural lean after-effects (LAE) and how they are affected by aging and age-related neural disease. LAE can be induced after prolonged standing on a toes-up tilted surface which subsequently causes the center-of-pressure (COP) to shift forward during quiet stance (QS) or causes a toes-ups surface tilt on a COP sway-referenced (SR) surface [1]. In aging and PD populations fast phasic postural reactions are affected [2], but in this study we examined the effect of slow tonic processes on posture. METHODS: 13 healthy elderly (63±8 yrs), 17 young (26±5 yrs), and 3 PD adults were tested. Baseline conditions were eyes-closed QS on a stable surface or standing on a SR surface. Four experimental conditions combined two types of toes-up ramp tilt adaptation (120s of toes-up static 7º tilt or sinusoidal 7º±3º tilt) with two types of post-adaptation (120s of QS or SR). RESULTS: LAE during post-adaptation QS showed significant anterior COP shift for both young and older adults (F2,60= 13.4, p<0.0000), but not PD (p=0.27,n.s.). All young and all but two older adults showed LAE during post-adaptation QS. Compared to young, LAE in elderly showed longer decay constants and did not return to baseline COP within the 120s post-adaptation period [F(1,28)= 4.5, p<0.05]. After-effects during SR which appeared as toes-up surface tilt were highly significant in healthy populations but not PD [F(4,60)= 5.18, p=0.001]. Young adults showed significantly larger dorsiflexion [F(1,28)= 6.9, p<0.01] and faster decay constants than older adults [F(1,28)= 5.3, p<0.05]. In PD, SR surface tilt aftereffects were absent after toes-up adaptation (p=0.4, n.s.). CONCLUSIONS: In summary, 1) postural aftereffects decayed to baseline when post-tilt surface was stable but returned to toes-up tilt during SR post-adaptation, 2) aftereffects differed between healthy age groups, 3) PD subjects show less adaptation to surface changes than healthy elderly. Differences in size and decay of aftereffects between young,

elderly and PD subjects suggest tonic neuromuscular processes play a role in how adaptable postural control is to changing surface conditions and this is affected by aging and basal ganglia function.

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O.19 EXERCISE II – AGING, *Cosmos 3C*

O.19.1 The effect of lower limb muscle fatigue on obstacle negotiation during walking in older adults

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BACKGROUND AND AIM: Tripping over obstacles commonly causes older people to fall when walking in challenging environments[1]: this may be attributed to age-related declines in physical function. Muscle fatigue can lead to a loss of strength, and has been shown to alter gait patterns in older adults during unobstructed walking[23]. However, in real-life situations, older people walk in distracting and challenging environments. This study investigated the effect of lower limb muscle fatigue on obstacle negotiation under dual-task walking conditions in older adults. METHODS: 30 older adults (13 women; aged 78.3 [6.2] years) negotiated a 12m obstacle course at their preferred walking speed, whilst simultaneously completing a secondary visual distraction task under two randomized conditions: rested or fatigued (conducted one week apart). For the fatigue condition, participants performed a repeated sit-to-stand movement, as fast as possible, until they could no longer continue. Knee extensor strength was measured before and after to assess muscle fatigue. Participants then immediately began walking trials. Kinematic data for lead and trail limbs on approach to, during, and after crossing, a height-adjustable target obstacle (10% and 20% of leg length), were collected using a CODA motion analysis system. Vertical loading rate of the lead limb after obstacle crossing was obtained from a Kistler force platform. RESULTS: The mean (SD) number of sit-to-stand repetitions performed was 62.5 (39.6), range 23-202, in a duration of 154.1 (108.3) seconds. Mean (SD) knee extensor strength decreased by 9.5%, from 32.4 (11.7) kg when rested to 29.7 (10.9) kg post-fatiguing task ($p<0.001$). Repeated measures ANOVA showed a statistically significant increase in vertical loading rate of the lead limb after stepping over the 10% obstacle when fatigued, relative to rested ($p=0.046$). Trail limb approach distance, and lead limb landing distance (to the obstacle), showed trends to be shorter when fatigued, compared to when rested. No statistically significant differences ($p>0.05$) were observed between conditions for any variable when negotiating the 20% obstacle. CONCLUSIONS: Lower limb muscle fatigue may reduce movement control in older people, indicated by a significantly greater vertical loading rate of the lead limb upon landing, after stepping over the 10% obstacle. On approach to, and after crossing the low-level obstacle, older adults also appeared to place their feet closer to the obstacle when fatigued, which may increase the risk of trips and/or falls. Successfully negotiating low- and high-level obstacles may require different attentional demands, and explain the lack of findings for the 20% obstacle.

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O.19.2 Perturbation-training can lower daily living fall-risk in community dwelling older adults

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OBJECTIVES: Trips or slips are responsible for about 60% of outdoor falls among community-living old adults. It is therefore highly desirable to develop interventions for preventing such outdoor falls. It has recently been proposed that perturbation training induced via support surface translations (i.e. repeated slips) can be employed to acquire adaptive fall-resisting skills. The purpose of this study was to determine whether the fall-resisting skills acquired from a single perturbation training session can be retained for 6 months or enhanced by an intermediate ancillary session. It was hypothesized that improvements resulting from a single training session, in the control of stability and in generating fall-resisting limb support, would be retained, resulting in lower balance loss and falls than their first novel slip. It was also expected that the single slip delivered at 3 months could further enhance performance. Participants: Forty-three community-dwelling elderly (>65 years). METHODS: Initial perturbation training was applied to all subjects using low-friction platform induced, unannounced blocks of repeated right-side slips, interspersed with non-slips. The single-session group was retested with a single slip 6 months later (n=27). The dual-session group received an additional slip at a 3-month interval, post initial session (n=16), followed by retest at 6 months. Slip outcome (including the incidence of falls and balance loss), dynamic stability (based on the center-of-mass position and velocity) and vertical limb support (based on hip height) were obtained and changes between the first and last slip of the initial session compared with that at 6 months for the single-session. Changes between the single and dual-session groups were analyzed at 6 months. RESULTS: Subjects in both groups reduced their incidence of laboratory induced falls and balance losses from the first to last training slips, which resulted from improved stability and limb support control ($p<0.001$ for all variables). Both groups demonstrated significant retention in all outcome measures at 6 months compared to the first novel slip ($p<0.05$); although there was an increase in balance loss incidence and decrease in stability at 6 months compared to the last training slip ($p<0.05$). The ancillary slip at 3 months led to significantly better control of stability ($p<0.05$), and hence reduced balance loss outcome in the dual-session group at 6 months, than the single-session group ($p<0.05$). CONCLUSIONS: The study showed older adults' still robust retention of fall-resisting skills 6 months after a single session of slip-perturbation training compared to their first novel slip experience. However, performance decay at 6 months was evident compared to performance at end of the initial training session. This memory decay could be slowed by providing a single ancillary slip. Perturbation training conducted in a safe environment could improve older adults' proactive and reactive defense mechanisms against falls. The beneficial effects of single-slip ancillary session combined could be exploited to design paradigms applicable to the frail elderly.

O.19.3 Association between Endurance Walk Capacity and Integrity of Brain Regions important for Processing Speed and Memory in Very Old Adults

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BACKGROUND AND AIM: Higher aerobic fitness assessed by graded maximal treadmill testing in older adults aged less than 80 has been associated with greater volume of hippocampus and prefrontal and parietal regions. Whether these associations exist in adults aged over 80 years is unknown, as maximal exercise testing in this age-group presents challenges. Using Long-Distance Corridor Walk (LDCW), an alternative measure of aerobic fitness designed for older adults, we examined the association between endurance capacity and brain MRI markers of regions related to memory, processing speed, and other subcortical regions. METHODS: Brain MRI and LDCW data were obtained from 313 participants (56% female, 42% black, mean age 82.9 yrs) in 2006-07. The LDCW consisted of a 2-minute walk followed immediately by a 400-m walk with the instruction to "walk as quickly as possible". Endurance capacity was categorized into five groups (coded as dummy with the contraindication group as referent): most fit, somewhat fit, least fit (by sex-specific tertiles), stopped, and excluded with medical contraindications (abnormal vital signs or electrocardiogram results, recent cardiac symptoms or surgery, or recent chest pain, shortness of breath, or fainting). Gray matter volume was computed as percentage of intracranial volume. Multivariable regression models were first adjusted for body weight measured at time of MRI, and further adjusted for age, sex, race, and education. RESULTS: Compared to those with a contraindication (N=56, 17.9%), those able to complete the test (N=187, 59.7%) and those who stopped (N= 58, 18.5%) were slightly younger, were more likely to be male and white, and had a lower BMI. In models adjusted for body weight (Table 1), compared to those with a contraindication, those who were somewhat fit and least fit had: (1) greater volume in dorsal cingulate cortex (p=.044 and p=.018) and (2) lower mean diffusivity (MD) in processing speed-related regions (superior parietal, p=.026 and p=.030; inferior parietal, p=.006 and p=.009; precuneus, p=.027 and p=.004; dorsolateral prefrontal cortex, p=.002 and p=.002; anterior cingulate cortex, p=.008 and p=.047) and dorsal cingulate cortex (p=.002 and p=.003). In addition, those who were most fit had lower MD in entorhinal cortex (p=.006). Results remained significant after further adjustment for age, sex, race, and education. No differences were observed in brain MRI markers between those with a contraindication and those who stopped. CONCLUSIONS: Endurance capacity at somewhat fit and least fit levels in very old adults was associated with less gray matter atrophy in dorsal cingulate cortex and with less MD of processing speed-related regions and dorsal cingulate cortex, whereas most fitness was associated with MD of the memory related region. Future studies are warranted to examine whether ability to complete the test and performance could be used as markers of underlying gray matter integrity in late adulthood.

Table 1. Multivariable regression models with endurance capacity measured at the time of MRI as main independent variable and MRI measures as dependent variables. One model was run for each MRI measure. Models are adjusted for body weight at time of LDCW assessment. Unstandardized regression coefficients, 95% confidence intervals and p values are reported for endurance capacity measures that were significantly associated with MRI measures in univariate models (text in bold).

	Macro-structural –Gray matter volume (higher is better)	Micro-structural – Mean Diffusivity (higher is worse)						
	Dorsal cingulate cortex	Superior parietal	Inferior parietal	Precuneus	Dorsolateral prefrontal cortex	Anterior cingulate cortex	Dorsal cingulate cortex	Entorhinal Cortex
Excluded (n=56)	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Stopped (n=58)	.269 (-.096, .635) .148	-.278 (-.661, .106) .156	-.384 (-.773, .005) .053	-.373 (-.757, .011) .057	-.353 (-.737, .031) .072	-.172 (-.565, .221) .390	-.282 (-.674, .109) .157	-.342 (-.734, .050) .087
Least fit (n=64)	**.430 (.074, .787) .018**	**-.414 (-.789, -.039) .030**	**-.509 (-.889, -.129) .009**	**-.554 (-.929, -.179) .004**	**-.597 (-.972, -.222) .002**	**-.389 (-.773, -.006) .047**	**-.593 (-.975, -.210) .003**	-.061 (-.444, .322) .754
Somewhat fit (n=62)	**.371 (.011, .731) .044**	**-.431 (-.809, -.053) .026**	**-.543 (-.927, -.159) .006**	**-.429 (-.807, -.050) .027**	**-.597 (-.976, -.218) .002**	**-.524 (-.911, -.136) .008**	**-.624 (-1.010, -.238) .002**	-.208 (-.594, .179) .291
Most fit (n=61)	-.139 (-.502, .225) .454	.099 (-.283, .481) .610	-.076 (-.463, .311) .698	-.056 (-.438, .326) .773	-.224 (-.607, .158) .249	-.351 (-.741, .040) .078	-.286 (-.676, .103) .149	**-.547 (-.937, -.157) .006**

O.19.4 Free-living Physical Activity and Brain Structures in Older Adults

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BACKGROUND AND AIM: Initial evidence indicates that greater physical activity is associated with larger gray matter volume 9 years later in late adulthood; yet there exists little concrete information on specific domains of free-living physical activity most strongly associated with brain structures in the elderly. This study examined longitudinal associations of multiple free-living physical activity (PA) domains with brain MRI markers of multiple networks in a well-characterized cohort of 313 older adults. METHODS: Three measures of PA were computed at study entry based on self-report questionnaires using previously developed methods: intensity (light < 3 METs, moderate 3-6 METs, and vigorous > 6 METs), activity type (lifestyle and exercise), and volume (low and recommended by 150 min/wk in PA of any intensity). Brain magnetic resonance images (MRI) were obtained at the Pittsburgh site on 3Tesla scanners in 2006-07. Macro-structural measures included white matter hyperintensities (WMH) and gray matter volume (GMV). Integrity of micro-structure was measured using diffusion tensor imaging separately for normal appearing white (fractional anisotropy, FA) and gray matter (mean diffusivity, MD). GMV was computed as percentage of intracranial volume. Multivariable regression models with PA categories (coded as dummy) were first adjusted for body weight at study entry, and further adjusted for age, sex, race, and education. Additional models were adjusted for smoking status, alcohol consumption, and cognition measured as Digit Symbol Substitution Test at study entry and for changes measured as Modified Mini-mental State Examination from study entry to time of brain MRI. RESULTS: The mean age of the cohort (N=313) was 82.9 yrs in 2006-07, 56% female, and 42% black. Compared to those who were sedentary, participants, engaging in light and moderate intensity PA at study entry, had larger bilateral hippocampus and parahippocampus (p<.05). Participants who were exercise active had

lower MD in bilateral anterior, dorsal, and posterior cingulate cortex ($p<.05$), while participants who were lifestyle active had lower MD in the anterior cingulate cortex ($p<.05$). Results remained similar after further adjustment for age, sex, race, education (Table 1), and other covariates. PA volume was not associated with any brain MRI markers. CONCLUSIONS: This study indicates that intensity and type of PA, but not volume, are associated with characteristics of gray matter 9 years later in older adults. There was an almost non overlapping association of PA measures with the spatial distribution and type of MRI measures. Intensity was associated with volume of memory-related regions (hippocampus, parahippocampus), whereas type was associated with mean diffusivity of the cingulate cortex, an important hub for processing speed and memory. These preliminary findings suggest that engaging in a variety of PA at light and moderate intensity may be optimal for brain health over time.

Table 1. Multivariable regression models with intensity and type of PA measured at study entry as main independent variable and MRI measures as dependent variables. One model was run for each MRI measure. Models are adjusted for body weight, age, sex, race, and education at study entry. Unstandardized regression coefficients, 95% confidence intervals and p values are reported for PA measures that were significantly associated with MRI measures in univariate models (text in bold).

		Outcome: MRI measures				
		Gray matter volume[1]		Mean diffusivity[2]		
		Hippocampus	Para-hippocampus	Anterior cingulate cortex	Dorsal cingulate cortex	Posterior cingulate cortex
Intensity	Sedentary[3]	reference	reference	reference	reference	reference
	Light	**.436 (.081, .791) .016**	**.497 (.137, .858) .007**	-.033 (-.393, .328) .859	.032 (-.336, .400) .863	.060 (-.314, .435) .752
	Moderate	**.479 (.106, .852) .012**	**.426 (.048, .805) .027**	-.080 (-.459, .299) .679	.124 (-.262, .511) .527	.002 (-.392, .395) .994
	Vigorous	.116 (-.269, .501) .554	.166 (-.225, .556) .405	-.077 (-.469, .314) .697	-.122 (-.521, .277) .548	-.046 (-.452, .360) .824
Activity Type	Sedentary[4]	reference	reference	reference	reference	reference
	Lifestyle	-.039 (-.377, .298) .819	-.287 (-.627, .054) .099	-.224 (-.559, .111) .189	-.190 (-.533, .153) .277	-.145 (-.492, .202) .411
	Exercise	-.120 (-.477, .238) .511	-.198 (-.559, .163) .282	**-.368 (-.723, -.013) .042**	**-.380 (-.744, -.017) .040**	**-.390 (-.758, -.022) .038**

[1]: Higher is better; [2]: Higher is worse. [3]: Sedentary is defined as < 1,000 kcal/week in any physical activities; [4]: Sedentary is defined as < 1,000 kcal/week in exercise activity and < 2,719 kcal/week in physical activity.

O.19.5 tDCS improves gait in small vessel disease: a double-blind sham controlled study.

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BACKGROUND AND AIM: To facilitate neural activity in the motor and premotor networks of patients with small vessel disease by combining non-invasive brain stimulation and motor training in order to improve gait and balance. METHODS: We used anodal transcranial direct current stimulation (tDCS) to induce excitatory changes over motor and premotor areas in 17 patients with small vessel disease and gait disturbances. They were divided in 4 groups: two groups underwent gait and balance training with stimulation between two assessments; two groups received no training between assessments. All patients were randomised to receive either real or sham tDCS over 2 separate sessions, in a cross-over double-blind design. Assessments included gait velocity, step length, step length variability and trunk

sway as appropriate for the 'timed up and go test', 6m walk, and retropulsion tests, and the Tinetti gait and balance index. RESULTS: In addition to an overall effect of training (p= 0.02), the combination of anodal tDCS and training improved gait velocity above training alone (p=0.0007) and with it trunk pitch motion. Step length variability decreased with training (p= 0.047) and reduced by 50% in the tDCS+training group compared to baseline. tDCS improved performance in the pull test irrespective of training (p=0?035). CONCLUSION: This is the first study to evaluate tDCS with locomotor training as a treatment for gait disturbance in SVD. Our data support the efficacy of anodal tDCS as a therapeutic treatment for neurological gait disorders, particularly when combined with training or physiotherapy. The effect of repeated sessions of tDCS, however, needs to be explored.

O.19.6 Integrated Motor Imagery Improves Walking and Self-Efficacy of Individuals Post-Stroke

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BACKGROUND AND PURPOSE: Recovery of community ambulation is an important goal and a challenge for individuals post-stroke. Walking velocity can be decreased by as much as 50% and is associated with degree of ambulatory independence. There are limited options for individuals post-stroke to receive treatment in the community. A vicious cycle of a sedentary lifestyle leads to decreased self-efficacy which in turn re-enforces less activity. We have previously reported on using motor imagery to improve walking of people post-stroke. In our previous work we focused on gait impairment training using pure motor imagery. The purpose of this study was to extend our work by combining motor and motivational imagery at the task-level to improve walking and self-efficacy for individuals post-stroke. METHOD: Twenty-two individuals post-stroke (mean age 73 years (±5.6) and chronicity (0.5 -2 years post stroke) participated in a randomized half-cross-over single blinded study. Motor imagery of walking was compared to an executed upper extremity control condition. Walking velocity (10 meter walk), self-efficacy (FESS) and community ambulation (number of steps collected with the Step Activity Monitor (SAM), were measured at pre, post and two-week follow up intervals. The interventions were delivered in the home for 15 minutes, three times a week for four weeks. Imagery tasks included sit-walk, walking in both inside and outside environments that were based on the participant's goals. Motivational aspects of walking imagery included anticipation and reward. Both kinaesthetic and visual modalities were incorporated into the imagery script. Treatments consisted of two minutes of relaxation followed by imagery practice of the tasks. The control group physically practiced upper extremity tasks for comparable time using their goals as the framework for the therapy. Data were analyzed descriptively. The results presented below refer to the first period of the study and are not presented for the cross over phase. RESULTS: Mean walking speed increased 22% for imagery intervention and only 2% for the control group. Self-efficacy scores improved by 25% for both groups. Number of steps decreased by 7% in the imagery group compared to 25% in the control group. CONCLUSIONS: Imagery of walking improved walking speed, self-efficacy but not number of steps taken. The control group did not improve walking or steps taken, however they had a comparable improvement in falls self-efficacy. The findings related to step counts concur with prior observations pointing to it being a discrete gait outcome variable that is not well correlated with indoors ambulation.

O.20 AGING II – GAIT, *Cosmos 3A*

O.20.1 Supraspinal locomotor control during the lifespan

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BACKGROUND AND AIM: Standing, walking, and running are sensorimotor tasks that develop during childhood and are preserved throughout life. The supraspinal brain network controls spinal pattern generators for automated locomotion. The present study used mental imagery of stance and locomotion in functional magnetic resonance imaging (fMRI) to investigate changes in the supraspinal network of healthy subjects during aging. METHODS: Eighty healthy subjects (ages: 6-78 y) were trained for the conditions lying, standing, walking, and running in order to imagine these conditions on command in 20-sec sequences with the eyes closed while lying supine in an MRI scanner. RESULTS: The following BOLD signal changes during locomotion and stance were found to be independent of age: 1) prominent activations in the supplementary motor areas, the caudate nuclei, visual cortical areas, vermal and paravermal cerebellum; 2) significant deactivations in the multisensory vestibular cortical areas (posterior insula, parieto-insular vestibular gyrus, superior temporal gyrus) and the anterior cingulate during locomotion. The following differences in brain activation during locomotion and stance were age-dependent: relative increases in the cortical BOLD signals in the multisensory vestibular cortices, motion-sensitive visual cortices (MT/V5), and somatosensory cortices (right post-central gyrus). In children and in advanced age the multisensory activation was increased. CONCLUSION: The functional activation of the basic locomotor and postural network, which includes the prefrontal cortex, basal ganglia, brainstem, and cerebellar locomotor centers, is preserved throughout lifetime. The mechanism of cortical inhibitory reciprocal interaction between sensory systems during locomotion and stance develops in childhood and declines in advanced age. Consequently, multisensory cortical control of locomotion and stance is increased in children and in the elderly. These findings may indicate a more conscious locomotor and postural strategy in children and aged people.

O.20.2 Impact of age-related brain changes on gait decline - A longitudinal study of older people

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BACKGROUND AND AIM: Associations between smaller brain volumes and poorer gait have been reported in previous cross-sectional studies. However, there have been very few longitudinal studies which would provide a greater support to causality. The aim of this study was to investigate the longitudinal associations between changes in brain structure and walking performance in a population-based study of older people. METHODS: Participants aged 60-86 years were randomly selected from the electoral roll. At baseline and follow-up, study participants underwent high resolution magnetic resonance imaging (MRI) on a 1.5T scanner. Volumes of grey matter, white matter, hippocampi and white matter lesions (WML) were calculated using automated segmentations methods. Gait variables (speed, step length, cadence, step width) were measured using a GAITRite computerized walkway. Brain infarcts at baseline were identified by consensus between 2 experts. Linear regression methods were used to estimate the effect of change in each brain variable with change in each gait variable. Time between appointments, age, sex, BMI, education level, total intracranial volume and medical history

were used as covariates. Interactions were tested between change in each brain variable and covariates. RESULTS: Two hundred and twenty five participants had baseline and follow-up data (mean follow-up 30.6 months). The mean baseline age was 71.4 (SD 6.8) years, 56.4% were male. A greater reduction in white matter volume was associated with a decrease in gait speed (p=0.001), step length (p=0.005) and cadence (p=0.001). Greater progression of WML volume was associated with a decline in gait speed (p=0.04). Greater age amplified the adverse effect of WML progression for step length (p=0.04). The presence of baseline infarcts amplified the adverse effect of grey matter atrophy on cadence (p=0.02). Bilateral hippocampal atrophy was associated with reduced gait speed (p<0.05) and step length (p<0.01), but only right hippocampal atrophy was associated with reduced cadence (p<0.05). CONCLUSION: These findings suggest age-related change in different brain structures may impact differently on gait variables, albeit with some common effects. These results provide insight into the underlying mechanisms of gait control and possible targets for interventions designed to prevent gait decline in older people.

O.20.3 Incident mobility disability in middle-aged and older persons: Its predictors and its relationship with adaptive locomotor performance.

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BACKGROUND AND AIM: Mobility, defined as the ability to walk safely and independently in one's natural environment, is critical for one's independence in daily activities. Although mobility disability is the first stage of the age-related disablement process, few studies have investigated factors that predict mobility disability. The purpose of this study was to identify determinants of 3-year incident mobility disability in participants who did not report mobility disability at baseline and its relationship with adaptive locomotor performance (ALP), in middle-aged and old persons. METHODS: The knee extensor strength, visual contrast sensitivity, cognition, depression, social support, level of education, age, sex and BMI were recorded at baseline for the population-based middle-aged and older cohort (n=622, age 50-85 years, 53.8% women) enrolled in the InCHIANTI study. Their mobility disability was recorded at baseline and 3-year follow-up using a standard self-report: self-reported inability to walk up a flight of stairs without support or inability to walk a quarter mile without stopping. Normal walking speed and speed in 4 adaptive locomotor tasks (fast walking, narrow-based walking. walking while talking and obstacle crossing while walking) was measured. RESULTS: The incidence of mobility disability at 3-year FU was 13.5% (men 8.7%, women 17.6%). Quadriceps strength in gender-specific lowest quartile, visual contrast sensitivity <1.7 on Pelli-Robson chart, significant depressive symptoms (CESD score >16), age ≥75 years and female sex were independent predictors of 3-year IMD (ORs 16.516-1.848) (Table 1). Adjusting for normal walking speed, participants with incident mobility disability at FU were significantly slower in adaptive locomotor tasks even at baseline. CONCLUSIONS: Modifiable sensorimotor and psychological factors may contribute to incident mobility disability over 3 years. Although self-reported mobility disability is traditionally considered as the first stage of the age-related disablement process, differences in adaptive locomotor performance are evident even before middle-aged and older persons report overt mobility disability.

Table 1. The predictors of 3-year incident mobility disability. Model 1 included only demographic variables (age group, sex). In addition to demographics, model 2 also included baseline variables that were different (p<0.100) between the participants with and without 3-year incident mobility disability.

	Model 1			Model 2		
variable	B(SE)	p	OR(CI)	B(SE)	p	OR(CI)
Age gr		<0.001			<0.000	
Age gr 1 (65-74 yrs)	1.959(1.028)	0.067	6.667(0.879-50.579)	1.756(1.039)	0.091	5.791(0.756-44.347)
Age gr 2 (75-85 yrs)	**3.371 (1.019)**	**0.001**	**29.101(3.948-214.056)**	**2.804(1.036)**	**0.007**	**16.516(2.170-125.718)**
Sex	**0.799(0.266)**	**0.003**	**2.223(1.321-3.735)**	**0.708(0.287)**	**0.014**	**2.030(1.157-3.560)**
Low Education[a]				0.037(0.433)	0.931	1.038(0.444-2.426)
Poor Cognition[b]				0.050(0.317)	0.874	1.052(0.565-1.957)
Significant Depression[c]				**0.614(0.268)**	**0.022**	**1.848(1.092-3.128)**
Poor Contrast sensitivity[d]				**0.866(0.384)**	**0.024**	**2.378(1.121-5.044)**
Quadriceps strength lowest quartile[e]				**1.002(0.268)**	**<0.001**	**2.778(1.642-4.698)**
Constant	-4.965(1.025)	<0.001	0.007	-5.189(1.068)	<0.000	0.007

[a]Low Education: education less than high school level
[b]Poor Cognition: Mini Mental State Examination score < 24
[c]Significant Depression: Center for Epidemiological Studies Depression scale score > 16
[d]Poor Contrast sensitivity: Pelli Robson Score < 1.7
[e]Quadriceps strength lowest quartile: men < 17.7kg , women < 11.7 kg

O.20.4 Gait Characteristics Partially Explain the Underestimation of Walking Intensity in Older but not Young Adults

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BACKGROUND/AIMS: The Compendium of Physical Activity links specific activities performed with their respective intensity or MET level. (Ainsworth et al, 2000) These estimates are based primarily on research from young healthy adults and may underestimate intensities in older adults. Factors such as resting metabolic rate, body composition and gait characteristics may impact activity intensity. The purpose of this study is to examine the discrepancy between estimated and measured MET levels for preferred-pace walking in young and older adults; and if gait characteristics explain the discrepancy. METHODS: Twenty-seven young and 26 older (mean ages 24.4 and 77.6) adults independent in ambulation walked at their preferred walking speed on a treadmill while oxygen consumption was determined by analysis of expired gases. Mean oxygen consumption was determined from 2-3 minutes of walking at physiologic steady state. Measured MET level was calculated as mean oxygen consumption (ml/kg/min) divided by 3.5 ml of oxygen/kg/min per MET. Estimated MET level for preferred walking speed was extracted from the Compendium of Physical Activity. Mean gait characteristics (step length, stance time, step time double support time, base of support) were derived from gait recorded using a computerized walkway. Linear regression models were used to examine the contribution of each gait characteristic to the measured - estimated MET difference in young and older subjects. RESULTS: The

Compendium underestimated walking intensities of preferred walking speed by 49% in young and by 74% in older adults. None of the gait characteristics explained the underestimation of walking intensity in young (all p>0.15). Stance time (Beta=-7.2, standard error=SE=2.7, p=0.01, R2=0.20) and double support time (Beta=-16.1, SE=5.8, p=0.01, R2=0.22) partially explained the underestimation in old. CONCLUSIONS: Caution should be used when applying Compendium MET levels to walking activities, especially in older adults. Age-related gait changes that may reduce movement efficiency, increase energy expenditure and subsequently increase the effort of walking partially explain the Compendium's underestimation of walking intensity in older adults. Factors other than gait may impact activity intensity in young adults.

O.20.5 Effect of Age and Vocal Reaction Time on the Kinematics of the First Recovery Step Following Single Unexpected Medial or Lateral Underfoot Perturbations during Gait

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BACKGROUND AND AIM: Elderly falls often occur on uneven surfaces outside the home. Little is known about how stepping on single underfoot perturbation, like a pebble, affects stepping patterns at any age in the presence or absence of divided attention. We examined the effect of age and vocal reaction time on the first recovery step kinematics in response to single unexpected underfoot perturbations. METHODS: Twenty three healthy young (HY; 10 male; mean age 22.0±3.15 yrs) and 8 healthy old (HO; 5 females; mean age 72.0±6.4 yrs) adults were tested. Custom footwear with deployable medial and lateral flaps in the sole was used to unexpectedly perturb the left or right foot once as they walked along a 6-meter walkway at 1.3 m/s. Each perturbation was delivered by deploying a flap during the swing phase ~400 ms before heel contact to cause either ~10o midfoot inversion or eversion during single-support. The flap was retracted on offloading. In the divided attention trials, a high or low tone was sounded 370 ms before the heel strike of the perturbed foot: subjects immediately answered 'yes' if a high tone sounded. For each foot, 6 unperturbed trials with high or low tone, 6 medial and 6 lateral flap perturbation trials with high or low tone, and 8 underfoot medial or lateral perturbation trials without sound were randomized among 38 dummy trials. One way RM-ANOVA was used to analyze the results with p<0.05 being significant. RESULTS: Mean (SD) step kinematics during the unperturbed gait (UnP) and for the first recovery step after medial (MP) or lateral (LP) perturbation with and without vocal choice reaction time (vCRT) tasks are summarized in the table 1. HY responded by significantly altering their recovery step kinematics (p<.04) whereas HO were unable to do so whether or not attention was divided. Across all subjects, walking increased vocal reaction time relative to standing (167.2 ms), and an underfoot perturbation increased it further relative to unperturbed gait (49.6 ms; p<0.05). CONCLUSIONS: Age adversely affects the ability of healthy subjects to respond to an unexpected underfoot perturbation in a single step in the presence or absence of divided attention. These results are consistent with the "posture-first" hypothesis.

		UnP	MP	MP+vCRT	LP	LP+vCRT
HY	**SW** (cm)	15.1 (2.27)	*15.5 (2.39)	14.8 (2.36)	*15.2 (2.61)	15.5 (2.16)
	SL (cm)	71.2 (3.07)	*70.5 (3.17)	71.1 (3.25)	*70.2 (3.37)	70.0 (2.58)
	ST (ms)	578.6 (26.35)	576.3 (26.06)	578.7 (21.77)	580.8 (25.82)	575.2 (22.77)
HO	**SW** (cm)	12.0 (2.77)	11.5 (2.64)	12.4 (2.74)	11.5 (2.97)	11.6 (3.12)
	SL (cm)	67.1 (3.01)	67.2 (3.71)	65.7 (2.97)	*66.3 (3.46)	66.0 (3.66)

ST (ms)	538.4 (20.56)	536.8 (21.16)	534.3 (20.29)	534.8 (24.17)	540.0 (22.58)

Table 1. Mean(SD) step kinematics by age and test condition

O.20.6 Dynamic visual acuity (DVA) during locomotion for targets at near and far distances: effects of aging, head-trunk coupling and walking speed

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BACKGROUND AND AIM: During locomotion, gaze stabilization required for dynamic visual acuity (DVA) is achieved by reducing head perturbations[1]. The target distance influences the relative contribution of the canal and otolith inputs for preserving DVA[2]. We examined the effects of aging, head-trunk coupling and walking speed on DVA at near and far viewing distances. METHODS: 10 healthy participants were recruited in 3 groups [young(Y): 20-35 yrs, Old1(O1): 60-69 yrs, Old2(O2): 70-85 yrs]. The binocular DVA was measured while walking on a treadmill at 0.75 and 1.5 m/s speeds. The monitor that displayed Landolt 'C' optotypes was placed at 50 cm from the eyes for nearDVA and at 3.0 m for farDVA)[2]. On randomly selected trials, the head-trunk coupling was achieved by using the Philadelphia Cervical Collar®. DVA in each walking condition was computed by subtracting static visual acuity in quiet standing from the acuity in that walking condition[2]. A mix factor ANOVA (group x speed xcollar) was performed separately for the near and farDVA. RESULTS: NearDVA declined with the head-trunk coupling ($p=0.021$). Additionally, nearDVA worsened at 1.5 m/s compared to 0.75 m/s ($p<0.001$). NearDVA was better in Y than in O1 and O2 groups ($p=0.043$) at 0.75 m/s walking speed. At 1.5 m/s speed significant differences also appeared between O1 and O2 groups ($p=0.014$). FarDVA declined at 1.5 m/s compared to 0.75 m/s ($p<0.001$) with no effect of collar or age group. CONCLUSIONS: Near DVA that puts significant demands on otolith-based gaze stabilization is more sensitive to normal aging process. These age-related deficits become more apparent at higher walking speeds. Closer targets require significantly higher gaze compensation in the vertical direction. Effect of the collar on nearDVA suggests a possible additive effect of insufficient dampening of the vertical movement (bobbing) of the overall head-trunk coupled complex and inability of the linear vestibulo-ocular reflex to compensate for the consequent high discrepancy, during walking. It is known that farDVA, primarily dependent on angular VOR, declines with increasing walking speed. However, lack of collar and age effect suggests sufficient stabilization of the overall head-trunk complex and minimum age-related decline in angular VOR, respectively, for this purpose. Further investigation is warranted to understand head-trunk kinematics and compensatory ocular responses invoked for maintaining DVA at different distances.

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O.21 DEVELOPMENT OF POSTURE AND GAIT II, *Living 4*

O.21.1 How do you learn to walk? Thousands of steps and hundreds of falls per day

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BACKGROUND AND AIM: For more than 100 years, researchers have described the development of walking based on periodic gait over a straight, uniform path. However, research has proceeded without a natural ecology of infant walking: We know nothing about how much infants walk and how their activity is distributed over time, how far they travel and where they go, how frequently they fall, and how natural locomotion changes with development. Thus theories about walking development and clinical interventions are not connected to data on infants' real-world experiences. The current study presents the first data on infants' natural locomotion. We addressed two questions: Whether functional measures of walking change with development, and whether they relate to standard lab measures of walking skill. METHOD: One hundred thirty-one infants 12-19 months of age (walking from 5 to 289 days) were video-recorded during 15-60 minutes of spontaneous locomotor exploration in a laboratory playroom or in their homes. Coders scored videos for each step and fall, yielding functional measures of walking skill (steps, distance, and falls per hour). Infants also walked over a pressure-sensitive carpet yielding standard measures of walking skill during periodic gait (step length and step width). RESULTS: Experiences with natural walking are immense, right from the beginning: Infants tested within a month of walking onset took M = 2008.4 steps, covered M = 473.3 m, and fell M = 24 times per hour. However, natural locomotion improved with test age and walking age, rs > .33, ps < .001, as did standard measures of walking skill, rs > .60, ps < .001. Moreover, infants who were better walkers according to standard lab measures were also better walkers according to functional measures during natural locomotion, rs > .28, ps < .01, thus for the first time validating standard skill measures in terms of natural infant walking. Across development walking was distributed over time in short bursts of activity in variable contexts: On average, 46% of bouts consisted of 1-3 steps, too short to qualify as periodic gait. CONCLUSIONS: After a century-long tradition of studying the development of walking during periodic gait along a straight, uniform path, we compiled the first corpus of natural infant locomotion. Like standard measures of walking skill, functional measures develop. Infants walked more, traveled longer distances, and fell less with each day of walking. Immense amounts of time-distributed practice in variable contexts can account for this development.

O.21.2 The generation of locomotor trajectories in typically developing children: direct perception-action coupling or cognitive construction of space?

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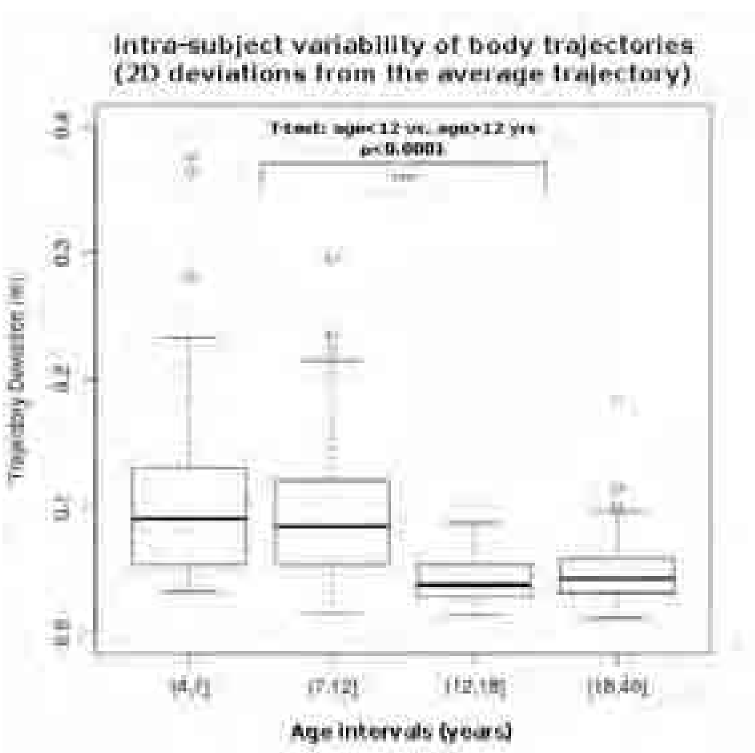
BACKGROUND: In goal-oriented locomotion, gait control has to be coupled with the generation of trajectories through the space of navigation. In this respect, locomotion shares important kinematic features with hand movements (Hicheur et al, 2005), thus confirming Bernstein's idea of motor equivalence. Healthy adults generate stereotyped trajectories and a consistent anticipatory head-turning behaviour (Hicheur et al, 2007), considered evidence of central motor planning. Other authors however claim that locomotor goals are attained by means of direct visual-motor coupling, mostly based on optic flow (Warren, 2001). AIMS: To investigate the typical development of the generation of locomotor trajectories. In particular, to proof the hypothesis that the kinematic invariants shown by adults do not only depend on the maturation of gait synergies, but also require the development of

cognitive strategies for navigation. METHODS: Subjects: 24 healthy subjects aged 4-34 yrs. (6 of 4-7, 6 of 8-12, 6 of 13-18 years, and 6 adults). Task: the subject is cued to reach one out of three luminous targets (centre, right or left), in a randomised order. Fifteen body markers are captured by an optoelectronic system (SMART®, BTS). Signals extracted (yaw plane): whole-body trajectories, absolute orientation of body segments and of walking direction, tangential velocity, acceleration and jerk of the whole body. Parameters: mean total jerk, intra- and inter-subject variability of the trajectory and of the foot-placements, head anticipation (mean distance of head turning from body turning). Statistical analysis: all age-groups compared as to all parameters with one-way ANOVA, and two by two with non-paired samples T-tests. Linear regression analysis performed with log(age) as determinant for total jerk and spatial variabilities. RESULTS: Age-groups significantly differ in total jerk and trajectory variability ($p<0.0001$). The latter decreases until adolescence, when it reaches adult values, while jerk also decreases from adolescence to adulthood ($p<0.001$). After scaling signals by subject's height (Hof, 1996), adolescents and adults no longer differ. Foot placements variability is far less related to age than trajectories variability. Linear regression: strong relationship between log(age) and both jerk and trajectory variability ($p<0.01$). Head anticipation is present in all age-groups, not related to age, but more variable in children younger than 12. CONCLUSIONS: Both total jerk and trajectory variability, as indexes of locomotor optimisation (Pham et al, 2007), only reach adult values in adolescence, i.e. much later than kinematic indexes of gait maturation, which stop changing at about 7 years (Vaughan et al, 2003). The dependence of trajectory generation on cognitive development is further pointed to by the fact that such a developmental trend is not shared by the variability of foot-placements, which is more directly related to the control of gait mechanics.



O.21.3 EMG Activity During Treadmill Stepping: Young Children with Typical Development

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INTRODUCTION: Across the first year healthy infants tend to perform alternating steps when supported upright on a motorized treadmill.[1-2] Kinematic analyses also show that significant changes occur over the year in infants' leg patterns and interlimb coordination [1,3] as is true of all other motor skills over such a wide developmental time frame. Missing is examination of underlying muscle activation patterns that produce these changes in step behavior. This information is critical to understanding how control of stepping emerges in healthy as well as disabled infants. METHOD: We tested 12 infants with typical development (TD) at 1, 6, & 12 months of age and placed EMG electrodes bilaterally on lateral gastrocnemius (LG), tibialis anterior (TA), rectus femoris (RF), and biceps femoris (BF), sampled at 1200 Hz. We supported babies upright on a treadmill for 12, 20s trials presented in 2 sets of 6 speeds: 0, .068, .144, .182 and .220 m/s. We behavior coded: alternating steps, gait events, and non-stepping leg movements. We determined muscle burst onset and end via algorithms applied to EMG traces for each cycle [4]. RESULTS: Step characteristics: With age, infants increased significantly percent of time in stance [$F(2,21)=9.27, p<.001$], decreased leg flexion [$F(2,21)=9.27, p<.001$], and shifted foot contact mid-stance from toe to flat-footed [$F(2,20)=17.5, p<.001$]. Muscle patterns: We analyzed percent of time combinations of LG, TA, RF, & BF were "on" during strides. Results show that "no muscles active" occurred 20% in stance and 40% in swing, with no age effect. "All muscles on" decreased with age [$F(2,12)=6.9, p<.01$]. Agonist-antagonist co-activation decreased with age from 35% to 19% by 12 months. Probability: The probability that each muscle was active at each point in normalized cycles for TA and BF reached 50%. Timing of peak probabilities for TA, BF, and RF did not align with that seen in skilled walkers though peaks for LG did. Probabilities decreased with age. CONCLUSIONS: Results show that infants with TD significantly change leg and foot postures during treadmill stepping over the first year. Muscle activation patterns varied significantly from stride to stride with only the LG showing signs of rhythmic firing. These data suggest that infants have and use many degrees of freedom when supported on a treadmill and behavior is exploratory, rather than prescribed. Changes in patterns over time reflect intrinsic improvements in ability to control their limbs. We argue from a complex systems perspective, this illustrates the many ways in which a kinematic pattern like a step can be produced (muscle combinations) that infants must explore to discover stable movement patterns.

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O.21.4 Bipedal asymmetries during relaxed standing reveal postural control deficits in young adults with CP

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BACKGROUND AND AIM: Postural control in children and adults with cerebral palsy (CP) has been an important research focus for decades. However, studies have typically focused on quite standing only and quantified postural sway characteristics across both feet. It is unknown what postural control deficits might be revealed in persons with CP during standing relaxed and how each foot contributes to posture. The aim of the current study was to investigate bipedal asymmetries in weight-bearing distribution and in postural contribution of the affected and non-affected foot in young adults with CP during quiet and relaxed standing. METHODS: Participants consisted of 9 young adults with CP (mean age 20.6 ± 2.8 years) and 12 young healthy adults (mean age 21.8 ± 3.5 years). Two standing conditions were tested in both groups, one minute quiet standing and one minute relaxed standing. Data were collected using two Kistler force plates, allowing calculation of centre of pressure trajectories, and a video camera. Bipedal asymmetries were calculated with respect to weight-bearing distribution and centre of pressure (CoP) area. RESULTS: During quiet standing, the CP group displayed three different weight-bearing distributions (asymmetric weight bearing on non-affected foot, asymmetric weight bearing on affected foot, and symmetric weight bearing) and a strong bipedal asymmetry in CoP area, $t(8)=-3.267$, $p=.011$. In contrast, the control group displayed one weight-bearing distribution (symmetrical) and bipedal symmetry in CoP area ($p>.4$). From quiet to relaxed standing, the CP group maintained their weight-bearing distributions and bipedal asymmetry in CoP area, $t(8)=-2.613$, $p=.031$, whereas the control group shifted distribution and adopted an asymmetric stance. Although the non-affected side contributed significantly more to adjustments in postural sway in the CP group, the control group displayed no such bipedal difference ($p>.4$). CONCLUSIONS: Compared to healthy controls, the CP group appeared less capable to reduce body movement when instructed to stand still, and less capable to recruit additional movement possibilities when allowed to stand relaxed. Although as a group they did not uniformly unload their affected side during either quiet or relaxed standing, their non-affected side contributed more to postural sway than their affected side.

O.22 VESTIBULAR FUNCTION, *Cosmos 3C*

O.22.1 Postural Responses to Sensory Conflict during Combined Sinusoidal Galvanic Vestibular Stimulation and Optic Flow

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BACKGROUND AND AIM: Sinusoidal galvanic vestibular stimulation (SGVS) and an immersive sinusoidal virtual environment (VE) have been shown to produce corresponding frequency responses in the head and in the position of the body in space. This study investigated how postural behaviors accommodate a visual-vestibular mismatch by presenting SGVS and virtual optic flow at different frequencies. METHODS: Seventeen subjects (20-28 yrs) were immersed in a 3-wall VE while standing quietly on a force plate following informed consent. SGVS at 0.5 mA was delivered (Techno Concepts, France) with the anode and cathode placed over right and left mastoid processes, respectively. Effects of SGVS (Protocol 1) and optic flow (Protocol 2) were individually identified in six subjects. Protocol 1 consisted of two 60 sec trials containing 15 sec of SGVS at 0.25 Hz in a stationary VE. Protocol 2 consisted of six 70 sec trials of VE rotation in the roll plane at 3 frequencies: 0.10, 0.13, and 0.25 Hz. Eleven subjects received two 85 sec trials of VE rotation in the roll plane at 0.25 Hz (Protocol 3.1) or 0.10 Hz (Protocol 3.2) with 20 sec of SGVS at 0.10 Hz (3.1) and 0.25 Hz (3.2) delivered after 40 sec of VE immersion. Fast Fourier transforms (FFT) were performed on center of pressure (COP), head angle (HA), trunk angle (TrkA), and hip angle (HipA) responses for each protocol. Amplitudes of the response at the two input frequencies for 20 sec prior to SGVS (Pre-SGVS), during SGVS, and after SGVS (Post-SGVS) were identified. Amplitudes of the principle frequencies in the HA, TA, HipA and COP data were compared with a repeated measures ANOVA across these 3 periods. RESULTS: Kinematic response frequencies correlated with the input frequencies during protocols 1 and 2. In protocol 3.1, amplitude of the HA

frequency response was significantly larger at the SGVS frequency (0.1 Hz) during SGVS compared to Pre- and Post-SGVS ($p < 0.05$). In protocol 3.2, amplitudes of both COP and HA frequency responses were significantly larger at the SGVS frequency (0.25 Hz) during SGVS compared to Pre- and Post-SGVS ($p < 0.05$). Amplitudes of HA, TrkA and HipA at the frequency of visual rotation did not change during or after the presentation of SGVS, but they were significantly different from the response prior to presentation of the optic flow. During SGVS stimulation, responses at the frequency of visual rotation were also larger than responses at the SGVS frequency. CONCLUSIONS: Results indicate that optic flow more strongly modulates postural behavior than direct vestibular stimulation even when visual flow conflicts with vestibular inputs. Frequency response magnitudes at the head changed with SGVS frequency. Whole body sway, however, was only modified by SGVS frequency when it exceeded the visual frequency. Therefore, the CNS accommodates sensory conflict by differentiating segmental behaviors, the impact of which may not be reflected in the resultant force vector of the whole body.

O.22.2 The effects of postural threat on vestibular reflex gain.

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BACKGROUND AND AIM: Height-induced postural threat is known to induce robust changes in arousal, anxiety, and postural control [1]; however, the mechanisms underlying these postural changes are not well understood. These changes may be related to threat-induced gain changes to the sensory systems involved in postural control. While there is emerging support for this theory from the proprioceptive system [2], there is also indirect evidence to suggest that the gain of the vestibular nuclei might be increased by threat, and thus influence postural control. Anatomical studies have revealed excitatory projections between CNS structures involved in emotional and autonomic control and the vestibular nuclei [3]. Furthermore, arousal and anxiety have been associated with increased vestibulo-ocular reflexes [4]. Therefore, the purpose of this study was to test the hypothesis that height-induced postural threat can increase the gain of vestibular reflexes in postural muscles during quiet stance. METHODS: Postural threat was manipulated by having subjects stand quietly in two threat conditions: LOW (ground level) and HIGH (3.2m above ground). EMG was collected from the soleus (SOL), medial gastrocnemius (MGas) and tibialis anterior (TA) muscles. Each trial consisted of 3min of continuous galvanic stochastic vestibular stimulation (SVS; 2-25Hz, anode right). This bandwidth of SVS was chosen because it elicits muscular responses with minimal correlated postural perturbations during quiet stance [5]. Coherence, signal gain and cumulant densities were calculated within and across subjects [6] and used to assess changes in vestibular reflex gain. RESULTS: Four of 7 subjects had coherence between the SVS and SOL EMG in both threat conditions; a further 2 subjects had coherence in the HIGH, but not the LOW condition. These six subjects were included in the pooled analysis for SOL. Preliminary evidence suggests that coherence is increased between SVS and SOL EMG between 5 and 12Hz, and a slight increase between 13 and 16Hz. This observation is accompanied by a slight increase in signal gain calculated between 5 and 12Hz and larger amplitudes for both peaks of the biphasic muscle response observed in the cumulant density [5]. Coherence in both threat conditions was inconsistent in MGas and TA, and therefore was not analysed further. CONCLUSIONS: These preliminary data support the theory that postural threat induces an increase in the gain of the vestibular system. These changes may reflect an attempt by the body to amplify incoming sensory information related to posture in this highly threatening scenario, in order to gain a richer sensory picture of the current postural state.

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O.22.3 Vergence and standing balance in subjects with idiopathic bilateral loss of vestibular function

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BACKGROUND AND AIM: There is a natural symbiosis between vergence and vestibular responses [1]. Deficits in vergence can lead to vertigo, disequilibrium, and postural instability in quiet stance [2,3]. This study examines vergence eye movements in patients with idiopathic bilateral loss of vestibular function. It also examines standing balance and its relation to vergence.. METHODS: 11 patients (49.5± 12.6 yrs) participated in the study. Total bilateral loss of vestibular function was objectivated with a caloric test (44-30° water irrigation combined with VNG) a rotatory vestibular test, and the Head impulse test. Vergence testing: An LED display with targets at 20, 40, and 100 cm along the median plane was used to elicit vergence eye movements, recorded with the IRIS device Standing balance: Four conditions were run, each lasting 1 min: fixation at 40 cm requiring sustained convergence of 9°; fixation at 200cm requiring reduced convergence (2°); this condition was repeated with eyes closed. In the fourth condition, two LEDs, one at 20 and the other at 100 cm, were light on, one after other for 1sec, causing the eyes to converge then diverge. Standing balance was recorded with an accelometer placed at the back at the approximate height of the center of mass (McRoberts, Dynaport -sway test). Sixteen controls (30.06± 8.13) were also tested. RESULTS: Vergence- Relative to controls, convergence eye movements in patients showed significantly lower accuracy (gain 0.6 vs 0.8), lower mean velocity (30°/s vs 40°/s), and saccade intrusions of significantly higher amplitude (2.8° vs 1.2°). In contrast, their divergence eye movements were normal. Balance: The normalized 90% area of body sway was significantly higher for patients than for controls while fixating at far (eyes open 3.29 vs 1.63 mm2/s, eyes closed 5.36 vs 1.97), as well as the RMS of AP displacements. With eyes closed, the RMS of ML and AP velocity was significantly higher in patients (25.09 vs 15.7mG, 14.26 vs 6.64). For all conditions, the mean power frequency was significantly lower for patients than for controls (all at $p<0.05$). For patients only, the area decreased significantly when performing vergence eye movements compared to fixation at far (5.362 vs 2.07 2mm/s). CONCLUSIONS: Abnormal convergence is in line with prior reports for symbiosis of vergence and vestibular systems; loss of vestibular function deteriorates convergence. Balance instability shown by larger area and velocity is also expected to result from vestibular loss as well as the lower mean power frequency. The improvement of balance by vergence movements could be mediated by efferent and afferent oculomotor signals [4]. Functional exploration of vergence and re-training may be of interest in such patients.

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O.22.4 Lack of vestibular information alters navigational behaviour and brain activation during real navigation

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BACKGROUND AND AIM: Patients with bilateral vestibulopathy show deficits in virtual spatial orientation tasks. The present study aimed to investigate behaviour and brain activation during real navigation in patients with complete vestibular loss in comparison to healthy controls. METHODS: 8 normal persons and eight patients with bilateral vestibulopathy had to perform a navigation paradigm in a complex unknown spatial environment of an outpatient clinic. The area, in which five items had been placed, was shown to the subjects first. Afterwards FDG was injected and subjects had to find the items in a pseudo-randomized order over the next 10 min. Subjects carried a gaze-controlled head-camera throughout the experiment to document their visual exploration behaviour. As a control condition all subjects had to perform a steady-state locomotion paradigm without navigation following FDG injection at a second time point. Brain activation patterns were compared for the navigation vs. locomotion paradigm and correlated with the recorded visual exploration behaviour during navigation. RESULTS: During navigation in normal persons brain activation was found in the pontine brainstem tegmentum and the anterior hippocampus (right>left). The comparison of navigation-induced brain activation in normal persons and patients with bilateral vestibulopathy showed a significantly higher activation of the right anterior hippocampus as well as the posterior insula bilaterally in controls, whereas an increased activation of the posterior parahippocampus was found in patients with bilateral vestibulopathy. Analysis of visual exploration behaviour indicated a navigation strategy following a cognitive spatial map for normal persons, whereas patients with bilateral vestibulopathy navigated more by a landmark-based strategy. CONCLUSIONS: The navigational behaviour in normal persons and patients with complete vestibular loss is significantly different. A navigational strategy using a cognitive spatial map in normal persons correlates with an activation of the anterior hippocampus, while a landmark-based strategy in patients with bilateral vestibulopathy goes with an increased activation of the posterior parahippocampus. It can be assumed, that the lack of vestibular information impairs the construction of a spatial cognitive map via head direction and place cells in the hippocampus, which is compensated by visually-guided parahippocampal navigation.

O.22.5 Visual-vestibular interactions during obstacle crossing: Effects of aging on whole body and segmental control

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BACKGROUND AND AIM: The ability to safely negotiate obstacles is an important component of independent community mobility, requiring adaptive locomotor responses to maintain dynamic balance (Patla et al., 1991). Although age-related decline in the visual and vestibular systems is well documented, it is not known how these systems affect movement control when stepping over an

obstacle in the travel path in older adults. This study examined the effects of aging and visual-vestibular interactions on whole-body control during obstacle crossing. METHODS: Twelve young (YA) and 15 older (OA) adults walked along a straight pathway and stepped over one obstacle (height=20cm) placed in their path under two vision conditions: (1) Normal vision (V) or (2) blurred vision simulating cataract (using custom-made blurring vision goggles, BV). Vestibular information was intact (no-GVS) or perturbed (GVS) on randomly selected trials for each vision condition. For each condition, whole-body and segmental control (whole-body centre of mass (COM), head and trunk movement (roll and pitch angles)) was measured through the swing phase of the lead limb crossing the obstacle. RESULTS: Obstacle crossing time of the lead limb was significantly increased under the BV condition in both YA and OA compared to V condition (p<.001). In terms of whole body control, vision also significantly influenced medial-lateral COM displacement, where BV condition showed greater peak M-L deviation and greater range compared to V condition (p<.01), irrespective of age and GVS condition. There was no effect of age, vision or GVS condition on head pitch angle or trunk roll angle. However, OA showed greater maximum trunk pitch and head roll angles compared to YA, under both visual and GVS conditions (p<.012). Under the blurring condition, the older group only also showed greater peak to peak trunk pitch angles compared to intact vision condition. CONCLUSIONS: There is significant reliance on visual but not vestibular information for locomotor control during obstacle crossing. The lack of differences in GVS effects suggests that vestibular information is not up-regulated for obstacle avoidance (McFadyen et al., 2007) and this finding is not differentially affected by aging. However, in older adults, insufficient visual input appears to affect ability to minimize anterior-posterior trunk movement despite a slower obstacle crossing time when vision is impaired. Combined with larger medial-lateral deviation of the body COM with insufficient visual information, the older adults may be at a greater risk for imbalance or inability to recover from a possible trip when stepping over an obstacle.

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O.22.6 Vestibulospinal influence on upper body coordination

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BACKGROUND AND AIM: When arm and trunk segments are involved in reaching for objects within arm's reach, vestibulospinal pathways compensate for trunk motion influence on arm movement. This compensatory arm-trunk synergy is characterised by a gain coefficient of 0 to 1. Vestibular patients have less efficient arm-trunk synergies and lower gains. To assess the clinical usefulness of the gain measure, we used a portable ultrasound-based device to characterize arm-trunk coordination deficits in vestibular patients. METHODS: Arm-trunk coordination without vision was measured in a Stationary Hand Task where hand position was maintained during trunk movement, and a Reaching Task with and without trunk motion. RESULTS: Sixteen unilateral vestibular patients and16 matched controls participated. For the first task, patient gains ranged from g=0.94 (good compensation) to 0.31 (poor compensation) and were lower than in controls (patients: 0.68±0.20; controls: 0.85±0.07; p<0.01). In acoustic neuroma resection patients (n=6), gains correlated with clinical tests (Sensory Organization; r=0.99, p<0.01, Functional Gait Assessment; r=0.84, p<0.036). Blocking trunk movement during reaching modified hand position (by 7.4±4.1 cm for patients, 4.5±1.7 cm for controls, p<0.02). CONCLUSIONS: This approach can

help characterize sensorimotor problems in vestibular-deficient patients and track recovery following therapeutic interventions. The ultrasound-based portable device is suitable for measuring vestibulospinal deficits in arm-trunk coordination.

O.23 NEUROLOGICAL DISEASES V - PARKINSON`S DISEASE, *Cosmos 2*

O.23.1 Towards the Detection of the neural correlates of Parkinson's disease sub-types using MRI

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BACKGROUND AND AIM: Parkinson's disease (PD) is a progressive neurodegenerative disorder manifested by motor and non-motor symptoms. Patients with PD can be classified into Tremor Dominant (TD) and Postural Instability Gait Difficulty (PIGD). The neural basis for these sub-types is largely unknown. We aim to differentiate between the neural correlates underlying each of the PD sub-types using a multi-modal imaging approach. As the PIGD group may suffer from cognitive decline and difficulties in movement initiation, we expect to detect changes in brain correlates related to higher cognitive functions in this subgroup. METHODS: Patient's were classified based on the Unified Parkinson's Disease Rating Scale (UPDRS) parts II and III. For each patient, items regarding Tremor and PIGD were summed to give total scores and a PIGD index based on the ratio between the scores. We examine 38 TD patients (mean age: 66.5± 10.9 yrs) and 54 PIGD patients (mean age: 64.3±6.9 yrs). Magnetic Resonance Imaging (MRI): Acquisition was performed in the "on" state using a 3T imaging system. The following techniques were applied: Resting state functional MRI (rs-fMRI): Using functional connectivity we investigated group differences in the corticostriatal motor network, the 'Central Executive Network' (CEN), the 'Default Mode Network' (DMN) and the Salient Network (SN). Diffusion Tensor Imaging (DTI): The Fractional Anisotropy (FA) value which represents axonal organization was computed. Voxel Based Morphometry (VBM): Segmentation of the brain into white and grey matter was performed for each patient. RESULTS: The rs-fMRI showed that within the motor network, DMN and SN, the PIGD showed over-connectivity in the anterior cingulate gyrus, compared to the TD group. The PIGD score was correlated with increased connectivity of the motor network, the CEN and the SN. Compared to the PIGD group, the TD group showed over-connectivity in the cerebellum and precuneus within the SN. In line with this, DTI analysis showed that the PIGD group had decreased axonal organization in the superior frontal gyrus. The TD group had decreased organization of white matter in the cerebellum, precuneus, postcentral gyrus and thalamus. VBM analysis showed correlations between PIGD score and grey matter in the medial frontal gyrus ($r= -0.22$, $p<0.05$). The tremor score was correlated with the grey matter in the thalamus ($r= -0.23$, $p<0.05$). CONCLUSIONS: The present findings suggest that the brain mechanisms underlying each of the PD subtypes are different. The MRI results are consistent with the possibility that PIGD symptoms are related to exaggerated connectivity of brain networks related to higher cognitive functions. In contrast, the tremor symptoms are apparently related to dysfunction of sensorimotor regions including the thalamus. These findings may offer additional opportunities for enhancing prognosis of PD and perhaps, for tailoring therapy to underlying mechanisms.

O.23.2 STN Deep Brain Stimulation in patients with Parkinson's disease: Does it reduce the negative effects of dual tasking on gait?

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BACKGROUND: Sub-thalamic nucleus (STN) Deep Brain Stimulation (DBS) is commonly performed to improve motor function, typically after years of treatment with medication. The beneficial effects of DBS on equilibrium and motor function are well-known. Despite the significant improvement in usual walking abilities in response to DBS, falls have been reported to be more common after DBS. One possibility is that DBS enhances motor function, while cognitive function and the ability to walk while dual tasking (DT), factors previously associated with fall risk, do not respond favorably to DBS. AIM: The purpose of this study was to examine the impact of DBS on DT gait in order to shed light on functional mobility and fall risk in patients with advanced PD after DBS. METHODS: 28 patients (mean age: 61.46±8.13 years, 3 females. mean disease duration: 13.2±5.0 years) completed a computerized cognitive battery that generated an index of executive function (EF) and other cognitive domains. The motor portion of the Unified Parkinson's Disease Rating Scale (UPDRS) was used to describe parkinsonian motor symptoms. Gait was assessed using performance-based tests and by quantifying walking during single and dual-task conditions (verbal fluency and serial 3 subtractions). The tests were held in 4 conditions: "off" medication, with the stimulator turned on and off, and "on" medication, with the stimulator turned on and off. RESULTS: STN DBS improved motor function and spatiotemporal parameters of gait while usual walking. For example, off medications, the UPDRS motor score improved from 41 to 28 and gait speed increased from 1.02 to 1.06 m/sec (p=0.009). Gait variability did not improve with stimulation. STN DBS improved the global cognitive score and attention (e.g., attention index improved 78 to 88), but the EF score did not improve. The DT effects on gait did not change in response to DBS, both on and off anti-parkinsonian medications. This was true if estimated the cost as the percent change, with respect to usual walking, or the difference with respect to usual walking and for both DTs (verbal fluency and serial 3 subtractions). For example, while off medications, the negative effect of the DT on gait speed was 0.18 m/sec without DBS and 0.23 m/sec with DBS (p>0.65). CONCLUSIONS: Consistent with previous reports, STN DBS improved parkinsonian motor symptoms, certain features of gait and even some aspects of cognitive function in response to STN DBS. Nonetheless, stimulation failed to improve DT walking ability, an important contributor to fall risk. The observed changes in cognitive function were apparently not sufficient or specific enough to elicit beneficial changes to DT gait abilities. Regardless of the precise reasons, the present findings suggest that patients who undergo STN DBS should also complete some form of therapy to enhance DT gait abilities; otherwise, they may likely suffer from an increased risk of falls.

O.23.3 'Think Big' verbal cuing in Parkinson's disease leads to modulation of postural responses but not electroencephalographic potentials of contingent negative variation.

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BACKGROUND AND AIM: Previous electroencephalography (EEG) studies have demonstrated that the cerebral cortex is involved in the preparation of postural responses for anticipated postural perturbations. People with Parkinson's disease (PD) are unable to modify postural responses and correspondingly demonstrate a lack of modulation of contingent negative variation (CNV) potentials with changes in the predictability of perturbation amplitude. We used the "Think Big" attentional and movement cuing strategy for PD to elicit changes in postural responses and tested for resulting

modulation of CNV potentials. METHODS: Twelve participants with moderate PD were instructed to maintain balance without taking a step in response to a fast, 12-cm backward translation of the support surface. They received a visual warning cue 2 s before each surface translation. There were 3 conditions: 30 baseline trials, 30 trials with "Think Big" cuing and another 30 baseline trials. We collected EEG data using a 32-channel cap and measured CNV amplitude at the Cz electrode. Postural responses were measured using center of pressure data. RESULTS: CNV amplitudes were not significantly different between baseline and "Think Big" conditions, while postural responses were. CONCLUSIONS: Although participants with PD were able to modulate their postural response performance when receiving "Think Big" cuing, modified postural responses were not preceded by modification of CNV potentials. Next we will investigate whether "Think Big" cuing elicits changes in alpha event-related desynchronization, an EEG measure of cortical excitability. Our overall goal is to understand whether modification of postural responses with "Think Big" verbal cuing is the result of a recovery of the ability to modulate cortical pre-movement potentials or compensatory cortical activity.

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O.23.4 Are balance control asymmetries in Parkinson's disease related to falls and walking difficulties?

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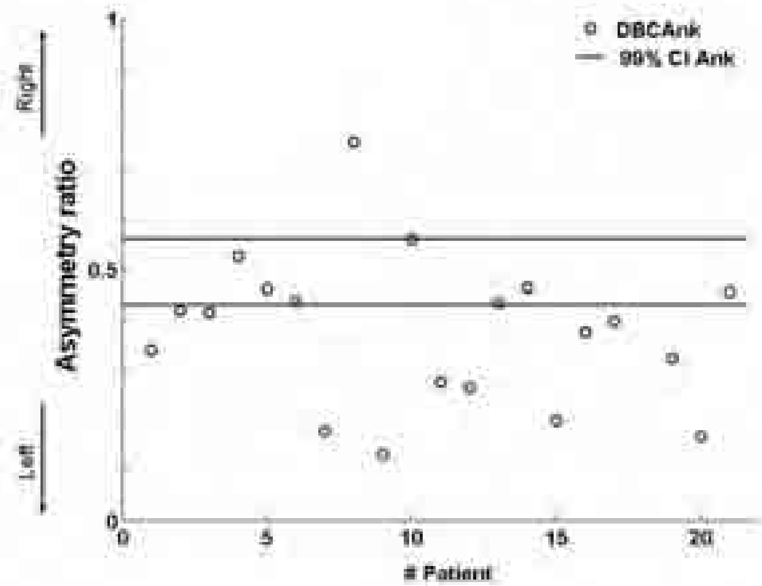
BACKGROUND AND AIM: Parkinson's disease (PD) is an asymmetrical disease; motor symptoms usually start on one side of the body and, throughout the course of the disease, this side remains most prominently affected. Balance control can be asymmetrical in PD patients. That is, one leg is contributing more to body stability than the other leg. However, not all patients show this asymmetry. This raises the question whether there is a relationship between asymmetrical balance control and clinical phenotypes of PD, such as for example Freezing of Gait (FoG). Indeed, it has been shown that FoG is related to asymmetries in gait. To date, it is unknown to what extent asymmetrical balance control is a clinically relevant symptom in PD. Therefore, we investigated asymmetries in balance control and their relation to disease severity, FoG and history of falls in PD patients. METHODS: Twenty participants with idiopathic PD (OFF medication, 11 without FoG, 6 female, mean age: 63, std: 8) and nine healthy aged matched controls (2 female, mean age: 65, std: 5) were asked to maintain their balance without moving their feet, during continuous random platform movements and continuous random force perturbations in the forward-backward direction. Body sway angle and the reactive forces of each foot were measured. These measurements yielded the Frequency Response Function (FRF) of the stabilizing mechanisms, which expresses the amount and timing of the generated corrective torque in response to sway at specified frequencies. The FRFs were used to calculate the relative contribution of each ankle and hip joint to the total amount of generated corrective torque to resist the perturbations. In addition, the Unified Parkinson Disease Rating Scale (UPDRS), severity of FoG, fall risk, fear of falling, 10 meter walk (TMW) and Timed Up and Go (TUG) were evaluated. RESULTS: Using the responses of the healthy controls, the 99% confidence interval of balance control asymmetry for the ankle and hip joint was determined. Thirteen of the 20 patients were outside the normal values (Figure 1). The ankle joint was more affected than the hip joint. No significant relationship with UPDRS, FoG, fear of falling or TMW was found. However, there was a trend towards a relationship with the TUG (p=0.07); as asymmetrical patients were slower. Also, 50% of the asymmetrical patients were at an increased risk of falling, compared to only 17% of the other patients. CONCLUSIONS: Balance control can be asymmetrical in PD

patients. However, the clinical relevance of this finding is not clear yet, as in our sample balance control asymmetries were not related to disease severity, FoG or fear of falling. However, the relationship with the TUG and the increased fall risk in the asymmetrical group highlight the importance of balance control asymmetries for axial problems.

Figure 1: Dynamic balance contribution (DBC) ratio of the ankle joint. The black lines denote the 99% confidence interval.



O.24 PAIN, *Living 4*

O.24.1 Inflexible use of anticipatory postural adjustments with low back pain

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BACKGROUND AND AIMS: Low back pain (LBP) associates with impaired postural coordination of anticipatory postural adjustments (APAs) to their related goal-directed movements. We previously demonstrated that people with chronic LBP exhibit decreased inter-trial variability in the timing of their APA, and pre-movement electroencephalographic (EEG) potentials were not lateralized based on the side of arm movement for those with LBP, suggesting less potential for specificity and adaptability of the APA in this population. In a series of studies, we investigated the effects of cueing, limb support, and motor retraining treatments on the APA of people with chronic LBP. METHODS: Study One evaluated the pre-movement EEG potentials and APA timing of people with and without chronic LBP during self-initiated versus cued rapid arm raises. Study Two evaluated the incidence of APAs associated with unsupported versus supported leg movements in people with and without chronic LBP, and Study Three further investigated the effects of two treatments (Stabilization versus Movement System Impairment

(MSI) directed exercises) on the use of APAs during these leg movements in subjects with LBP. RESULTS: In Study One, the 13 subjects with LBP exhibited later onset of the external oblique compared to the 8 subjects without LBP (76 versus 17 ms after deltoid onset; F = 6.1, P < 0.05), but APA onset of multiple trunk muscles did not significantly change between self-initiated and cued conditions for either group. Pre-movement EEG potentials, however, were larger (more negative) in the group with LBP (-9.1 versus -1.1 µV, F = 6.0, P < 0.05), with pre-movement negativity remaining evident in the cued condition for only the group with LBP (-7.6 versus 0.8 µV). In Study Two, the 18 subjects without LBP generally only utilized an APA in the unsupported condition (an APA occurred in 100% of unsupported trials, compared to 8.9 ± 15.8% of supported trials). In contrast, prior to treatment, the 34 subjects with LBP exhibited a similar incidence of APAs regardless of limb-support condition (F = 2.0, P > 0.05): an APA occurred in 76% and 69% of unsupported trials versus 78% and 83% of supported trials for the MSI and Stabilization groups, respectively. In Study Three, treatment increased the incidence of APAs (F = 10.2, P < 0.05) in the 22 subjects receiving MSI treatment and the 12 receiving Stabilization treatment, but did so for both the supported (92% and 74% of trials for each treatment, respectively) and unsupported tasks (91% and 85% of trials for each treatment, respectively). CONCLUSIONS: Chronic LBP associates with a diminished adaptability of the APA or of pre-movement cortical function under changing conditions, and neither the MSI-directed nor Stabilization exercises successfully address the lack of contextual specificity for utilizing an APA. ACKNOWLEDGEMENTS: Funded by the NIH/NICHD, grant 2R01HD040909-06A2; NIH/NCRR, grant 5P20RR016435; NIH/NIAMS, grant T32AR07568.

O.24.2 Do wearing unstable shoes enable a more upright posture during standing in patients with low back pain?

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BACKGROUND AND AIM: Low back pain (LBP) is a costly world-wide spread musculoskeletal burden. Numerous studies reveal the importance of posture in the development of low back pain [1]. Wearing unstable shoes during walking and standing have been claimed to promote a more upright posture [2] which should be beneficial to reduce low back pain [3]. The purpose of the present study was to evaluate the effect of unstable shoes on posture in patients with chronic LBP during standing. METHODS: A pilot randomized controlled trial (n=26) was conducted among health professionals working at the University Hospitals of Geneva. Patients have been included if they suffered from LBP (> 30/100 on the visual analogue scale) at the inclusion and were without sciatic symptoms. The intervention group (IG, N=13) was equipped with unstable shoes (model MBT Fora) and the control group (CG, N=13) with conventional sport shoes (model Adidas Bigroar). Patients had to wear these shoes at work during 6 weeks. For the posture assessment, subjects were asked to stand upright on force plates for 30-seconds in two different conditions (barefoot and with respective shoes (Adidas or MBT)). Three trials per test conditions have been realized. The sagittal posture parameters (distance between locations of gravity line (GL), mid-point between heels, mid-point between posterior superior iliac spines (PSIS), and C7) has been evaluated at baseline and at 6-weeks follow-up by the mean of reflective markers (optoelectronic system - Vicon Mx3) and synchronized two force plates (AMTI Accugait). Statistical significance between groups was tested by use of a t-test ($p<0.05$). RESULTS: For the barefoot condition, no group difference could be identified at baseline and at follow-up. For the shoe condition, no group difference was identified at baseline. Distances between heels and all other locations (GL, PSIS and C7) were significantly longer in the IG compared to the CG at follow-up (Table 1). CONCLUSIONS: Our results do not support the hypothesis that unstable shoes promote a more upright

posture of LBP patients. We observed a less upright posture (forward leaning) with unstable shoes than with stable shoes after a period of adaptation. These findings are in agreement with the results of pressure distribution that showed more pressures of the forefoot and toes and less pressures on hindfoot and midfoot in unstable shoes versus control shoes during standing [4]. Further studies should investigate the influence of unstable shoes on patient's posture during gait and the relationships between modifications of posture and low back pain.

Table 1: Mean and standard deviation of posture parameters at baseline and follow-up for the control group (conventional sport shoes) and intervention group (unstable shoes). All posture parameters are distances expressed in mm between location of anatomical points and gravity line (GL). The p value indicate a significant difference between groups at baseline and follow-up.

	Baseline			Follow-up		
	Control Group	Intervention group	P-Value	Control Group	Intervention group	P-value
Barefoot						
HEEL-GL (mm)	-97.9 (11.7)	-103.6 (13.8)	0.265	-97 (12.9)	-100.8 (10.2)	0.414
HEEL-PSIS (mm)	10.4 (24.1)	1.6 (23.8)	0.357	13.6 (25.6)	0.6 (11.5)	0.106
HEEL-C7 (mm)	-26.1 (15.6)	-30.8 (15.8)	0.448	-26.3 (12.1)	-27.8 (22.7)	0.838
PSIS-GL (mm)	-108.3 (24.7)	-105.3 (18)	0.720	-110.6 (24.4)	-101.4 (11.5)	0.228
C7-GL (mm)	-71.8 (16.3)	-72.8 (11.6)	0.861	-70.7 (11.2)	-73 (18.2)	0.699
C7-PSIS (mm)	36.5 (25.2)	32.5 (21.4)	0.663	39.9 (28.3)	28.4 (22.2)	0.257
Shoes						
HEEL-GL (mm)	-114.7 (11.6)	-126 (16.1)	0.052	-110.2 (13.7)	-123 (10.3)	0.013*
HEEL-C7 (mm)	-44.5 (16.2)	-55.6 (21.6)	0.152	-39.7 (12.1)	-56.2 (20.7)	0.021*
HEEL-PSIS (mm)	-5.7 (24.4)	-18.3 (22.7)	0.187	2 (30.7)	-20.4 (13.3)	0.024*
PSIS-GL (mm)	-109 (25.8)	-107.7 (17.6)	0.881	-112.3 (25.8)	-102.6 (11)	0.226
C7-GL (mm)	-70.2 (15.5)	-70.4 (16.9)	0.978	-70.5 (10.2)	-66.8 (19.1)	0.547
C7-PSIS (mm)	38.8 (27.1)	37.3 (25.3)	0.886	41.8 (29.8)	35.8 (22)	0.565

*t-test with $P<0.05$

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O.24.3 Plantar orthotics for patients with chronic low back pain (CLBP) decreases pain and improves spine function and mobility

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BACKGROUND AND AIM: CLBP, a very common pathology, is the primary cause of work-associated accidents of musculoskeletal origin in France, with 5-10% of CLBP patients being responsible for 70-80% of health expenditures. Recent publications indicate that plantar orthotics can improve its treatment. This study evaluated the impact of plantar orthotics on CLBP. METHODS: Population: Fifty-seven patients with CLBP (daily low back pain for >3 consecutive months) followed in two private practices. Method: In each office, CLBP patients were select according to their choice of treatment (insoles or chiropody) assigned to have their therapy include plantar orthotics (treated), thin (≤ 3 mm) insoles

modify postural control(ref1) as assessed by a clinical posturology examination, or not (control). After 8 weeks of treatment, their characteristics were compared. Judgement criteria: Three variables: lumbar pain intensity, and its impact on spine function and mobility, were evaluated, respectively, with a visual analog scale (VAS), the French version of the Roland and Morris (RMF) questionnaire and a postural-dynamic test (PDT)(ref2). Between-group differences were evaluated with Student's t-test and between-criteria correlations with Pearson's correlation coefficient. A principal component analysis was also effected. RESULTS: Judgement criteria at inclusion for treated and control groups were comparable. The before and after 8 weeks of treatment criteria for the controls did not differ significantly. However, after wearing plantar insoles for 8 weeks, the treated groups' criteria were significantly improved: RMF and VAS ($p<0.05$), and PDT ($p<0.01$), with VAS and RMF being significantly correlated (r= -0,11784; $p<0.002$). CONCLUSIONS: These findings confirmed numerous clinical observations: CLBP was attenuated by wearing plantar orthotics and, more generally, postural treatments.

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O.24.4 The effect of daily perturbation training with a specially designed foot-worn system on balance control of elderly subjects with knee osteoarthritis

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BACKGROUND AND STUDY AIM: Osteoarthritis (OA) is the most common age-related degenerative disorder affecting the lower extremities and the leading cause of disability among elderly individuals. Subjects with knee osteoarthritis often present with reduced balance control, which may lead to falling. Perturbation-based training has been shown to be effective in improving balance control in older adults. The objective of this pilot study was to examine whether a novel biomechanical device and treatment methodology (Apos Therapy) that creates minor perturbations during walking can enhance balance and normalize gait parameters in patients with knee OA. METHODS: Seven subjects, mean age (SD) 71.6 (6.9) years, with uni- or bilateral knee OA were provided with the treatment as a means to improve function and reduce knee pain. The system consists of two foot-worn platforms with two adjustable convex rubber elements attached under each platform, which were individually calibrated by a physical therapist to assure optimal functional alignment, with the least ankle valgus or varus torques. Subjects were instructed to gradually increase walking with the specialized system during their normal routines, so that by the end of the fourth week, they walked with the system an accumulated time of 20 minutes per day. Assessment was carried out prior to the beginning of the trial and following 12 weeks of daily use. The percentage of single-limb support (%SLS), which is a measure of dynamic stability, was assessed utilizing a computerized gait mat. Center of pressure (CoP) total sway and sway variability in the anterior-posterior and medio-lateral directions were assessed with eyes open (EO) and eyes closed (EC), using an AMTI force-plate . Non-parametric Wilcoxon signed rank tests were used to compare pre- and post-treatment results. Significance was determined at p¡Ü0.05. RESULTS: Mean %SLS of both legs increased significantly (p=0.018) from a mean (SD) of 36.8 (1.6)% to 38.2 (1.6)%. A significant decrease in CoP path length was determined with EO (p=0.028), whereas the change in the EC condition did not reach significance (p=0.17). A tendency (p=0.063) was observed towards decreased CoP amplitude

variability in the medio-lateral direction following intervention when tested in the EC condition. Other measures of CoP variability did not reach significance. CONCLUSION: The results of this small group study are very encouraging. They demonstrate the feasibility and potential of the daily application of a foot-worn system and therapy program, providing a better functional alignment and slightly unstable base of support, to enhance balance control. This form of treatment may prove to be extremely valuable for individuals with balance control deficits, as it entails functional and repetitive training that can be individualized and carried out in the home environment. Large-scale randomized controlled studies are needed to validate these results.

O.25 EFFECT OF MEDICATION, *Cosmos 3A*

O.25.1 Effects of supramaximal dopaminergic replacement on freezing of gait when passing through doorways in Parkinson's disease

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INTRODUCTION: Freezing of gait (FOG) is one of the most debilitating symptoms for individuals with Parkinson's disease. The mechanisms of FOG are not well understood, and it is controversial whether FOG responds to dopaminergic treatment. True OFF-state freezing episodes are argued to decrease in number and duration by pushing dopaminergic medication [1], but some forms of FOG (during ON-state) are unresponsive to dopaminergic therapy [2-3]. Recently, Bloem & colleagues have questioned whether ON-state FOG might improve with higher levels of dopaminergic medication [3], but there has not been any investigation of supramaximal dopaminergic effects on motor symptoms or FOG. The purpose of the study was to determine whether FOG while walking through a doorway was responsive to a significantly higher dose of dopaminergic replacement, compared to the participant's normal medication regime. METHODS: 16 PD-FOG participants were tested 1 hour after taking their regular dosage of dopaminergic medication and completed 15 walking trials through a doorway. Then an additional dosage of dopaminergic medication was taken by participants, and after 60 minutes the participants completed another 15 trials. Overall motor symptoms were assessed using the UPDRS III. FOG as well as other gait parameters were captured using 3-D kinematic cameras. RESULTS: Supramaximal dopaminergic medication significantly increased gait velocity ($F=10.96$, $p<0.01$), stride length of the affected side ($F=4.79$, $p<0.05$) and significantly decreased UPDRS motor score ($t=4.33$, $p<0.001$). Step width variability unexpectedly also increased ($F=5.14$, $p<0.05$). However, there were no significant changes in the number of freezing episodes, duration of FOG in each trial, or percent of time spent in FOG. CONCLUSIONS: While supramaximal dopaminergic medication resulted in expected dopa-responive improvements to overall motor symptoms and gait (including stride length and gait velocity), the frequency and duration of FOG did not change. The unexpected increase in step width variability may be related to attempts to stabilize mild dyskinesia.

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O.25.2 Spatial memory and cognition in patients with Parkinson's disease: testing the dopaminergic effect.

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BACKGROUND AND AIM: Dementia in patients with Parkinson's disease (PDD) has attracted recent attention. However, the cognitive aspects affected and the pathophysiology are not fully understood. Previous studies have shown that the cholinergic pathway contributes more to cognitive functions than the dopaminergic pathway with the result that cholinergic drugs like donepezil are effective while levodopa is not. We hypothesized that spatial cognition and memory, which if impaired would lead to disorientation might be deficient in patients with Parkinson's disease (PD) compared with age-matched healthy volunteers (HV). Further, we hypothesized that such functions in PD patients should not be affected by dopaminergic intervention. METHODS: 14 patients with PD and 14 age-matched HVs were studied. We used a virtual reality (VR) task which requires the subjects to remember and retrieve the route that they should follow including turns in virtual corridors with first person perspective. The subjects were requested to remember the route to reach the goal first with a demonstration, and after a distraction task, they were requested to follow the route to reach the goal using a joystick. We prepared two versions including three (run1) or four (run2) turns to remember. Each run was repeated 4 times showing a different path at each trial. The success rate and the time taken to reach the goal were assessed. All the patients with PD were tested not in the off-med condition and on-med condition. All the subjects also completed the Montreal Cognitive Assessment (MOCA) which includes cube copying and clock drawing, both of which we considered to be related to spatial cognition and memory. The success rate and time taken to reach the goal were compared between patients and HVs, and between off-meds and on-meds in patients. The correlation between the summation score of cube copying and the clock drawing, and the time taken to reach the goal was statistically examined in all the subjects. $P<0.05$ was considered to be significant. RESULTS: In both runs, the with PD patients showed significantly lower success rate and took longer time to reach the goal compared with HVs. The comparison between off and on-meds in PD patients revealed no significant differences either in the success rate or in the time. The correlation analysis in run 2 showed a significant correlation between the summation scores in MOCA and the time taken to reach the goal, while there was strong tendency for correlation seen in run1. CONCLUSIONS: Our spatial navigation task seems useful in studying spatial cognition and memory. Our results show that the patients with PD have dysfunction in spatial cognition and memory compared to HVs. Additionally, it appears that spatial cognition and memory are not affected by the dopaminergic pathway in PD patients since there was no significant difference between off and on-meds condition.

O.25.3 Can memantine improve axial signs in Parkinson?s disease? A randomized, double-blind, placebo-controlled study

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BACKGROUND: Since memantine may decrease N-methyl-D-Aspartic Acid related glutamatergic hyperactivity in the brain and also in the subthalamic nucleus' efferent pathways involved in gait and posture control (particularly those projecting to the pedunculopontine nucleus), we sought to assess the drug's impact on severe gait and axial rigidity in Parkinson's disease. The inhibition of dopamine

reuptake was studied as another putative action mechanism of memantine. METHODS: We performed a 3-month, randomized, double-blind, placebo-controlled study with two parallel arms (ClinicalTrials.gov:NCT01108029). The following parameters were analyzed under standardized conditions before and after acute administration of L-dopa: gait (in an optoelectronic analysis and as the primary efficacy criterion), hypertonia and strength of axial extensors and flexors (isokinetic dynamometer), the axial and segmental Unified Parkinson's Disease Rating Scale motor scores and the Dyskinesia Rating Scale score. Inhibition of presynaptic dopamine transporters in the bilateral striatum was assessed with DaTSCAN. RESULTS: Twenty-five patients with severe axial signs were included. There was no significant improvement in gait in the memantine group. Compared with placebo, axial strength was significantly increased by memantine treatment (F(1,10)=9.3;p=0.012) and axial hypertonia (F(1,10)=12.9;p=0.005), the motor Unified Parkinson's Disease Rating Scale score (F(1,10)=6.6;p=0.028) and the axial and global Dyskinesia Rating Scale scores (F(1,10)=8.8;p=0.014) were significantly decreased by memantine treatment. The memantine group displayed a lower dopamine transporters density than the placebo group (F(1,10)=34;p=0.0001). CONCLUSIONS: Memantine decreased axial rigidity and increased axial strength without improving gait. The antagonist action at N-methyl-D-Aspartic Acid receptor and the slight inhibition of dopamine reuptake may account for this effect.

O.25.4 The complementary effect of exercise and medication on gait, balance, and disease severity in persons with Parkinson’s disease

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BACKGROUND AND AIM: Exercise is currently advocated for the management of Parkinson disease (PD). In addition, virtually all persons with PD, with greater than mild disease severity, will be treated with dopamine replacement medications. However, to our knowledge, no studies have examined the combined effects of exercise and dopamine replacement on measures of gait and balance. Furthermore, few studies have examined the effects of exercise using randomized clinical trial methodology including blinding of assessors and intention to treat analyses. Therefore, the purpose of this study was to examine the effect of 2 types of exercise interventions and medication on gait, balance, and disease severity outcomes in persons with PD following a 12-week exercise intervention. METHODS: All persons had neurologist confirmed idiopathic PD and were currently taking dopamine replacement medications. At baseline, all participants underwent testing of disease severity (motor-UPDRS), balance performance (Functional Gait Assessment [FGA]), and gait endurance (the 6-minute walk test [6MWT]) while off (after 12 hour withdrawal) and on (1-1.5 hours after ingestion) dopamine replacement medication. Following baseline testing, participants were randomly assigned to 1 of 2 exercise groups that differed only in the intensity of the lower extremity resistance training. A blinded examiner performed all testing. Differences between medication states and exercise time points were initially examined using separate 2 groups x 2 time periods x 2 medication conditions factorial ANOVAs using intent to treat analyses. If no group main effect was found, the groups were collapsed to examine general exercise and medication effects. In addition, post hoc testing and effect sizes were calculated. The level of significance for all tests was p <0.05. RESULTS: 41 persons with PD consented to participate with 36 persons completing the intervention. No between group differences were noted for any variables. Significant main effects for exercise and medication were noted for the 6MWT and the FGA (p<0.005) while only a significant medication effect was found for the motor-UPDRS. While both medication and exercise appeared to improve gait and balance, post hoc analyses of effect sizes revealed that medication had a greater effect on both gait and balance. CONCLUSIONS: Twelve weeks of exercise produced gait and balance

improvements comparable to those seen with dopamine replacement. The combined effect resulted in a 20-30% increase in balance and gait outcome scores. The lack of between group differences appears to indicate that the presence of activity is more important than the type of activity. In contrast to the gait and balance changes, exercise resulted in no consistent change in disease severity. Future research should include an inactive sedentary control group to fully visualize the positive effects of exercise.

O.26 TOOLS AND METHODS V, *Cosmos 3C*

O.26.1 Treadmill Training with Virtual Reality to Decrease the Risk of Falls in Elderly Idiopathic Fallers: A Pilot Study

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BACKGROUND: Falls in the elderly are a major health problem affecting a third of the elderly over the age of 65. Numerous fall prevention interventions have been suggested but to date, the content of the optimal exercise program as well as its optimal duration and intensity have not yet been established. Aim: The aim of this pilot study was to investigate whether Virtual Reality can be applied to address the multifaceted motor and cognitive deficits associated with fall risk in the elderly. METHODS: Five elderly women (67.1±6.5 years) with a history of at least 2 falls during the 6 months prior to the study, received 18 sessions (3 per week x 6 weeks) of progressive intensive treadmill training with virtual obstacles (TT + VR) consisting of obstacle navigation. Outcome measures included mobility and gait measures as well as cognitive performance relating to attention and executive function and dual task ability. Fall frequency was assessed for 6 months post training. RESULTS: Gait speed significantly improved during over-ground usual walking (p=0.05), dual tasking (p=0.04) and while negotiating physical obstacles (p=0.003). Post-training significant improvements were also observed in the performance-based measures such as the Timed Up and Go and the Four Square Step Test (p=0.04, p=0.02 respectively). Dual task costs (p=0.04) and over-ground obstacle clearance also improved (p=0.008). The frequency of falls was reduced by 73% during the 6 months period after training. CONCLUSIONS: TT + VR appears to be feasible for gait training of elderly fallers and apparently may improve physical performance and gait during complex challenging conditions. The dramatic reduction in fall frequency suggests that this multi-faceted paradigm also successfully decreases fall risk, however, larger scales studies are needed to confirm this exciting possibility.

O.26.2 Probability of Fall as a Measure for Upright Balance of Human States: An Analytic Method to Calculate the Probability in Ankle Strategy Model

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BACKGROUND: Control of balance is essential in human movements. Possibility of an individual to keep its balance from a perturbed situation depends on how good the balance is in that state. State here denotes the combination of human posture and its movements, or mathematically, the vector consisting

of all joint angles and angular velocities. This study aims to present a quantitative criterion to assess the balance in a certain human state. Traditionaly, the shortest distance of the vertical projection of the center of mass (CoM) to the base of support (BoS) was used to show how far from the balance a state is. Later, it has been brought to the attention that this criterion is not sufficient in dynamic situations, and the horizontal velocity of the CoM should also be accounted for, and the so called margin of stability (MoS) got suggested to represent the degree of stability of a state. It is now widely in use. However, the MoS addresses the momentum still can be received without falling, not the fall risk at the state. Momentum margin has a quite different pattern than fall risk. We suggest a criterion for the degree of stability of a human state: the chance of the balance to be regained if the individual does its best. METHODS: The presently reported work shows the calculation of fall probability for a simple 2-segment sagittal human model with 2-d state space. The idea may be extended to higher DoF models as well. To find the stability of a state independent of the individual, we use strength statistical data. Probability distribution of the maximum voluntary joint torque (MVJT) in balance posture is found based on Japanese adult databank (www.nite.go.jp). Maximum applicable torques in other states is found using experimental coefficients for torque-position-velocity relationships (Anderson et al, 2007). The maximum probability of all trajectories to the upright posture is the recovery probability from that state. Instead of going through a very computationally expensive trajectory optimization procedure, we use and analytical method. We have proven the relationship between the balanceable region and stable manifolds for this model in a previous report (Honarvar & Nakashima, 2010). The stable manifold passing through the objective state delivers the necessary ankle strength transferred to the reference state, for which the probability of an individual to be able to apply in known based on the distribution data. RESULTS: The recovery probability map for a 2-d state space is drawn, and compared to the MoS map. CONCLUSION: We suggested a criterion to assess how good the balance is in a human state, based on probability of fall from that state if the person does its best, and found using statistical data of human joint strength. Therefore, it is independent of the subject. We also proposed an analytical method to calculate the probability based on stable manifolds, which is computationally light. This study solves the problem only for a 2-segment.

O.26.3 Gait Segmentation for a Reliable Gait Assessment in Unsupervised Settings

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BACKGROUND AND AIM: The use of body worn inertial sensors is a cost effective and unobtrusive solution for ambulatory movement analysis in daily life activities. Several wearable systems are able to recognize activities such as laying, sitting, standing and walking; the outcome is usually limited to the duration and intensity of each activity and to the number of steps for each walking period. Impaired gait is associated to frailty [1] and fall risk [2] hence it would be important to monitor even subtle gait changes during the day. Gait measures are sensitive to many factors such as path, speed, dual task, so obtaining reliable measures in unsupervised settings is a challenge. In this work we propose a method to automatically identify those gait periods when the subject walked on a Straight Path (SP) to remove one of such potential confounding factors. METHODS: We examined 20 young healthy subjects (24±4 years, 11 female) wearing on the lower back an inertial sensor (McRoberts Dynaport Hybrid, sample rate 100Hz), embedding triaxial accelerometer and gyroscope. In a first phase, subjects were instructed to perform a 10 meter walking test (10MW) three times at their preferred speed. Gait temporal characteristics and coordination [3] have been assessed identifying the heel strikes [4]. The mean values of the parameters calculated for the three 10MW have been used as reference values. Subjects were

then instructed to walk on two different paths: PATH 1, composed of a mixed route with SP interspersed with 90° and 180° turns; PATH 2, where subjects were free to move in a room, performing activities of daily living. We developed an algorithm, based on the analysis of trunk yaw velocity, to automatically detect and segment walking periods. The algorithm is able to detect turns and curvilinear trajectories in order to filter them out. RESULTS: Table 1 shows the values of gait parameters obtained during the 10MW, PATH 1 and PATH 2. It also reports the results of ANOVA between the gait reference values estimated in the 10MW and the two mixed paths. CONCLUSIONS: Gait parameters estimated in PATH 1 and PATH 2 are statistically different from the 10MW reference values; gait variability and coordination apparently worsen just as an effect of the subject activity. Using the proposed selection algorithm such differences disappear with the exception of the mean step time and the gait cycle mean phase because of the frequent changes in gait velocity. Monitoring gait parameters in unsupervised settings without improving their reliability may result in misleading results or interpretation.

TABLE 1
GAIT PARAMETER VALUES: MEAN VALUE(STANDARD DEVIATION)

PARAMETER	10MW	PATH 1		PATH 2	
		WITHOUT A	WITH A	WITHOUT A	WITH A
Mean Step Time [s]	0,53(0.005)	0,56(0.04)*	0,54(0.04)	0,6(0.05)**	0,55(0.05)†
Step Time STD [s]	0,02(0.004)	0,05(0.02)**	0,02(0.015)	0,08(0.02)**	0,03(0.013)
Step Time CV [%]	4,58(0.71)	8,86(3.71)**	4,53(2.78)	12,53(3.1)**	5,1(2.06)
Mean Phase [°]	182,2(1.1)	180,3(2.32)*	179,5(2.9)**	179,9(3.37)*	179,1(3.1)**
Phase STD [°]	4,68(0.83)	8,5(4.61)**	4,83(3.44)	12(5.23)**	4,85(2.91)
Phase CV [%]	2,54(0.43)	4,72(2.55)**	2,68(1.89)	6,68(2.88)**	2,71(1.61)
PCI [%]	5,26(1.14)	8(4.1)**	4,89(3.06)	11,15(4.1)**	5,01(2.82)

10MW: 10 meters walking; STD: standard deviation; CV: coefficient of variation; PCI: phase coordination index; With A: using the gait interval selection algorithm; Without A: without using the gait interval selection algorithm. ANOVA, 10MW versus Path1 or Path2: †p<0.05; *p<0.01; **p<0.001

ACKNOWLEDGEMENTS: with the support of Italian Ministry for Foreign Affairs, Direzione Generale per la Promozione del Sistema Paese

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O.26.4 ISAW: Instrumented Stand and Walk Test for Quick Clinical Measurement of Balance and Gait

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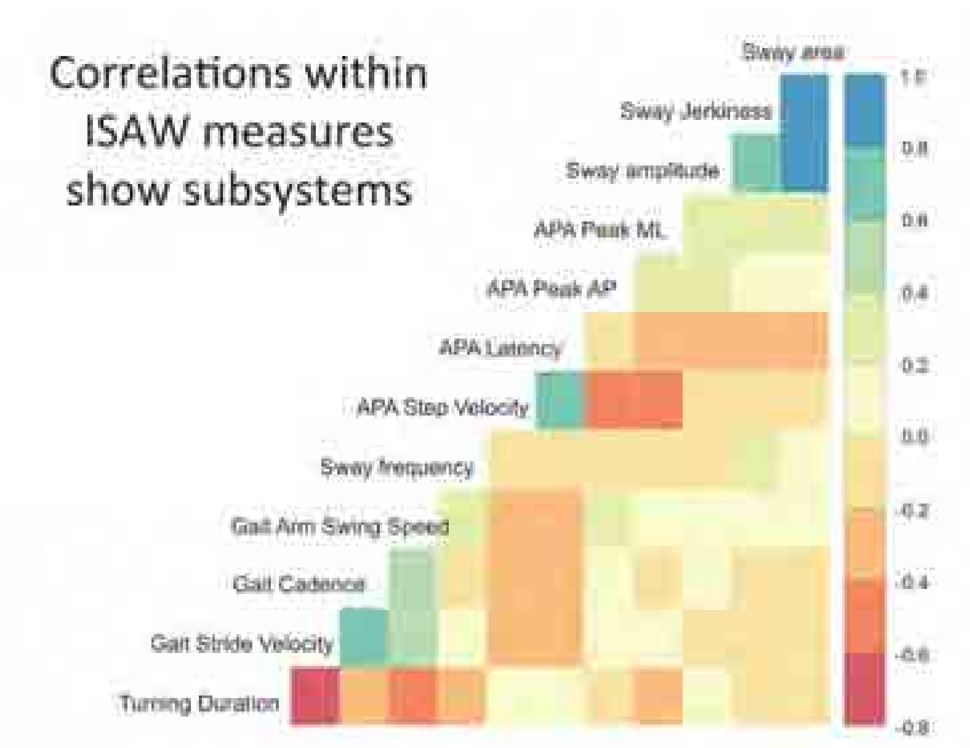
INTRODUCTION: Current clinical practice to assess mobility relies on clinical scales. The goal of our study was to develop an objective, yet short and easy to use, clinical test to assess relatively independent aspects of mobility including postural sway, anticipatory postural adjustments (APAs), gait and turning. ISAW combines several tests we developed for wireless, body-worn, inertial into one, quick protocol:

the Timed Up and Go (ITUG), Step Initiation (ISTEP) and Postural Sway (ISWAY) tests. We hypothesized that relatively independent aspects of mobility could be measured quickly in a single, clinical protocol. METHODS: ISAW was performed in a hospital hallway. After 30 sec of recording quiet stance, subjects were instructed to walk 7 meters, make a 180° turn and return back to where they started. Ninety subjects with moderate Parkinson's disease (PD) and 30 control subjects were tested. The average age was 65.7 ± 6.6 years old. All PD subjects were measured during their ON state and their average UPDRS motor scores was 32.5 ± 9.8. Each subject performed 3 trials of ITUG, ISWAY, ISTEP and ISAW. Automatic analysis algorithms calculated 52 ITUG, 7 ISTEP, and 38 ISWAY parameters using Mobility Lab software (APDM.com). To assess absolute agreement between the results of either ITUG, ISTEP or ISWAY with ISAW, Intra-Class Correlation (ICC) was used. We used factor analysis and examined the covariance structure of the measures to identify independent measures of balance and gait. RESULTS: Cross-correlation matrix of 50 ISAW metrics showed lack of correlation among metrics related to 1) postural sway, 2) APAs, and 3) gait but with high correlations between metrics within sway, APAs and gait subcomponents of the test. Factor analysis showed 5 relatively independent factors with metrics grouped approximately by postural sway, gait speed, gait temporal measures, range of motion of trunk and upper limbs and gait asymmetry. Gait and turning measures had excellent agreement between ITUG and ISAW: the ICCs for Cadence, Stride-Velocity and Turning Duration were 0.91, 0.91 and 0.85 respectively. The ICCs for the Sway Area, Amplitude and Frequency were 0.63, 0.68 and 0.74 respectively. ISAW trials took on average less than a minutes (59.0 ± 5.1 sec). DISCUSSION: ISAW is an objective, short and automated method to assess postural sway, APAs for step initiation, gait and turning in a clinical environment. It measures several different aspects of postural control in a single protocol. We are working on developing the best combined Mobility Scores from the ISAW to measure severity of balance and gait impairments. Objective, automatic assessment of stance and dynamic balance with inertial sensors is an ideal tool for clinical research and practice.



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O.27 AGING III, *Cosmos 2*

O.27.1 Lack of inhibitory control induces errors in step initiation in older adults

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BACKGROUND AND AIM: Postural dual task studies have demonstrated effects of various executive function components on gait and postural control in older adults. The purpose of the current study was to further explore the role of executive function on posture by assessing inhibition during lateral step initiation. METHODS: Forty community ambulating older adults participated (range 70-94 y). In order to explore inhibitory function in step initiation, we used a task that consisted of 4 minute blocks of lateral stepping in response to a visual cue of a left or right pointing arrow appearing on the left or right side of a computer monitor (24-32 stimuli per block). Task difficulty of the blocks was progressively increased. In the simple blocks, just one cue (e.g. left arrow on left side) was presented, with one correct step response (left step). In the choice block, the 2 randomly displayed cues (left arrow on left, right arrow on right), had 2 possible correct responses (left or right step, respectively). In the choice-attention blocks, congruent cues (left arrow on left side, right arrow on right) were randomly intermixed with incongruent cues (left arrow on right, right arrow on left). The step response depended on the direction in which the arrow was pointing. Vertical ground reaction forces (VGRF) were measured separately under each foot using force plates. Postural adjustments (PAs) were identified by inflection points in the VGRF. Subjects characteristically responded with either one PA or 2 PAs during simple blocks. The onset of each postural adjustment (PA1, PA2, PA3) and liftoff time of the stepping foot were determined from the VGRF. The effect of the step task difficulty on the number of PAs, median onset of the initial postural adjustment (PA1) and median liftoff was tested using repeated measures ANOVA. RESULTS: Delays in onset of PA1 ($p < 0.001$) and liftoff ($p < 0.001$) progressively increased among the simple, choice, attention-congruent and attention-incongruent tasks (Table 1). The attention-incongruent step conditions induced more PAs compared with attention-congruent, choice and simple conditions ($p < 0.001$), indicating an error in motor programming. In addition, when subjects made PAs in error in the attention-incongruent condition, the onset of PA1 was earlier and the liftoff time later compared with steps in which they did not make an error ($p < 0.001$). CONCLUSIONS: The delayed onset of PA1 during the choice conditions is consistent with increased cognitive processing, in particular when cues were incongruent. Furthermore, attention-incongruent conditions induced a greater number of PAs, primarily due to a failure of inhibiting the appropriate initial PA. These results suggest that deficits in inhibitory function may detrimentally affect step decision processing, and could be important for responding to conflicting sensory environments.

Table 1. Mean (SD) onset of initial postural adjustment (PA1) and liftoff, relative to onset of stimulus.

	Onset of initial PA (ms)	Onset of Liftoff (ms)
Simple	242 (56)	537 (131)
Choice	261 (46)	580 (130)
Choice-Attention, Congruent	294 (53)	614 (116)
Choice-Attention, Incongruent	346 (83)	743 (142)

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O.27.2 Relationships between appendicular skeletal muscle mass, percentage body fat and balance control in older people

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BACKGROUND AND AIMS: Recent research suggests that body composition affects physical functioning in older people, such that obese people with low muscle mass might be at increased risk of falls [1]. In order to understand why body composition is associated with functional declines, this study investigated relationships between body composition and neuromuscular function, balance and stepping, all fall risk factors amenable to intervention, in a large sample of older people. METHODS: 393 community-dwelling older adults (197 men, 196 women) aged 70 to 93 years (mean ± SD: 81±4) undertook measurements of body composition (lean mass and fat mass) using dual energy x-ray absorptiometry. Participants also completed tests of quadriceps strength, postural sway, controlled leaning balance (coordinated stability test) and choice-stepping reaction time. The appendicular skeletal muscle mass (ASM) index was calculated as sum of lean arms plus lean legs divided by stature (m) squared [1]. Participants were then classified into four phenotypes including normal lean (n=143), sarcopenic (n=45), obese (n=153) and sarcopenic obese (n=52) according to the definition of sarcopenia as ASM index <7.2 (males) and ASM index <5.4 (females), and obesity as >30% fat (males) and >40% fat (females) [2]. RESULTS: Decreased ASM index and increased percentage body fat were significantly correlated with reduced quadriceps strength (r=0.36, p<0.001 and r=-0.40, p<0.001) and with poor coordinated stability (r=-0.212, p<0.001 and r=0.31, p<0.001), after controlling for age and body weight. Multiple analysis of variance revealed a significant effect of phenotype on coordinated stability (p=0.007) after controlling for body weight whereby compared to the normal lean group, the obese and sarcopenic obese groups showed significantly poorer coordinated stability (p=0.004 and p=0.045, respectively) . CONCLUSIONS: These findings suggest that in addition to sarcopenia, excess adipose tissue may contribute to increased fall risk in older people, by impairing leaning balance control.

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O.27.3 Leg strength is associated with local dynamic stability of treadmill walking in elderly subjects

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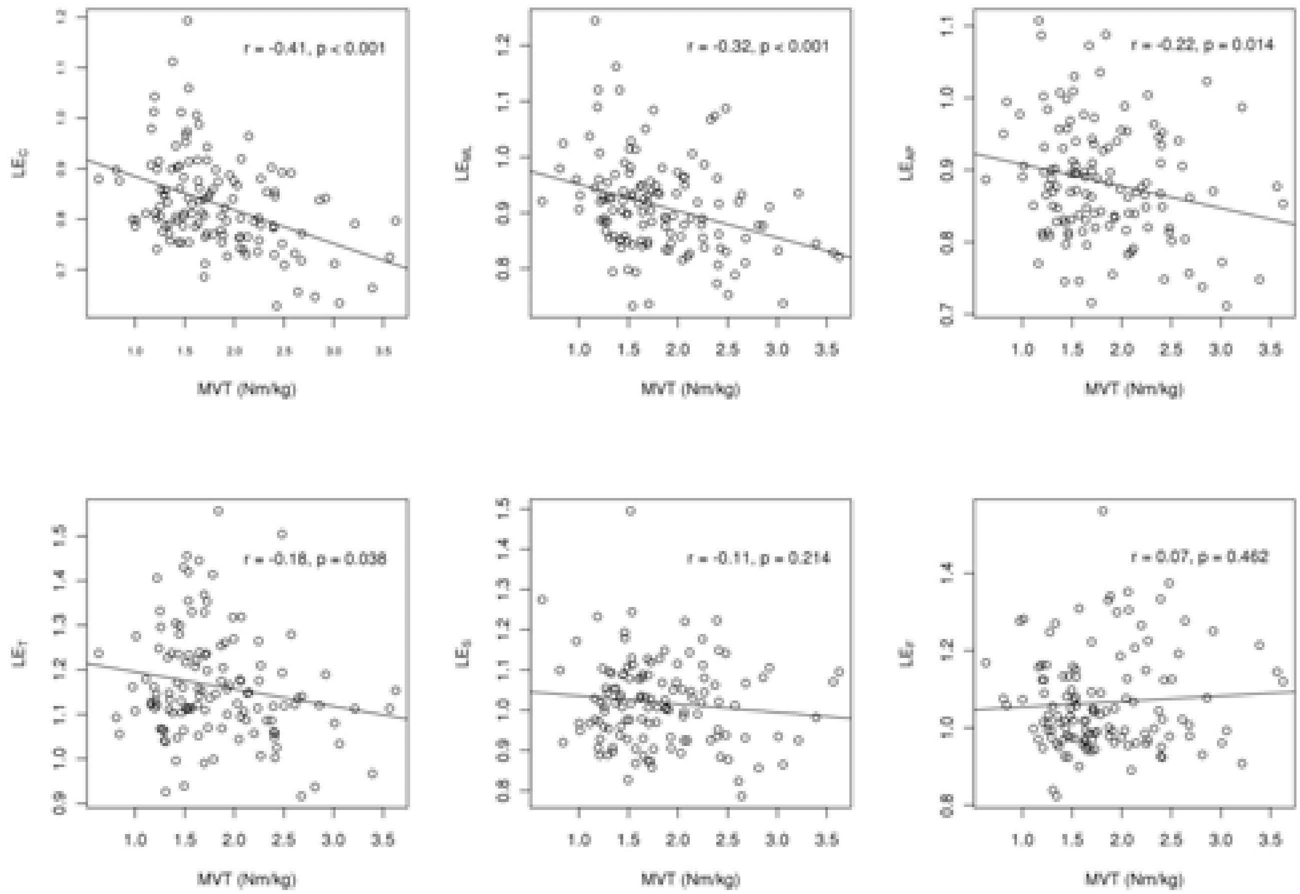
BACKGROUND AND AIM: Leg strength has been suggested to be associated with fall risk (Sturnieks et al. 2008). Recent results have shown that gait stability is also associated with fall history (Toebes et al. submitted). This might suggest that low leg strength reduces gait stability, which in turns increases fall risk. However, a recent study showed that after adjusting for differences in strength a difference in gait stability between young and old subjects remained. Moreover, there appeared to be no association between strength and gait stability within the age groups (Figure 4 in: Kang and Dingwell, 2008). The aim was to investigate the association between maximal leg strength of knee extensors and gait stability in a large group of elderly subjects. METHODS: Body mass corrected maximal voluntary knee extensor torque (MVT) and gait stability were measured in 129 subjects (Nmale=48, 62.5 (SD 6.2) years). MVT was measured while subjects were exerting maximal force, sitting tightly strapped in a chair with a knee angle of 90°. The highest MVT of 3 trials separated by 1 minute of rest was used. An inertial sensor measured trunk accelerations and angular velocities during treadmill walking at a velocity of 4.0 km/h. Gait stability was quantified by the short-term Lyapunov exponent of anterior-posterior and medio-lateral trunk accelerations (LEap and LEml respectively), transverse-, sagittal- and frontal plane angular velocities (LEt, LEs, LEf) and all angular velocities combined (LEc). The LE indicates the averaged short-term rate of divergence of two, initially infinitesimally close, trajectories through state-space. Positive values indicate instability, larger positive values indicate more instability. 150 strides were used for calculations. Linear regression analyses were performed with MVT as independent, and the LE variables as dependent factors in separate analyses. The results were checked for confounders (age, gender). A negative association between MVT and LE was hypothesized. RESULTS: The figure shows that MVT was negatively associated with LEc ($p<0.001$, $r2=0.17$), LEml ($p=0.001$, $r2=0.10$), LEap ($p=0.014$, $r2=0.05$), LEt ($p=0.038$, $r2=0.03$). After correction for age (LEc), gender (LEt), or both (LEml and LEap) the association disappeared. No association was found between MVT and LEs ($p=0.21$), and LEf ($p=0.46$). CONCLUSIONS: The results indicate that leg strength is possibly one of the, changeable, factors associated with gait stability and a target for training. However, the relatively small explained variance (3-17%) indicates that there are also other relevant factors.



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O.27.4 The temporal relationship between cognitive performance and handgrip strength in the oldest old

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BACKGROUND: Cognitive decline and muscle weakness are prevalent health conditions in elderly and often co-occur. We hypothesized that cognitive decline precedes muscle weakness. The aim of this study was to analyze the temporal relationship between cognitive performance and handgrip strength in oldest old people. METHOD: Leiden 85-plus Study, a prospective population based four year follow-up study of 555 subjects, all aged 85 years at baseline. A neuropsychological test battery was used to assess global cognitive performance attention, processing speed and memory. Subjects were followed up over a four year period with repeated cognitive tests. Handgrip strength was measured at age 85 and 89 years as a proxy for muscle strength. Cross-sectional and prospective associations between cognitive performance and handgrip strength were analyzed by linear regression analysis adjusted for

anthropometry, income, education, comorbidity, and physical activity. RESULTS: At age 85 and 89 years, better cognitive performance was associated with higher handgrip strength (all, P <.03), except for attention. In the longitudinal analysis, better cognitive performance at age 85 years was associated with slower decline in handgrip strength in the following four years after adjustment for possible confounders (all, P< .01, Figure1). There was no longitudinal association between baseline handgrip strength and cognitive decline (all, P> .10), except for global cognitive performance (P= .007). CONCLUSIONS: Baseline cognitive performance was associated with change in handgrip strength, whereas baseline handgrip strength was not associated with cognitive decline. Our results suggest that cognitive decline precedes the onset of muscle weakness and not vice versa.

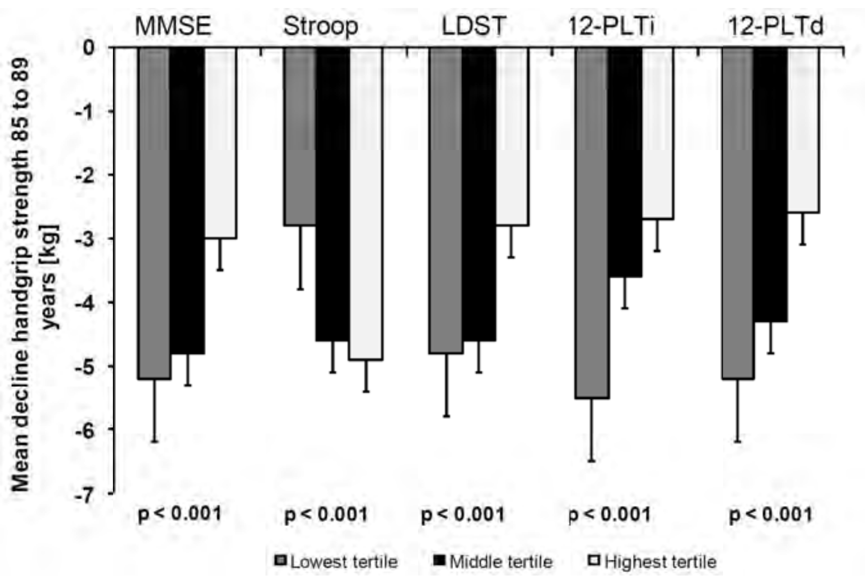

Figure 1. Decline in handgrip strength from age 85 to 89 years in tertiles of baseline cognitive performance (MMSE, Stroop, Letter Digit Substitution Task (LDST) and 12-Picture Learning Test (12-PLT immediate (i) and delayed recall (d)). Error bars indicate standard error (SE).

O.27.5 Effect of uni- and multi-modal cueing on handrail grasping behavior in older adults

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INTRODUCTION: The CNS requires visuospatial information (VSI) about handrail location in order to reach and grasp the rail in response to sudden loss of balance. Age-related deficits in visual attention may impair ability to acquire the needed VSI and this in turn may increase risk of falling by reducing ability to grasp the rail rapidly and effectively [1]. To counter this problem, we have developed a proximity-triggered cueing system [2] that provides a visual cue (flashing lights) and/or verbal cue ("attention, use the handrail") to attract attention to the handrail. This study examined the effect of handrail cueing on grasping of the rail and associated gaze behavior in older adults. METHODS: The cueing system comprises LED's mounted inside a translucent black railing, audio speakers, and a photocell that triggers cueing when a person approaches (~1-2s before the body is adjacent to the rail). This system was mounted on a large (2x6m) motion platform configured to simulate a real-life environment [1]. Subjects performed a daily-life task that required walking to the end of the platform, which was triggered to perturb balance by moving suddenly when they were adjacent to the rail. A deception was used to ensure that the perturbation was truly unexpected. To prevent adaptation, subjects performed only one trial, which was their very first exposure to the perturbation and environment. 160 subjects (age 65-80) were randomly assigned to one of four cue conditions: 1) no cue; 2) visual cue; 3) verbal cue; 4) multimodal (visual-plus-verbal) cue. RESULTS: Verbal cueing markedly increased the tendency to grasp the rail proactively (prior to perturbation onset) particularly when delivered unimodally (93% of subjects, vs 60% for multimodal-cue, 0% for visual-cue and 13% for no-cue; p<0.0001). Subjects were otherwise much more likely to rely on reactive balance control, i.e. grasping the rail in reaction to the perturbation (78% of visual-cue and 80% of no-cue subjects, vs 5% for verbal-cue and 28% for multimodal-cue; p<0.0001). Visual cueing had mixed effects: collisions of the back of the hand with the rail during perturbation-evoked reaching were less frequent (10% of subjects vs 34% for no-cue; p=0.032); however, the reactions were slightly slower (earliest onset in biceps or deltoid: 229ms vs 213ms for no-cue; p=0.015) and proactive grasping was somewhat less frequent (0% of subjects vs 13% for no-cue; p=0.055). Analyses of gaze behavior and other aspects of the balance reactions are in progress. CONCLUSIONS: Results to date support the viability of using unimodal verbal cueing to reduce fall risk by increasing proactive handrail use. Although visual or multimodal visual-plus-verbal cueing may also have some benefits, results to date are not unequivocal.

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O.27.6 Cognitive and physical performance in familial longevity

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BACKGROUND AND AIM: Loss of cognitive and physical performance are highly prevalent health conditions in elderly. Both do frequently co-occur, suggesting an association between cognitive and physical performance. In order to get a better understanding of mechanisms of healthy aging, we defined the following three research questions: First, the association between cognitive and physical performance with chronological age and, secondly, with biological age. Thirdly, we studied the association of cognitive performance with physical performance. METHODS: Cognitive and physical performance were assessed among subjects of the Leiden Longevity Study, a cohort of families enriched for exceptional, familial longevity together with environmentally and age matched controls. In the current analysis 250 middle-aged offspring (mean age 66.3 years, range 48 - 84 years) of nonagenarian siblings and 250 partners thereof (mean age 65.7 years, range 45 - 84 years) were included. Memory function was measured by the 15-Picture Learning Test (15-PLT), attention and processing speed by the Stroop test and Digit Symbol Substitution Test. Physical performance was assessed by the Short Physical Performance Battery, 30 seconds balance testing in several conditions, Timed Up and Go test, Chair Stand Test and a 30 meter walk (with and without cognitive dual task). All physical performance tests were performed with the use of gyroscopes to extract qualitative measures of physical performance additional to the frequently used quantitative measures. Furthermore, seven day actual level of daily physical activity was measured by use of accelerometry. Cognitive and physical performance was

analyzed dependent on chronological and biological age using linear regression analysis adjusted for possible confounders. RESULTS: Cognitive and physical performance was significantly worse in subjects with a higher chronological age. Cognitive performance differed significantly between offspring of nonagenarian siblings and their partners, being better in the offspring, even after adjustment for possible confounders (15-PLT trial 3, the immediate and delayed recall, p=0.016, p=0.036 and p=0.015, respectively). No differences were found between offspring and their partners according to quantitative measures of physical performance and daily activity level. Cognitive performance was significantly positively associated with physical performance (p<0.025). CONCLUSIONS: Middle aged offspring of nonagenarian siblings being enriched for familial longevity showed better cognitive performance compared to their partners, indicating preservation of cognitive performance with age. No differences between offspring and partners were found in physical performance despite significant relations between cognitive and physical performance. This emphasizes the need for further analysis of the qualitative measures of physical performance.

O.28 MODELING, ROBOTICS & BIOMECHANICS II, *Living 4*

O.28.1 Feedback mechanisms for frontal-plane balance control are strongly influenced by stance width

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BACKGROUND AND AIM: Intuitively, stability is enhanced at wider stances because larger frontal-plane excursions of the body's center-of-mass can occur that still remain within the base of support. However, a recent theoretical study indicates that wider stances place greater constraints on the neural feedback control necessary for stability [1]. Our goals were to identify how feedback control properties change as a function of stance width and to look for evidence indicating greater constraints in feedback control at wider stance widths. METHODS: A mathematical model was developed to account for frontal-plane lower body (LB) and upper body (UB) sway evoked by continuous surface-tilt perturbations at one of 3 amplitudes (1°, 2°, or 4° peak-peak) while subjects stood eyes closed at one of 4 stance widths (~11 cm to 37 cm between heel centers). Corrective torques used to control LB and UB motion were assumed to arise from both active mechanisms (torque caused by muscle activation via time-delayed sensory feedback from proprioceptive and vestibular systems) and passive mechanisms (torque caused by muscle/tendon stretch acting with no time delay). Model parameters were adjusted to match model-predicted and experimental frequency-response functions (0.023-6 Hz) from 7 healthy subjects [2]. RESULTS: In narrow stance, LB control was primarily based on active mechanisms. The experimentally observed amplitude-dependent changes in LB dynamics were accounted for by sensory re-weighting whereby subjects shifted away from reliance on proprioceptive feedback that oriented the LB to the surface and shifted toward reliance on vestibular feedback that oriented the LB upright as stimulus amplitude increased. In contrast, the UB control remained relatively linear (unchanging control parameters across stimulus amplitude) in narrow stance even though there were changes in UB dynamics. These changes in UB dynamics were accounted for by 1) LB sensory re-weighting that influenced the UB through interaction torques and 2) inter-segmental proprioceptive feedback that oriented the UB toward the LB. As stance width increased, active UB torque generation decreased, LB passive stiffness increased, and LB active control became more linear (unchanging control parameters across stimulus amplitude). CONCLUSIONS: Stance width had a dramatic effect on the underlying

mechanisms contributing to balance control. In narrow stance, LB control relied on sensory re-weighting to limit perturbation-induced body motions. As stance width increased, subjects adopted a "simpler" control strategy whereby reliance upon feedback from different sensory systems remained constant when stimulus amplitude changed. This simpler control strategy may be indicative of the restrictions on stability predicted in [1].

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O.28.2 Vector space analysis of the body centre of mass movements to determine gait stability in normal and impaired locomotion

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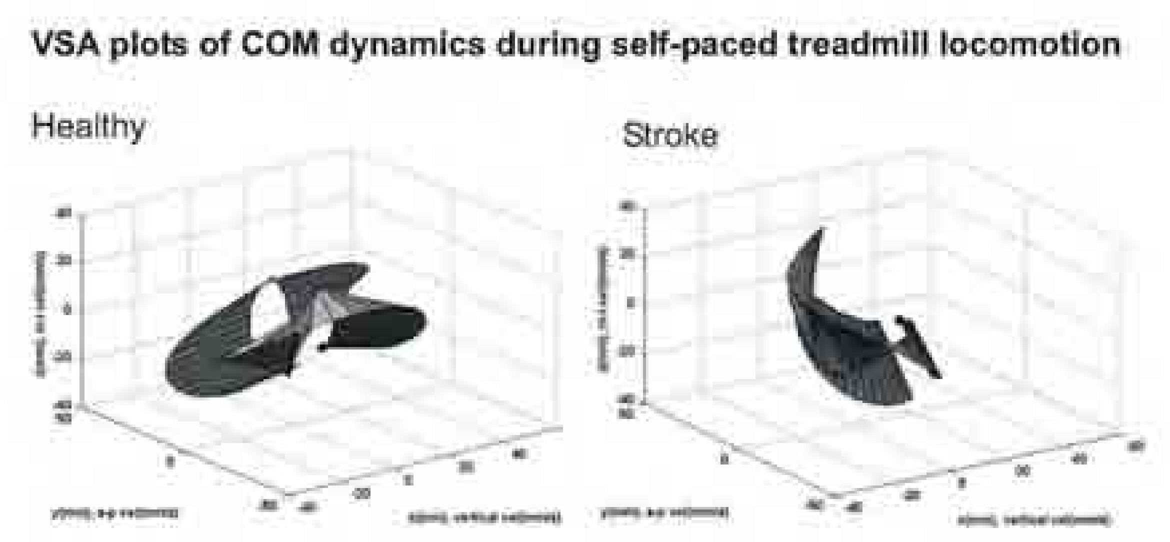
BACKGROUND AND AIM OF THE STUDY: Stability is a vital element in gait control, indicating the ability to maintain functional mobility despite small kinematic disturbances or control errors. Many complex, non-linear dynamical systems approaches have been used to quantify gait stability. We propose a novel approach based on vector space analysis (VSA) of the body's 3-dimensional (3D) centre of mass (CoM) movements during self-paced treadmill locomotion. We hypothesize that this novel VSA approach can distinguish the gait performance between healthy subjects and persons with chronic stroke. METHODS: Eight subjects with chronic stroke and 8 age-matched healthy controls walked on a servo-controlled treadmill in a virtual environment for 40m and were instructed to maintain a comfortable, preferred speed (self-paced). Body motions were captured and analyzed with a 6-camera VICON MX system. The body's CoM position was computed and normalized in time to the stride cycles (as depicted by the toe trajectories) of the individual paretic limb (for stroke participants) or the equivalent right/left limb (for healthy controls). CoM velocity was obtained by differentiating CoM position in time, and smoothed with a low-pass filter of 10 Hz. The VSA involves plotting 3D velocity vectors along with 3D mean CoM trajectory points to construct a 3D phase diagram that embeds the 6D data set. This output is essentially a 3D plot of the velocity-position coordination of COM (Figure). The 3D velocity vector projections in each axis across the gait cycle were then squared and averaged. The mean sums of squares were then calculated for each direction and summed to represent the mean total kinetic energy of the CoM related to the unit mass, which can be simply defined as the mean circulation of the 3D velocity vectors over the CoM loop, according to the VSA approach. Unpaired Student's t-tests were used to determine any significant difference comparing the mean total and directional kinetic energy values between the healthy and post-stroke groups. RESULTS: One important difference when comparing the VSA 3D plots between groups is that the CoM velocity vectors of the stroke subjects are markedly increased in the mediolateral (ML) direction as compared to healthy individuals, indicating a compromise in ML stability. Indeed, statistical analyses comparing the mean sums of squares of the velocity vectors between the two subject groups revealed a significant increase in the ML direction ($p=0.004$) and decrease in the vertical direction ($p=0.009$) in stroke participants. However, the mean total kinetic energy was not significantly different between groups. CONCLUSIONS: The VSA is a simple and useful approach for gait analysis. The results from this study show that ML stability during gait is impaired in persons with stroke.

Such instability might be compensated by decreased movement velocity of the COM in the vertical direction, so that the mean total kinetic energy is conserved.



O.28.3 The dependence of human balance control on stimulus amplitude.

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BACKGROUND AND AIM: To maintain upright stance in a gravitational field, orientation information from different sensory systems (i.e. vision, vestibular and proprioception), is merged and used to produce a corrective action. When the perturbation amplitude directly affecting one sensory system increases, that sensory system will be down-weighted and the more reliable information from the other systems will be up-weighted [1]. We developed a computational framework that predicts how humans dynamically weight sensory contributions to stance control and tune their corrective actions to minimize the energetic effects of sensory noise and external stimuli [2]. A model prediction we want to validate is that sensory re-weighting depends not only on the sensory perturbation amplitude but also on the frequency content of the stimulus. METHODS: Eleven healthy subjects maintained their balance with closed eyes while perturbed by support surface rotations or with eyes open while perturbed by visual surround rotations (as in [1]). The stimulus was applied with increasing amplitude across trials. For each of four amplitude conditions three different realizations of the stimulus signal were used that had the same RMS position amplitude but with a different power spectrum (and thus a different RMS velocity amplitude). Body sway responses were measured and Frequency Response Functions (FRFs) were estimated [3] that defined the sensitivity of the sway responses relative to the stimulus. RESULTS: The sensitivity to the sensory perturbations depended not only on the stimulus position amplitude but also on stimulus velocity amplitude as predicted by the theoretical framework. Different log-log plots of normalized RMS sway responses against RMS stimulus position amplitude or stimulus velocity amplitude, revealed that amplitude-dependent sensitivity changes could be best described by the ratio of RMS body sway velocity to RMS stimulus velocity as a function of RMS stimulus velocity. FRF model fits showed that changes in sensory weights alone could not fully account for amplitude-dependent FRF

changes. CONCLUSION: Sensory re-weighting only partially accounts for the observed dependence of response sensitivity changes on stimulus velocity.

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O.28.4 A stance control model incorporating canal-otolith integration predicts the time course of body sway evoked by galvanic vestibular stimulation

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BACKGROUND AND AIM: A previous study [1] demonstrated a characteristic "step-ramp" lateral pelvis displacement in response to an 8 s, 0.3 or 0.5 mA galvanic vestibular stimulation (GVS). Results were obtained in eyes closed conditions that limited proprioceptive contributions (narrow stance on foam) and permitted large sway excursions (feet weighted and strapped to floor). That study posited that the step component of the step-ramp waveform was due to a net GVS activation of otolith afferents signaling body tilt and the ramp component was due to net activation of semicircular canal afferents signaling a continuous roll velocity. We used existing mathematical models of stance control [2] and canal-otolith integration [3] to test this hypothesis and to consider other possible explanations. METHODS: The basis for our modeling efforts was a stance control model developed to explain sway responses to surface-tilt perturbations [2]. This model included vestibular feedback that assumed that centrally processed vestibular signals provided essentially perfect measures of body tilt angle with respect to gravity and angular velocity. These signals were processed through a "neural controller" to generate ankle torque to stabilize the body. An additional model component was a positive torque-feedback pathway that moved the body toward vertical to reduce the magnitude of ankle torque. A detailed model of canal-otolith integration [3] was substituted for the vestibular feedback in order to simulate GVS-induced bias of canal and/or otolith signals. Outputs from the canal-otolith model include estimates of gravity direction and angular velocity; both derived by combining canal and otolith signals. These output signals were used as inputs to the neural controller. RESULTS: We found that our model could generate a typical experimental step-ramp sway response to an 8 s constant current GVS without GVS activation of otoliths. GVS was assumed to affect only canals by inducing a roll velocity bias in the canal signal. Canal-otolith integration of the biased canal signal produced biased measures of both body tilt angle and angular velocity even though the otoliths were not influenced by GVS. The step component of sway was caused primarily by velocity-related torque evoked by the onset and offset of GVS. The ramp-component was strongly influenced by the properties of the torque-feedback pathway. The torque feedback reduced the influence of the biased canal signal on body sway and thus reduced the slope of the ramp compared to the step component. CONCLUSIONS: Model-predicted sway responses to GVS provide an explanation for the step-ramp time-course that does not require net GVS activation of otoliths.

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O.28.5 On the validity of the Lyapunov exponent for gait stability

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BACKGROUND AND AIM: Lyapunov exponents are often used to quantify local dynamic stability of walking. These calculations, originating from theories in physics and mathematics (e.g. Kantz and Schreiber 2003, Sprott 2003), are for example used to estimate fall risk (Toebes et al. 2011) and seem very promising as prediction or evaluation tools of gait stability. However, when applying such measures on gait data, issues such as noise and data series length can seriously affect the outcome validity (Bruijn et al. 2009). The crucial question is therefore, under which circumstances are Lyapunov exponents a valid measure? METHODS: We tackled this question by studying time series from seminal dynamical systems (Lorenz and Roessler) in conjunction with gait data (accelerometry). We briefly summarize a typically applied algorithm for estimating Lyapunov exponents (Rosenstein et al. 1993) and assess its applicability in the case of short data sets that are contaminated with noise. RESULTS: By altering the strength of both dynamical and measurement noise and by changing the time series' length, we mimic characteristics of typically observed gait data. An in-depth investigation of the divergence curves, which underlie many commonly applied estimates of the Lyapunov exponents, reveals profound pitfalls due to the presence of noise and the finite length of the time series under study. We pinpoint to what degree validity and accuracy is limited using large-scale statistics in the case of the aforementioned chaotic attractors. As an example of this, the included figure shows the effects of sample size and white measurement noise (with a signal-to-noise-ratio of 100) on mean and standard deviation of the estimated Lyapunov exponents of a Lorenz attractor. These effects can be quite dramatic in case of short data series and high noise levels, where we see offsets and standard deviations above 30%. CONCLUSION: We conclude that when using Lyapunov exponents calculated from short and noisy time series to evaluate the local stability of a given process, it is essential to take estimated variances and offsets into account.

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O.28.6 Phase-dependent changes in local dynamical stability of human gait

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BACKGROUND AND AIM: Several methods derived from nonlinear time series analysis have been suggested to quantify stability in human gait kinematics. One of these methods is the definition of the maximum finite time Lyapunov exponent (ë) that quantifies how the system responds to infinitesimal perturbations. However, the computation of ë is limited by the assumption of an exponential increase in initial perturbations and the absence of transition in ë between single and double support phases within the stride cycle. This study presents a new method to quantify intra-stride changes in local dynamical stability ë(t) and employs the method to 3D lower extremity gait kinematics in 10 healthy adults walking on a treadmill at 3 different speeds. METHOD: The local dynamical stability was quantified by a modified version of the algorithm developed by Kantz (1994). First, a 30 dimensional state space was reconstructed for each leg containing the 3D position and 3D velocity for the toe and heel markers together with the estimated ankle, knee and hip joint centers. Secondly, initial perturbation distance was considered at the point in the reconstructed state space of each heel strike and toe off separately. Third, the time evolution of the initial perturbation distance was traced during an entire stride cycle to the next heel strike or toe off. Fourth, the average distance for the ensemble of neighboring trajectories was computed before the average distance was normalized to stride time. Fifth, the median and interquartile range of average distance was computed for each participant. Sixth, the time-dependent Lyapunov exponent ë(t) was computed at each point within the stride cycle (see Fig. 1). RESULTS: The gait kinematics of the healthy adults shifted between stable and unstable dynamics during the stride cycle indicated by the temporal change in ë(t). These shifts were closely related to the transition between single and double support phases and, consequently, to weight transfer during gait. Furthermore, the dependency between local dynamical stability and gait speed changed during the stride cycle. The gait kinematics during fast gait speeds were more stable at toe off, but more stable at heel strike during slow speeds. CONCLUSION: The present method resolves some fundamental limitations of the conventional definition of local dynamical stability by finite sized Lyapunov exponent, thereby revealing intra-stride shifts in local dynamical stability related to weight transfer during gait. Consequently, the present method might be important for assessment of gait function in older persons and other clinical groups at risk of developing gait impairments.

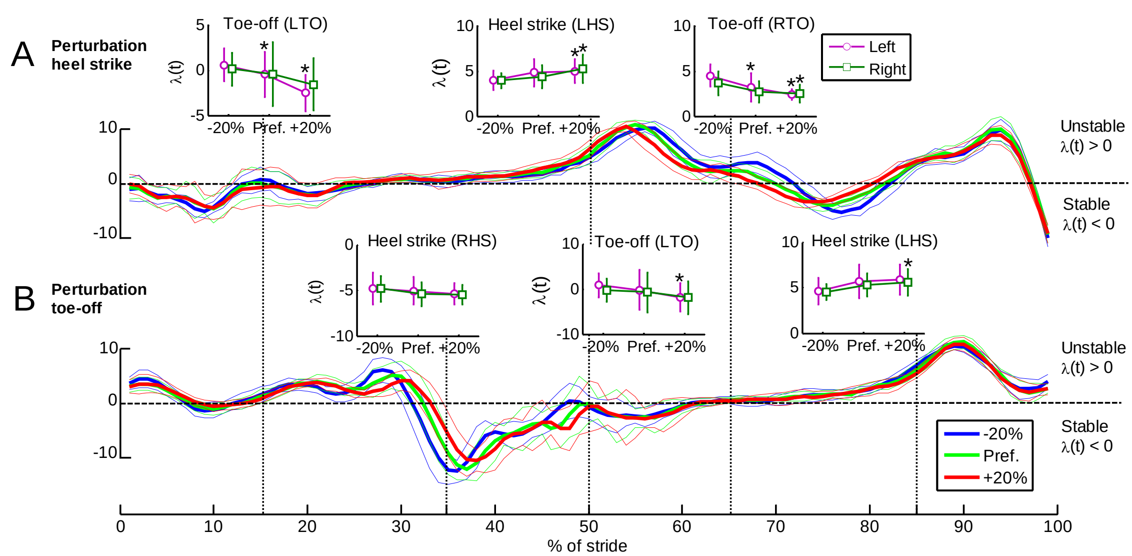

Figure 1. The mean $\lambda(t) \pm 1$ SD for preferred (*green*), -20 % (*blue*) and +20 % (*red*) walking speed conditions for perturbation at right heel strike (A) and right toe off (B). The smaller subplots are the cross-sectional differences in

mean $\lambda(t)$ ± 1 SD with walking speed at consecutive heel strikes and toe offs (*p < 0.05; paired-samples t-test between walking speed conditions).

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O.29 SENSORIMOTOR CONTROL III, *Cosmos 3A*

O.29.1 Posture-gait problem and its solution

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BACKGROUND AND AIM: Locomotion is presumably guided by feed-forward shifts in the referent body location in the desired direction in the environment. We propose that the difference between the actual and the referent body locations is transmitted to neurons that virtually diminish this difference by appropriately changing the referent body configuration, i.e. the body posture at which muscles reach their recruitment thresholds. Muscles are activated depending on the gap between the actual and the referent body configurations resulting in a step being made to minimize this gap. This hypothesis implies that the actual and the referent leg configurations can match each other at certain phases of the gait cycle, resulting in minimization of leg muscle activity. Our hypothesis also predicts that, in response to perturbations of gait, the rate of shifts in the referent body location can temporarily be changed to avoid falling. The rate influences the phase of rhythmic limb movements during gait. Therefore, following the change in the rate of the referent body location, the whole gait pattern, for all four limbs, will irreversibly be shifted in time (long-lasting and global phase resetting) with only transient changes in the gait speed, swing and stance timing and cycle duration. METHODS: The prediction of multiple EMG minimization at certain phases of motion in each leg was tested by recording surface EMG activity of 12 muscles of each leg (24 muscles in total; telemetric EMG system, Aurion, Italy) and 3D kinematic data (10-camera motion analysis system, Vicon Peak, Oxford, UK) during forward and backward gait on the floor. The prediction of long-lasting phase resetting in response to perturbation was tested by briefly arresting forward motion of one leg in the swing phase during walking on a treadmill. RESULTS: We found several leg configurations at which EMG minima occurred, both during forward and backward gait. It was also found that the set of limb configurations associated with EMG minima can be changed by modifying the pattern of forward and backward gait. Aside from transient changes in the duration of the swing and/or stance phase in response to perturbation, few previous studies have documented long-lasting and global phase resetting of human gait in response to perturbation. Such resetting was a robust finding in our study. CONCLUSIONS: By confirming the notion that feed-forward changes in the referent body location and configuration underlie human locomotion, this study solved the classical problem in the relationship between stability of posture and gait and advanced the understanding of how human locomotion involves the whole body and is accomplished in a spatial frame of reference associated with the environment (Feldman et al. 2011).

O.29.2 Error-signals driving locomotor adaptation: effects of peripheral nerve stimulation on ankle control during walking in an elastic force field

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BACKGROUND AND AIM: Proprioceptive and cutaneous feedback play an important role in modifying the ongoing motor pattern during locomotion. In addition to feedback mechanisms, the nervous system must also adapt to deal with predictable dynamics between our body and the environment. Adaptation is an error-dependent motor learning process, where sensorimotor maps are updated based on mismatch between intended and actual sensorimotor outcomes - this reduces errors in the feedforward command during subsequent movements. We hypothesize that cutaneous feedback provides a mechanism for monitoring contact forces during walking, and mismatch between expected and actual force feedback drives adaptation. Here we blocked peripheral input using non-invasive repetitive nerve stimulation and examined the effects on 1) proprioception versus tactile perception and 2) ankle dorsiflexion adaptation during walking in an elastic force field. METHODS: We focused on sensory feedback from the foot, and stimulated the superficial peroneal (foot dorsum) and medial plantar nerves (foot sole). Repetitive nerve stimulation was administered with a constant current stimulator that delivered 1 ms pulses at 80 Hz. The intensity was set at a level where subject perceived a tingling sensation that radiated towards the toes. Tactile perception on the right great toe was assessed using Vibratron II to measure vibration thresholds, and Von Frey monofilaments to measure pressure thresholds. Proprioception was tested during an active ankle position-matching task. Sensory tests were first performed without stimulation, and then repeated with stimulation. During walking adaptation, subjects were exposed to a position-dependent force field produced by an elastic band attached between the back of the shoe and the calf band of an ankle-foot orthosis, which produced the largest force when the ankle is in dorsiflexion. In the baseline period, subjects walked with no external force at the ankle - a sham elastic (13 cm) was attached. In the adaptation period, a 6.5 cm elastic was attached and subjects were instructed to 'resist the force and walk normally'. In the post-adaptation period, the elastic force was removed to test for after-effects. Each subject repeated the adaptation paradigm in a randomly assigned sequence of conditions (peroneal nerve, plantar nerve, no stimulation). RESULTS: Repetitive nerve stimulation of the superficial peroneal and medial plantar nerves worsened cutaneous sensation, but not proprioception. Adaptation of ankle dorsiflexion and tibialis anterior activation during force field walking was reduced with peroneal nerve stimulation, whereas plantar nerve stimulation had no effects compared to the no stimulation condition. CONCLUSIONS: This study showed that cutaneous feedback plays an important role in driving error-based adaptation during walking. Identifying salient neural signals that drive adaptation could increase the efficiency of gait rehabilitation.

O.29.3 Does the cortex contribute to exploratory postural sway?

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BACKGROUND: Recent evidence has shown that experimentally restricting postural sway leads to an unexpected increase in centre-of-pressure (COP) displacement. It has been argued that participants increase COP displacements under these conditions in an attempt to move the body and regain a certain level of afferent input, which is otherwise acquired through natural sway. However, the origin of this increase in COP displacement remains unknown. In the current investigation, we used corticomuscular coherence (CMC) to investigate whether the relationship between oscillatory activity in the cortex and lower leg muscles increase together with COP displacement during conditions of restricted postural

sway. METHODS: Only participants demonstrating significant levels of CMC between EEG and lower leg EMG during a 2-min seated low-level voluntary contraction were included in the experiment (n=3). Subjects stood as still as possible on a forceplate and were firmly braced with their back against a rigid board to prevent movement at any joint except the ankle. The board was attached to a closed-loop pulley system that allowed normal postural sway about the ankle joint and was equipped with a brake that allowed the board (and centre-of-mass (COM)) to be discretely locked in place in the sagittal plane. In each of 2 trials, following an initial 60s standing period, participants stood freely in the "unlocked" condition for 135s and were subsequently "locked" at their mean COP position for a further 135s. Kinematics and forceplate measures were collected (512Hz) and used to calculate the root mean square (RMS) of estimated COM and COP displacements over the last 120s in each condition. EEG (Cz) and bilateral EMG (soleus, lateral and medial gastrocnemii) were collected (2048Hz) and used to estimate CMC over the same time periods. Estimates of CMC were deemed significant if they surpassed a 95% confidence interval, and differences between unlocked and locked conditions were tested using a difference of coherence test. RESULTS: With locking, COM RMS decreased in all trials from 6.72 to 0.2mm, while COP RMS increased in 5 of 6 trials (4.74 to 7.13mm). In the unlocked condition, there was little to no CMC between Cz and any of the recorded muscles. Similarly, CMC remained low or absent when participants were stabilized or "locked" in the sagittal plane. There were no significant differences in the magnitude of CMC between unlocked and locked conditions. CONCLUSIONS: Increases in COP displacement observed during restricted postural sway suggest a possible exploratory role of postural sway. The results from the current study suggest that this increase is not associated with an increase in the relationship between cortical and muscle activities. Rather, it may be that increases in COP displacement with locking are mediated by subcortical structures as a means of increasing sway to provide the CNS with a constant flow of sensory information.

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O.29.4 Patient-Customized Vibrotactile Feedback for Postural Control

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BACKGROUND AND AIM: Sensory substitution balance prostheses aim to augment sensory information available for balance, to compensate for natural sensory losses, such as in older persons and patients with vestibular deficits. One form of sensory substitution uses vibrotactile feedback based on the subject's trunk position and velocity (Wall, 2003). This feedback is effective at reducing low frequency body sway (below 0.5 Hz) in response to perturbations while standing; however, it causes an undesirable increase in high frequency sway (Goodworth, 2009). Unlike other sensory prostheses such as hearing aids, which are tuned to the user, current vibrotactile prostheses employ a ``one size fits all'' approach, in that they use the same device and parameter settings (position and velocity weights) for all subjects. Our aim is to redesign vibrotactile feedback so that it does not generate increased high frequency sway, and is designed for the specific user. METHODS: For the currently used "position-velocity" (PV) feedback, the vibrotactile feedback activation signal is determined by $f(t)=P\theta(t)\ V\theta'(t)$ where P and V are fixed weights, typically the same for every subject, and $\theta(t)$ and $\theta'(t)$ are the measured body angle position and velocity, respectively. In contrast to this fixed approach, we present a customized design using engineering system identification methods that tailors the device to the subject. Model-based analysis shows that this approach incorporates not only body position and velocity in the vibrotactile feedback, but also acceleration and a predictive component, all with subject-specific

parameters. RESULTS: For the customized approach, the tactor activation signal is given by $f(t)=h(t)*[K_p\theta(t)\ K_v\theta'(t)\ K_a\theta''(t)]$ where $\theta''(t)$ is body acceleration and the subject-specific parameters K_p, K_v and K_a are determined by system identification analysis of the subject's response to balance perturbations. Moreover, the function $h(t)$ is a filter, with subject-specific parameters, including a predictive component that compensates for the subject's postural control delay in sensory processing and torque generation. Our analysis shows that this approach reduces the high frequency body sway produced by current vibrotactile devices, because the custom approach activates the tactors sooner than the fixed PV design (Fig. 1a). The custom filter further allows one to specify frequency-specific reductions in body sway, so that one can design the device to preferentially reduce low frequency sway (Fig. 1b), high frequency sway, or provide uniform reduction. CONCLUSION: Incorporating system identification methods in the design of vibrotactile feedback tailors the device to the patient and can potentially reduce the high frequency sway caused by current devices. The proposed approach is a first step toward the development of user-customized vibrotactile prostheses, that could help advance the use of vibrotactile feedback.

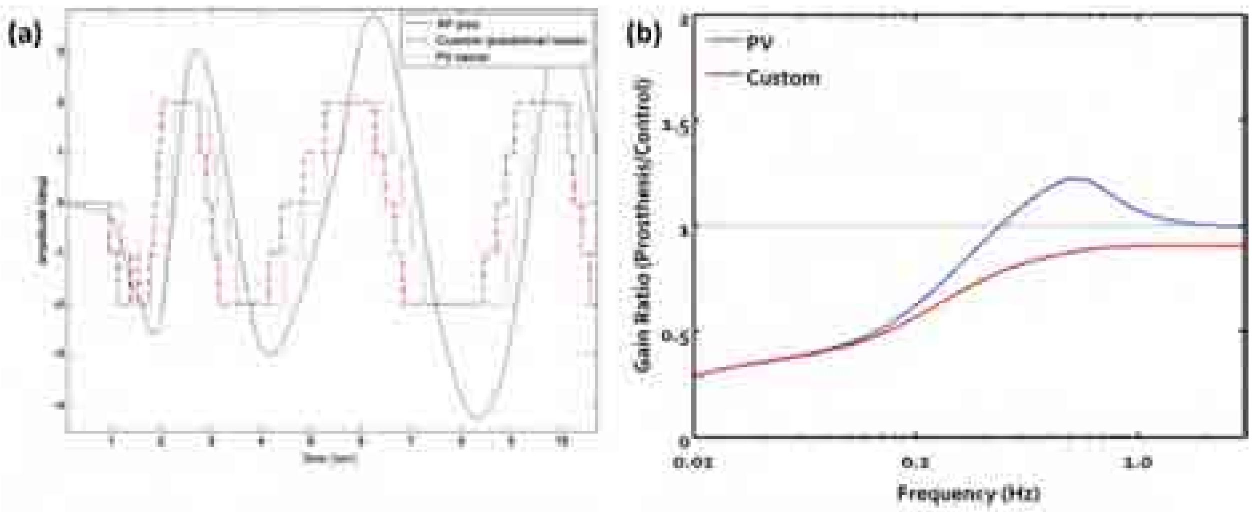

Fig.1 (a) Comparison of vibrotactile activation signals for default "position-velocity" settings (blue) and customized design (red). The solid black curve is AP body sway data. By incorporating a subject-specific combination of position, velocity and acceleration, as well as a predictive component, the proposed custom design causes the tactors to activate sooner, thereby providing the user with greater "lead time" to react to the vibrotactile feedback. (b) Our simulations, using accepted models of balance (Goodworth, 2009), demonstrate that the custom vibrotactile approach can potentially reduce the increased high-frequency sway seen with current devices.

O.29.5 The effects of vibrating insoles on standing balance in diabetic neuropathy

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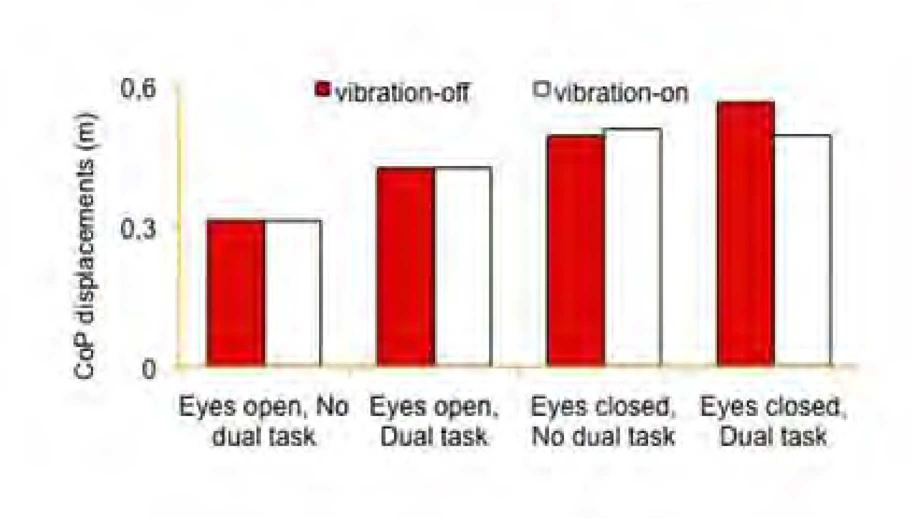
INTRODUCTION: Mechanoreceptors on the plantar side of the feet provide the CNS with information concerning the pressure distribution. In Neuropathy this information is conducted to the CNS worse, leading to a decrease of balance skills and, therefore, an increase of the chance on falling. Stochastic vibration of the footpad is supposed to improve the proprioceptive information of footpressure1,2,3 and therefore increase balance skills. METHODS: 17 people with Diabetic Neuropathy (mean age 52.1, sd 6.0) and 15 healthy controls (mean age 51.8, sd 5.6) were selected. Neuropathy was tested with a

Semmes Weinstein Monofilament (10 g). The subjects were asked to stand on a pair of vibrating insoles that were attached to a force plate. The amplitude of the noise was gradually increased till the subject reported to feel the signal. During the measurements the amplitude was set at 90% of the tactile threshold of each individual subject. Balance parameters were measured during trials of 60 s. under different circumstances: eyes open, eyes open with attention-demanding task (ADT), eyes closed, eyes closed with ADT. Vibration was turned on during the first or second 30 s of each trial. Balance parameters: mean velocity and path length of Center of Pressure displacements. RESULTS: In the controls we saw no effect of the stochastic vibration in either situation, as expected, since healthy people do have an optimal proprioceptive signal. In the patients only with eyes closed and an ADT there was an effect of stochastic vibration. Fig 1. CoP displacement (mm/s) in Diabetic patients with Neuropathy. DISCUSSION / CONCLUSIONS: The findings in our study seem less pronounced than in other studies. This can be due to the chosen parameters and the properties of the insoles. A weakness of our study can also be responsible for this. 71% of the subjects with Neuropathy did not feel the maximal amplitude of the vibration. Therefore we don't know if the threshold was set at 90% and probably it was not sufficient to reach the sensory detection threshold. The Neuropathy could be too serious or the amplitude of the vibration is not high enough. The findings of this study are encouraging. The use of stochastic vibration seem to improve balance skills and people with Diabetic Neuropathy may benefit from this. In the next phase we will develop new insoles in shoes, with higher amplitudes and measure also balance parameters during walking.



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O.29.6 Muscular Effort in Maintaining Balance by Handrail Grasping: Implications for the Design of Public Transportation Vehicles

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BACKGROUND AND AIM: Falls in standing passengers are the most common cause of injuries on public transportation vehicles (buses and subways). The primary means for balance maintenance in this scenario is handrail grasping, and a systematic approach to environmental design should result in safer vehicles. In the current study, we addressed this issue by conducting laboratory experiments to test the effect of handrail configuration, stance configuration and perturbation magnitude on the muscular effort involved in balance recovery during simulated vehicle starts and stops. METHODS: Sixteen adults (25 (SD=5.3) yrs) participated in experiments where they stood on a platform grasping a cylindrical handrail located shoulder height or overhead. A linear motor (of length 1.2 m) accelerated the platform forward, backward or sideways at high (2m/s2) or low (1m/s2) perturbation magnitudes. Forces applied to the handrail (from a load cell), COP displacements (from a force-plate) and muscle responses (from EMG) were recorded. Muscular effort was expressed as peak values normalized by maximum attainable values. RESULTS: Peak hand forces were greater for shoulder-height than overhead handrails (71 versus 54% of maximum attainable values; p<0.01), and during forward than sideways perturbations (77 versus 54%; p<0.01). The combination of shoulder-height handrail and forward perturbation direction was associated with 72% greater hand forces (on average) than other stance and grasp combinations. COP excursion was greater during backward than forward perturbations (83 versus 66% of maximum values; p<0.01), but was unaffected by handrail configuration. Muscle onset times averaged between 164 and 253ms. Biceps and tibialis anterior activated earlier and with greater intensity in forward than backward perturbations, while triceps and gastrocnemius activated faster and more forcefully in backward than forward perturbations. Higher perturbation magnitudes caused increases of 157% in peak hand force, 21% in COP displacement and 55% in muscle activation intensity. CONCLUSIONS: Hand forces were highest when grasping shoulder-height handrails, and in forward perturbations. Conversely, COP excursion was highest in sideways and backward perturbations. This reflects that participants relied more on COP excursion than hand force to maintain balance during backward and sideways perturbations, while the opposite was true for forward perturbations. Practically, a forward stance configuration will result in perturbations in both forward and backward directions (during starts and stops, respectively), while a sideways configuration largely eliminates this directional sensitivity. Collectively, these observations indicate that a combination of overhead handrail grasping and sideways stance is most effective in minimizing the muscular effort associated with balance maintenance while standing on public transportation vehicles.

O.30 COGNITIVE IMPAIRMENT, *Cosmos 3C*

O.30.1 Can the Stroop test for double-task locomotor performance reveal the existence of cognitive decline?

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BACKGROUND AND AIM OF THE STUDY: The Stroop test consists in a mental inhibition task that is affected by normal and pathological aging (Fournet, 2007). The objective is to determine whether or not the Stroop interference effect is heightened in various walking situations according to the type of cognitive impairment. METHOD: 35 older aged, autonomous volunteers without any pathology likely to influence walking or posture were given a psychometric test (MMSE : Folstein et al, 1975 ; BREF : Dubois et al, 2000 ; 5 mots de Dubois : Dubois, 2002), an evaluation of the inhibitory functions (Stroop adapted

from Golden et al, 1978 and the psychomotor version of Kipnis et Glickman, 1962), and an instrumented 10m walking test (GaitRite). We divided the participants into 3 groups according to their levels of performance with regard to the executive functions (EF): 9 low EF patients (memory and EF impairment), 17 older age high EF subjects (7 memory impaired and 10 healthy older adults) and 9 middle EF patients. In dual-task performance (DT), the Stroop test is applied to walking tasks through different procedures: - Walking Stroop Carpet (WSC), with displacement towards the stepping targets constituted by words and colors on the floor. Two versions of WSC were used that differed in the pattern of placement of words and colors. Three subsequent subtasks were tested on the mat (walk on the words, on the colors and on the ink color of the printed words). - Walking Stroop Verbal (WSV), in which, while walking, the participants were instructed read the words, name the colors, and finally, name the ink color of the printed words as quickly and as accurately as possible in the three subsequent subtasks projected on a screen. RESULTS: The only correlation observed is the one between WSV motor performances and the psychomotor version of the Stroop test (R = 0.39 à 0.62). With regard to the WSC test, it was observed that the low EF groups performed less satisfactorily than the other groups, and there also existed a significant difference between the middle EF and the high EF participants. The WSV test did not allow for differentiation between the groups. DT cost under congruent conditions (reading) and non-congruent conditions (name the ink color of the printed words) showed no significant difference between the two forms of exercise. CONCLUSIONS: The Stroop interference effect is markedly modified during the walking exercise. WSC is a complex DT task facilitating early detection of dysexecutive impairment.

O.30.2 Physiological Fall Risk Factors in Cognitively Impaired Older People: A one year prospective study

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BACKGROUND AND AIM: Falls in people with dementia/cognitive impairment pose an international health challenge. Cognitively impaired older people are at twice the risk of falls compared to cognitively intact, with approximately 60% falling once or more per year. Why fall risk is increased remains unclear, as few studies have examined fall risk factors prospectively in this population. The current study aimed to investigate physiological fall risk factors in community dwelling cognitively impaired older people. METHODS: One hundred and seventy-seven community dwelling older people with moderate to marked cognitive impairment (MMSE<24, ACE-R<83) underwent a detailed assessment of physiological performance. This included measures of vision, hand reaction time, proprioception, quadriceps strength, sway on both firm and compliant surfaces and co-ordinated stability. All participants had a minimum of 3.5 hours per week face to face contact with their carer. Falls were recorded prospectively for 12 months using monthly calendars with the assistance of carers. RESULTS: One hundred and eleven participants (66%) fell 1+ times and 71 (43%) fell 2+ times in the 12 month follow-up period. Multiple fallers were more likely to have fallen in the previous year, use a walking aid, take more medications and report previous diagnoses of cardiac arrhythmias, claudication and cancer ($p < 0.05$). After adjusting for age and sex, logistic regression analyses identified the following fall risk factors: hand reaction time (OR=1.51, 95%CI=1.09-1.92), sway on floor (OR=1.45, 95%CI=1.02-2.04), sway on foam (OR=1.91, 95%CI=1.34-2.74), co-ordinated stability (OR=2.81, 95%CI=1.84-4.31) and overall Physiological Profile Assessment (PPA) falls risk score (OR=2.00, 95%CI=1.39-2.88). The multivariate model including hand reaction time, sway on foam and co-ordinated stability showed an AUC of 0.74 (95% CI=0.66-0.81). The more comprehensive multivariate model including six tests of the PPA (vision, hand reaction time, proprioception, quadriceps strength, sway on foam and co-ordinated stability) showed an AUC of 0.75

(95%CI 0.68-0.83). Multiple fallers also performed worse on measures of vision, proprioception and quadriceps strength; however, these associations were not significant. CONCLUSIONS: Poor performance on physiological measures, particularly balance, increases the risk of falls in cognitively impaired older people. These deficits are potentially amenable to treatment, but further research is required to establish if balance training reduces fall rates in this high risk population. Not all physiological domains of the PPA were significantly associated with multiple falls in this population, however clinically it is advantageous to assess performance in each domain as it helps to design individually tailored intervention programs.

O.30.3 Mobility in persons with early-onset Alzheimer's disease

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BACKGROUND AND AIM: Mobility in terms of ambulation and transfer is no longer considered as unaffected in persons with Alzheimer's disease (AD) in general. However we have not found any studies investigating mobility in persons with early-onset AD (EOAD). Persons with EOAD develop symptoms of dementia before the age of 65. They therefore give us the opportunity to explore changes in mobility that might be related to the disease process itself without pronounced accompanying age-related changes. The aim of this study was to explore changes in mobility over one year in persons with EOAD, and to compare mobility in EOAD with persons with other types of early-onset dementia (EOOD). METHODS: Seventy- eight community-dwelling persons (38 women) between 48-67 years of age (mean age 61.8±4.0) who had received diagnosis of mild to moderate early-onset dementia were included in a clinical observational study at the Clinical Memory Research Unit in Malmø, Sweden. Forty-three patients had EOAD and 29 had EOOD. All patients were assessed by the same physiotherapist. The assessments of mobility were video-recorded, and the analyses are based on the videotapes. The Timed Up and Go (TUG), a modified version of Clinical Outcome Variables Scale (COVS) and timed performances of walking over a training staircase, walking through an obstacle course and rising from lying supine on floor assessed mobility. Descriptive statistics were used to provide means and distributions. Univariate analysis of variance including gender was used to compare mobility scores in EOAD and EOOD groups at baseline, and paired samples t-test was used to compare the results from baseline to one-year follow-up in the EOAD group. RESULTS: At baseline the EOAD group performed better than the EOOD group on all mobility tests, p-values ranging from 0.013 for the obstacle course to <0.001 for the modified-COVS and for the rise from floor task. After one year 26 persons with EOAD were tested again, only 10 persons where tested after one year in the EOOD group thus we did not perform statistic analysis on this group. The performance on TUG (p=0.038), stair walking (p=0.014) and the obstacles course (p=0.026) had deteriorated at the one-year follow-up in the EOAD group. CONCLUSIONS: In what we believe is the first study concerning mobility in early-onset dementia we found that persons with EOAD performs better on tests of mobility than persons with other types of dementia. These relative young persons with EOAD performed worse on the mobility tests one year after baseline. We therefore interpret that the ongoing disease process due to AD has a substantial impact on mobility even in younger people.

O.30.4 Physical and Cognitive Function in Relation to Medial Temporal Lobe Metabolism: 1H MRS in Amnestic Mild Cognitive Impairment and Cognitively Healthy Older Adults

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BACKGROUND AND AIMS: Older adults with amnestic mild cognitive impairment (aMCI) are at higher risk for Alzheimer's disease (AD). Neuronal metabolism within the medial temporal lobe (MTL) may affect physical as well as cognitive function. Proton magnetic resonance imaging spectroscopy (1H MRS) is a non-invasive technique used to measure metabolite concentrations, including N-acetyl aspartate (NAA), a marker of neuronal viability, choline (Cho), a marker of membrane turnover, and creatine (Cr), a measure of energy metabolism. Alterations in MTL metabolites have been reported in aMCI and AD progression. Study Aims: 1) To determine whether there are differences in MTL metabolite levels in older adults with aMCI vs. cognitively healthy older adults (HC); and 2) To determine whether MTL metabolite levels are associated with physical and cognitive function in nondemented older adults. METHODS: A cross-sectional study of 23 older adults (15 aMCI and 8 HC; mean age = 85.0 (SD 4.8). The Mini Mental Status Exam (MMSE), Wechsler Logical Memory (LM) 1 & 2 and Clinical Dementia Rating Scale (CDRS) were used for group assignment. The Trail Making A & B and Alzheimer's Disease Assessment Scale-cognitive subscale (ADAS-Cog) were used to assess cognitive function. The Short Physical Performance Battery (SPPB) and eight-foot walk at usual pace were used to assess physical function. 1H MRS was used to measure NAA, Cho and Cr within the left MTL hippocampus region. A Philips Achieva 3T scanner and 8-channel SENSE head coil were used. 1H MRS short echo (TE=32, TR= 2000, 64 averages) with acquisitions from 2 voxels (2x2x3 cm) centered over the left hippocampus (MTL) and left occipital lobe (control) using a PRESS shim sequence. Metabolites were calculated as absolute concentrations scaled to the unsuppressed water peak using LCModel. A weighted average correction was applied. Statistical Analysis: We applied independent t-tests (95% CI) for group differences and Pearson's correlations between MTL metabolites and physical as well as cognitive function. RESULTS: Group differences: As expected, the aMCI group had lower mean scores on the MMSE ($p=<.001$), LM1 ($p<.001$), LM2 ($p=.001$) and ADAS-Cog ($p=.01$). The walk time was slower ($p=.001$), the mean concentration of Cho was higher ($p =.036$) and NAA/Cr was lower ($p=.058$) in the aMCI compared to HC group. Bivariate Correlations: For aMCI and HC subjects combined, lower SPPB was correlated with lower NAA/Cr ($r=.46$, $p=.03$); and slower eight-foot walk time was correlated with lower NAA/Cr ($r =-.45$, $p=.035$) and NAA/Cho ($r=-.48$, $p=.02$). Slower Trail-Making A was correlated with lower NAA/Cho ($r=-.42$, $p=.046$). CONCLUSIONS: Markers of neurodegenerative disease progression were associated with reduced lower extremity function, slower usual paced walking and lower attention. These findings support a relationship between markers of medial temporal lobe metabolism and physical as well as cognitive function in nondemented older adults.

O.30.5 The influence of focal cerebellar lesions on a working memory task with and without walking

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INTRODUCTION: The cerebellum is - besides its role in motor control - under debate to be involved in cognitive processes including working memory On the other hand, studies showed that gait disorders in neurological patients are accentuated when they perform concurrent cognitive tasks while walking. In this study we examined patients with focal cerebellar lesions in order to investigate the influence of different regions of the cerebellum on the performance in a working memory task (n-back) with and without walking movements. METHODS: We examined 17 patients (age 27.4±8.6) with chronic focal lesions after resection of benign cerebellar tumours and 17 age-matched controls. Patients showed mild to moderate ataxia symptoms (ICARS 6.3±7.3). N-back tasks have been executed with n=2-4 in (i) sitting , (ii) during treadmill walking at 1m/s and (iii) executing tandem walk at 0.3m/s. Quantitative gait analysis was used to determine mean values and variability measures (CV) of step length, step width, lateral sway and step cycle time. The extent of surgical lesions was defined by individual 3D MRI data sets. Based on SUIT-normalized lesions, voxel-based lesion symptom mapping was performed to examine the effect of lesion sites on n-back performance in the 3 different conditions and on gait pattern. RESULTS: Group level performance in the n-back task (n=2-4) did not differ significantly between patients and controls in sitting position ($p>0.1$). Patients showed decreased performance during walk ($p<0.01$) and tandem walk ($p<0.001$). Gait analysis reveals a significant increase of variability in step length and step cycle time only for tandem gait ($p=0.001$; this is due to the rather mild degrees of ataxia in our population). Lesion symptom mapping revealed that decreased n-back performance during sitting is associated with lesions of the lateral cerebellar hemisphere and the posterior portion of the dentate nucleus. Decreased n-back performance in tandem walk is increasingly associated with anterior portions of the dentate nucleus (dorsorostral), the interposed nucleus as well as lesions of the vermal and intermediate cerebellar cortex. Lesion symptom mapping for tandem gait confirmed that different areas in the cerebellum are relevant for visually-guided, precise walking movements with high requirements to balance control. Analysing interaction effects in the dual task condition revealed, that many patients with no/mild clinical ataxia symptoms become highly variable in gait. CONCLUSION: These results deliver evidence for the hypothesis, that for the pure n-back tasks, areas in the lateral cerebellum including the ventrocaudal part of the dentate nucleus play an important role, which are suggested to be involved in a non-motor and more cognitive domain. Whereas for dual task walking - and in particular for tandem gait, when goal-directed leg movements were executed - lesions in motor related intermediate regions become increasingly relevant.

O.30.6 Visual scanning during the navigation of complex environments in persons with mild to severe traumatic brain injury

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BACKGROUND AND AIM: The ability to multi-task during locomotor navigation has been shown to be affected after both mild and moderate/severe traumatic brain injury (mTBI and m/sTBI) [1,2], particularly for visual interference [3]. To our knowledge, no one has studied visual scanning during such multitasks following a TBI. Earlier work has shown that saccade behaviour in a dynamic situation is altered after TBI, likely due more to attention deficits than eye movement problems [4]. Here we studied eye movements during the navigation of environments with different visual attention demands in persons with TBI of different severity. METHODS: To date saccadic eye movements have been analyzed in 7 subjects with m/sTBI (mean age 42.2 yrs) and compared to 7 healthy controls (HC; mean 39.6 yrs) as well as 4 elite athletes with mTBI compared with 4 control elite athletes (AC). Subjects walked both straight ahead and while circumventing a fixed or moving obstacle with and without a simultaneous Stroop task requiring subjects to name the congruent or incongruent ink colour of the words red, green, or blue. Whole body movement was measured with an Optotrak system. Electrooculography (EOG) of horizontal eye movements was recorded and conditioned using a previous technique [5] combined with qualitative observation to detect saccades of 5 degrees or greater. Visual scanning behaviour was measured as the number of saccades performed during the approach to the obstacle, as well as the proportion occurring in the first and last 2 meters of approach and compared between groups using non-parametric statistics (for m/sTBI for now). RESULTS: Although subjects with TBI generally tended to produce more saccades, there were no group effects. However, for proportion of saccades used during approach areas, the more complex combination of moving obstacles and visual interference (Stroop) resulted in greater differences between TBI and control groups for all severities. In particular, more saccades were used by persons with both mTBI and m/sTBI in the latter 2 meters during approach to the obstacle, while control subjects performed the majority of their saccades in the first 2 meters of approach. CONCLUSIONS: In this preliminary study, it appears that persons with TBI have different visual scanning behaviour than control subjects when navigating complex, but ecologically-based, environments. More eye movement later in the approach area of the more complex environments suggests deficits in attention and possibly in anticipatory gaze behaviour. Visual scanning measures may prove to be important to evaluate readiness to return to activities in complex environments following TBI regardless of severity.

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O.31 COGNITIVE, ATTENTIONAL & EMOTIONAL INFLUENCES, *Living 4*

O.31.1 Cognitive loading differentially affects gait-characteristics and conscious monitoring of gait

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BACKGROUND AND AIM: Dual Task paradigms have successfully been used to illustrate the multi-faceted control of human locomotion and the active role played by cognition [1, 2]. An important cognitive aspect of motor control has not, however, been addressed in these paradigms. The perception of action is known to be closely related to the control of action. As such, the sense of agency, i.e. recognising movements as our own, forms a crucial aspect of bodily self-consciousness [3]. Although we usually pay little or no attention to the details of our movement, especially locomotion, no studies have systematically investigated the effect cognitive loading (CL) has on the sense of agency. In our current study we therefore investigated the effect of CL on gait characteristics and on the conscious monitoring of one's own gait, in particular the sense of agency. METHODS: Participants (N=15) walked on a treadmill while their movements were tracked by an active optical motion capture system (SF=30Hz). They received visual feedback of their gait via an individually mapped, life-size avatar either in real-time (intrinsic delay of 75ms) or with a randomised additional delay of 25ms to 1350ms. After each 3 second trial participants judged if the gait of the avatar matched their own gait (agency). In a second block participants repeated the task while counting backwards in 7s (articulated). Motion capture data was recorded and analysed off-line. RESULTS: CL significantly influenced agency and increased perceptual

thresholds from 210ms to 395ms. There was a significant interaction between the two factors Dual Task and Delay (p=.00325): agency was only affected in trials with strong temporal conflicts; agency remained constant for real-time feedback and feedback delayed by a full step-cycle. In the single task condition the delay of the visual feedback caused participants to sinusoidally modulate their stride-time. Participants took slower than average steps for feedback that was in phase, faster steps for feedback that was out of phase (effect of delay p<.0001). CL significantly dampened the sinusoidal modulation of ST across all delays (effect on RMS deviation: p<.05). CONCLUSIONS: Our data illustrate that we experience agency for continuous full-body movements for delays up to 197ms. Cognitive loading increased this threshold to 348ms. We further found that participants systematically adjusted their stride-time to their visual feedback. This sinusoidal modulation was suppressed by the concurrent cognitive load. A crucial finding was that while CL suppressed this automatic gait behaviour across all delays, it only affected gait agency in trials with strong temporal conflicts, suggesting specific influences of cognition on the sense of agency.

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O.31.2 Dual-task priority during single-support standing balance: Effects of hearing difficulty

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BACKGROUND AND AIM: The involvement of cognitive resources in the maintenance of balance increases with aging (Woollacott & Shumway-Cook, 2002). Given that cognitive processes also compensate for age-related hearing loss (Pichora-Fuller et al., 1994), high-level cognition may be doubly relevant when older adults listen in everyday activities also requiring motor control. Although 65% of seniors who suffer from hearing limitations also report mobility difficulties (Statistics Canada, 2006), few studies have examined the association between high-level cognition, hearing, and balance. The current study examined the effect of simulated age-related hearing loss in a dual-task paradigm involving balance and cognitive load. METHODS: Eighteen young adults balanced on one leg and performed an auditory n-back task alone and concurrently. They performed these tasks both under quiet or noisy hearing conditions (with the addition of multi-talker babble). To equate for auditory challenge across individuals, the n-back and babble sound levels were adjusted to each participant's absolute mean threshold of pure-tone hearing. We used a signal-to-noise ratio of -10 dB to simulate difficult hearing conditions for the young adults. Working memory load was varied by comparing 1-back to 2-back task conditions. A MatScan apparatus was used to measure postural stability (COP variability) in the mediolateral dimension. RESULTS: When noise was added, postural stability worsened under single-task conditions, but improved under dual-task conditions. Dual-task costs in postural sway were positively correlated with concurrent dual-task costs in cognitive task performance. This correlational pattern was shown during trials involving dual-task balancing with noise, but was reversed under quiet listening conditions, irrespective of working memory load. CONCLUSIONS: Together, the results suggest that simulated age-related hearing challenge leads to changing prioritization of posture over cognitive performance, which mimics what has been found in older adults in dual-task situations (Posture First Principle: Shumway-Cook et al., 1997). Furthermore, the results imply that older adults with sub-clinical hearing loss may be particularly vulnerable to loss of balance in multi-tasking situations if postural prioritization cannot occur.

O.31.3 Attentional Dynamics during Perturbation Recovery in Young and Older Adults

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BACKGROUND AND AIM: This study examined the influence of attention on motor response selection during balance recovery to a postural perturbation and the interaction with sensory processing. Attentional dynamics during translational balance perturbation are rapid, being completed within 250 milliseconds in both young and older adults. An attention 'bottleneck' model in decision-making of the postural response is suggested. However, there appears to be an attentional influence on the sensory channels during the perturbation as well. Visual information appears to be facilitated during a perturbation while auditory input inhibited. Thus, in addition to a decision bottleneck, there also may be an effect on perceptual processing during a perturbation that operates similarly in young and older adults. The purpose here was to examine the interaction of sensory processing and motor selection in response to postural perturbations. METHODS: Seventeen young (mean age 23.5 ± 3.2) and eighteen older (mean age 74.8 ± 4.0) healthy adults performed a dual-task paradigm of responding to a platform perturbation (Toes-up Rotation only, Translation only, mixed Rotations and Translations) while performing reaction time (RT) tasks: Auditory Choice RT task, Visual RT task, or Auditory Disjunctive RT task. Button pushes were required in response to the stimuli. The perturbations were designed to provide the same ankle dorsiflexion, but required opposite motor responses to maintain balance, setting up a decision process for the proper motor response in the mixed perturbation case. The RT tasks varied the sensory modality (Audio vs. Visual) and task complexity (Choice vs. Disjunctive). Stimuli for the RT tasks were presented randomly between 50 ms prior to the perturbation to 400 ms afterwards to examine the temporal dynamics of attentional switching. RTs were examined. RESULTS: The perturbation produced an increase in RTs during the Choice task, but not during the Disjunctive task, indicating that the complexity of the motor side of RT task (two potential motor outputs in the Choice task versus one in the Disjunctive task) influences attentional allocation. The Choice RTs remained elevated for a longer period of time after the perturbation, and this effect was greater in older adults (250 ms) compared to young adults (100 ms). Comparing sensory inputs, the perturbation effect on RTs was greater for the Auditory CRT (40ms) compared to the Visual CRT (20 ms), suggesting a sensory bottleneck on the translation between sensory input and motor output. CONCLUSIONS: Greater RT interference in the Choice RT task compared to the Disjunctive RT task suggests attentional allocation during recovery from a perturbation is used in motor response selection. In addition, the auditory vs. visual results suggest a bottleneck in the sensorimotor process. Finally, the temporal dynamics of attentional switching is longer in older adults.

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O.31.4 Emotional influences on the kinematics of interactions between two walkers: preliminary results on angriness

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BACKGROUND AND AIM: Gait kinematics are influenced by the emotional state [1] or the emotional context [2]. Observers recognize emotions from the whole body motion [1,3]. We investigated the influence of emotions on the kinematics of interactions between two walkers. We focused on the specific case of walking together. METHODS: 2 professional actors walked in an 8m circular area. They were first asked to walk alone in a neutral or angry emotional state. Then they walked simultaneously: individually or together. For these 2 situations, either both actors had a neutral emotional state or one or both of them experienced angriness with variations: transitive or not (Tr/NTr) and with or without talking (D/ND). Alone and individual situations were used as controlled tasks. Each task was 1' long and repeated 3 times. We focused on walking speed, relative angle and distance between actors. RESULTS: In neutral state, walking speed depended on the situation (H=8.9, $p<0.05$). It was slower when actors walked together: neutral gait may not be modified by the presence of another walker but by the interaction itself. No difference was observed between the 3 situations for one angry actor (NTr-ND). Nevertheless, when walking together the actor in neutral state walked faster when the other was angry NTr-ND (U=1114, $p<0.001$). The neutral actor may adapt his speed to follow the angry actor. For together situation, results showed that walking speed was slower when angriness was transitive (U=38472, $p<0.001$) or when actors spoke (U=35713, $p<0.001$) and faster when both actors were angry (U=36792, $p<0.001$). Moreover, the distance between actors was higher when angriness was transitive (U=14406, $p<0.001$) and when both actors were angry (U=21214, $p<0.001$) and lower when they spoke (U=21377, $p<0.001$). There was no difference between relative angles when both actors were neutral or angry NTr-ND but when only one actor was angry NTr-ND, he walked ahead. When one actor was angry, he also walked more ahead in NTr variation compared to Tr one (U=7553, $p<0.001$). CONCLUSIONS: This preliminary study suggests leader-follower interactions depending on emotions when two humans walk together. These interactions are expressed by relative positions and walking speed adaptations. A neutral walker accelerates to follow an angry one (NTr-ND) and this latter walks ahead as if he leads the motion. Distance between walkers is increased when both of them experience transitive angriness. This may indicate that personal spaces are adapted with respect to the perceived risk that should be enhanced with the combination of negative emotions towards the other. Future work will extend analysis to more participants and investigate the influence of other emotions and their variations on interactions while walking.

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O.31.5 Effects of Manipulating Anxiety on Stepping Behaviour During Adaptive Locomotion

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BACKGROUND AND AIM: Looking in the right place at the right time is crucial for safe walking, and there are age-related changes to gaze behaviour which increase falls-risk in older adults. For example, older adults at a high risk of falling tend to look away from a target they are still stepping towards in order to look at potential obstacles ahead [1, 2]. This early gaze transfer impairs the accuracy of stepping and increases the likelihood of tripping. We have provided evidence that this maladaptive gaze behaviour is associated with increased anxiety [3]. However, the direction of this association remains unclear: it could be that anxiety is causing inappropriate gaze behaviour and stepping problems, but it is also conceivable that anxiety increases as a result of poor stepping performance. To test the former possibility, the present study used social evaluative threat (SET) and differing task complexities to experimentally manipulate anxiety. It was hypothesized that increased anxiety would results in increased variability in foot placement. METHODS: Eight undergraduate students (mean age 18.9 ± 0.4 years) walked 7-metre obstacle courses in control and judged (SET) sessions. Within each session there were 4 difficulties: 1) a stepping target box only; 2) a target following by a far obstacle; 3) a target followed by a near obstacle; 4) a target followed by both obstacles. Full body kinematics were recorded using a Vicon MX motion capture system. Physiological anxiety was measured using salivary á-amylase and heart rate, while the State Anxiety Inventory (SAI) was used as a measure of self-reported anxiety. RESULTS: SET augmented á-amylase (17.7 ± 9.3 to 44.4 ± 13.4 U/mL, t(31)=-2.2, p<.05), heart rate (-2.0 ± 3.9 to 2.9 ± 5.8 bpm, t(31)=-3.5, p<.001) and SAI (6.6 ± 1.6 to 7.9 ± 1.7, t(24)=3.7, p<.001) markers of anxiety in comparisson to the control condition with respect to baseline. Furthermore, a RM ANOVA showed a significant interaction effect between task complexity and SET in A/P foot placement variability (F(3, 21) = 3.4, p<.05); participants in the SET condition showed greater A/P foot placement variability, but only in the near object task condition. CONCLUSIONS: The results present social evaluative threat as a novel paradigm to experimentally manipulate anxiety during a short precision stepping course. The results also demonstrate a causal link between anxiety and impaired stepping performance during adaptive locomotion. In young adults, the effects of anxiety on stepping became apparent only with increasingly complex stepping tasks. Analysis of kinematic data collected from older adults is currently underway, along with electroocculographic (EOG) data to determine saccade timings relative to heel contact in the target box.

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O.32 AGING IV, *Cosmos 2*

O.32.1 Age Related Changes in Knee Muscle Specificity During Weight Bearing

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BACKGROUND AND AIM: The primary roles of knee joint muscles are to support body-weight and control mobility while opposing forces that would lead to non-physiological motion and injury. When a person plants the foot during gait, or steadies themselves while opening a door, a stable platform must be maintained, allowing the person to complete the task by modulating ground reaction force (GRF) direction and magnitude. These GRFs are transmitted across the knee joint through shear and compressive loads and knee joint muscles contract to stabilise the joint. This stability is essential for both mobility and posture control. Evaluating the role and contribution of individual muscles is essential for understanding age-related changes to knee joint stability. The purpose of this investigation is to use a novel, highly controlled joint loading target matching protocol[1] to evaluate age-related changes in neuromuscular activity of knee joint muscles during weight bearing. METHODS: Seventeen healthy younger (24 years ±2) and 16 older (59 years ±5) adults had to manoeuvre a cursor projected on screen by modulating ground reaction forces. Their dominant foot was in a boot fixed to a force platform.

Targets appeared at random one at-a-time, separated by 30o around a circular trajectory. Subjects applied loads to the force platform in various horizontal directions to move the cursor while also controlling body weight. A successful match required 50% body weight while applying 30% of their peak horizontal effort for one second. EMG of eight knee joint muscles, GRF, and kinematic data were recorded for each target. Maximal voluntary isometric contractions collected on a Biodex were used to normalize EMG. The mean magnitude of muscle activity (XEMG), specificity index (SI), coactivation index (CI) and mean direction of muscle activity (Φ) were calculated at each target location. Intra-class correlation was used to evaluate the repeatability of activation patterns. RESULTS: The GRFs required to meet the targets ranged from 0.48-58 N/kg of BW in the horizontal plane while maintaining 50%BW in the vertical plane and are comparable to a range of activities of daily living. Older adults have higher CIs and increased XEMG in the vastus lateralis, vastus medialis, biceps femoris, semitendinosus, medial gastrocnemius and tensor facia lata (p>0.025). No significant differences in Φ and SI were found between age groups. Intraclass correlations (ICC(2,k)) for all muscles ranged between 0.84 to 0.97, indicating both groups used similar activation synergies to achieve targets. CONCLUSION: Significant increases in XEMG and CI indicate older adults utilise an altered neuromuscular strategy to achieve similar goals as younger adults. However, the high ICC values and the lack of significant differences in Φ and SI indicate that older healthy adults use the same muscle synergies as younger healthy adults.

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O.32.2 Visualizing age-dependency of central vestibular compensation - a rat microPET study

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BACKGROUND AND AIM: The present study aimed to investigate the influence of age on central compensation of a unilateral peripheral vestibular lesion. METHODS: Young and old Sprague-Dawley rats (3 vs. 18 months, 8 female animals per group) underwent a left-sided chemical labyrinthectomy (UL) by transtympanic injection of bupivacaine and arsenilate. The brain glucose metabolism of the rats was investigated by [18F]-FDG-microPET at the day before and at days 1, 2, 4, 7, 9, 15 and 30 after UL. Simultaneously, behavioural testing for vestibular imbalance was done by registration of nystagmus, head tilt and postural imbalance. MicroPET images were analysed at the group level using a statistic parametric mapping based protocol. RESULTS: Young rats showed a rapid behavioural compensation of vestibular damage (i.e. absence of nystagmus by day 3 and static postural imbalance by day 9 after UL). In comparison, old rats had a prolonged course of vestibular imbalance (absence of nystagmus by day 9 and static postural imbalance by day 30 after UL). Accordingly, the regional glucose metabolism in the vestibular nuclei was asymmetric until day 15 after UL in the old rats, whereas it turned symmetric until day 3 after UL in the young rats. The inter-group analysis indicated relatively increased glucose consumptions bilaterally in the thalamus and multisensory cortical areas as well as in the vestibulo-cerebellum (right>left) in the older animals. In young rats the regional glucose uptake was enhanced in the hippocampus bilaterally. CONCLUSIONS: Central compensation of a unilateral peripheral vestibular damage is delayed in old age. The underlying mechanism may be a deffered rebalancing of activity in the vestibular nuclei, possibly resulting from less efficient commissural or vestibulo-cerebellar interaction. In advanced age thalamo-cortical multisensory pathways are recruited more extensively to substitute the

process of central vestibular compensation.

O.32.3 The impact of individual perceptual style on ability to resolve sensory conflicts and maintain balance in healthy young and older adults

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INTRODUCTION: The purpose of these studies were to i) identify the percentage of individuals with a visual vs. somatosensory perceptive style and ii) to characterize the impact of individual perceptual style on ability to resolve sensory conflicts and maintain balance in healthy young and older adults. METHODS: A total of 20 young adults, 18-35 years old and 30 older adults, 65-85 years old participated. All subjects were healthy with no acute musculoskeletal conditions, no history of neurological problems or motion sickness. A composite measure including the Rod and Frame, Spatial Conflict Task, Useful Field of View and Functional Acuity Contrast Tests was used to determine individual perceptual styles. Subjects were asked to maintain quiet stance while standing on two force plates and viewing a visual virtual environment of a walking path in the forest displayed on a 180° cylindrical screen. Perturbations were induced by translating the virtual environment ±10 cm in the anterior-posterior direction. The perturbation signal applied to the visual virtual scene was a pseudorandom sum of sine function, with 4 frequencies 0.1Hz, 0.15Hz, 0.2Hz and 0.25Hz, known to produce a sway response1. The visual virtual environment was also manipulated by randomly superimposing a 5º, 10º or 15º vertical tilt of on the translational stimulus described above introducing three levels of sensory conflict: low, medium and large. Trials of 120 seconds allow for collection of sufficient cycles at all frequencies, while maintaining a duration that is well within the tolerated non-fatiguing time for older adults 2. Body kinematics, forces and moments, and EMG of lower limb, trunk and neck muscles were recorded. RESULTS: Based on the composite measure of individual perceptual style, there is an larger percentage of individuals with visual (58%) vs. (42%) somatosensory perceptive style in both young and older adults. The postural responses of visual-dependent subjects were more affected compared to those of somatosensory-dependent subjects as reflected in greater displacements of center of pressure and longer muscle activation latencies. Aging disrupted the distal-to-proximal muscle recruitment sequence and a visual-dependent perceptual style exacerbated the inconsistencies. Ankle and hip muscles latencies that are delayed in older adults compared to healthy young controls were further prolonged in conditions of sensory conflicts. CONCLUSIONS: A compounding effect of aging and an individual perceptual style produced the largest centre of pressure displacements and longest muscle activation latencies in older adults who are visual-dependent. Older adults whom were first categorized as having somatosensory perceptive style dealt with sensory conflicts better than older adults with a visual perceptive style.

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O.32.4 Age-related differences in gaze behaviour during virtual walking

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BACKGROUND AND AIM: Laboratory studies comparing the gaze behaviour of older and younger adults during walking demonstrate that older adults with a high risk of falling adopt seemingly maladaptive visual sampling behaviour which results in reduced stepping accuracy and increased risk of falling [1, 2]. However, these lab-based studies have limited ecological validity and therefore the observed gaze patterns may not be representative of real world behaviour. The aims of the present studies were to identify any age-related differences in gaze behaviour during scene viewing, which might add to our understanding of the mechanisms underlying increased incidences of falls with age. METHODS: Nine younger adults (mean age 24.3 yrs, 6 female, 3 males), eight low risk older adults (mean age 68.9 yrs, 6 female, 2 males) and six high risk older adults (mean age 74.2 yrs, 5 females, 1 male) watched scenes from a first person perspective of various everyday real-world walking scenes, e.g. walking down a high street, walking along a canal, etc. while their gaze patterns were recorded using an ASL 500 mobile eye tracking system. The results were then compared to ascertain if there were measureable differences between the percentage of time participants visually sampled different characteristics of the scenes between groups and the number of times characteristics were fixated. RESULTS: There was a significant main effect of participant group on the percentage of time participants fixated aspects of the travel path ($F(2,20) = 3.5$, $p<0.05$). Pairwise comparisons revealed that the high risk older adults (M=62%, 95% Cl [37.35, 86.26]) fixated the travel path for a significantly longer percentage of time than the low risk older adult (M=43%, 95% Cl [37.87, 48.3]) and the younger adults (M= 45%, 95% Cl [35.51, 53.41]). The results also showed a significant main effect for the number of times participants' fixed different aspects of the scene. There was a significant effect for the number of times the travel path was fixated ($F(2,20) = 5.233$, $p= .015$). Pairwise comparisons showed that the low risk older adults (mean number of fixations = 21.25, 95% Cl [14.33, 28.17]) made fewer fixations to the travel path compared to the young (mean number of fixations = 34.56, 95% Cl [28.85, 40.26]). CONCLUSIONS: Our findings supports the hypothesis that a scene viewing paradigm can identify measurable differences between gaze behaviour of high and low risk older adults which are consistent with those measurable during real walking tasks [1, 2]. In combination these findings suggest that measuring gaze during scene viewing paradigms may be useful for identifying and understanding the mechanisms underlying suboptimal visual behaviour in frail individuals that contribute to their increased risk of falling.

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O.32.5 Cortical and subcortical brain activity during imagined gait tasks across age

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BACKGROUND AND AIM: Gait imagery during functional magnetic resonance imaging (fMRI) is used to probe the neurological underpinnings of human gait, taking advantage of the large overlap in brain activation between imagined and overt movement. However, few studies have measured blood oxygen level dependent (BOLD) signal, a measure associated with brain activity, during complex imagined gait tasks such as turning and backward walking. Understanding how the BOLD signal changes across simple and complex gait tasks is an important step toward understanding the neural underpinnings of gait. Further, measuring this change across age groups can provide insights into how the neural control of gait changes across the lifespan. In the current study, changes in cortical and subcortical brain BOLD signal were compared across imagined gait tasks of differing complexity, as well as between age groups.

Our aim was to provide a better understanding of the neural control of gait as it relates to age. METHODS: Nine young (mean±SD=27.6±6.0) and 3 older (70.0±7.8) healthy adults imagined three gait tasks (forward walking, backward walking, and turning in a small (0.6m radius) circle) during BOLD signal acquisition. Eco-planar imaging data (TR=2200ms, TE=3ms, 4.0mm3 voxels) were acquired during alternate imagined gait tasks (approximately 15 seconds each) and rest periods (11 seconds) in which subjects focused on a cross-hair. Subjects completed 2 imagined walking BOLD sequences, each lasting about 9 minutes. A region of interest (ROI) analysis was conducted on the supplementary motor area (SMA), caudate, putamen, globus pallidus (GP), and mesencephalic locomotor region (MLR). RESULTS: In the young group, imagined turning resulted in higher BOLD signal in bilateral SMA ($p<0.001$) and GP ($p<0.001$) with respect to imagined forward and backward gait. Preliminary data on older adults also suggest increased BOLD signal in the SMA during turning with respect to forward walking ($p=0.05$). Across group comparisons show trends toward increased BOLD signal during backward walking (with respect to forward) in older adults in the caudate ($p=0.10$), putamen ($p=0.069$), and SMA ($p=0.10$). CONCLUSIONS: Previous studies suggest complex gait tasks result in increased cortical activation. In the current study, the increase in BOLD signal change in the SMA during turning in both old and young groups is in support of these previous results. The increased cortical activation during turning, a relatively complex gait task, may represent a reduction in task automation with respect to forward walking. During imagined backward walking, older adults exhibited trends toward larger BOLD signal changes in cortical (SMA) and basal ganglia (caudate, putamen) structures with respect to young. This result suggests that during imagined backward walking, older adults exhibit greater differential activation of structures within the cortico-basal ganglia loop, and less task automation than young subjects.

O.32.6 Workers adaptability to gait and movement constraints as a function of age

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BACKGROUND AND AIM: Working in the industry often requires workers to move from one place to another and also to rapidly adapt their movements to be able to follow the imposed working rhythm. However, it generally becomes more difficult with age to face the demanding work. One possible reason could be a decrease in movement smoothness as a function of age [1]. The aim of this study was to investigate the effect of age and working rhythm on strategies of movement adaptation during an assembly repetitive task. METHODS: 3 groups of 65 subjects (Y (30 to 35), M (45 to 50) and S (60 to 65 years old)) came to our laboratory to realise a repetitive assembly task during 20min. into 2 rhythm conditions: comfortable one (C) and a rapid one (R). For each subject and in both conditions, recorded data were i) forces on the mounting table and on the ground recorded by means of 2 six axes force plates and ii) marker displacements recorded with an optoelectronic system. A biomechanical model was computed by inverse dynamics as proposed by Hanavan [2] on the base of 47 passive markers placed on subject's entire body and 60 anthropometrical measures. RESULTS: We first observed that each group can succeed with the task, but if the Y group never had delays or difficulties in achieving the task in both rhythm conditions, S group showed difficulties to manage to do it mainly in the R condition. Conditions comparison: Speeds to squat down and to stand up significantly increased ($p<0.0001$) in R compared to C condition only for M and S groups. Squat down amplitude was significantly higher ($p<0.0001$) in C compared to R condition only for Y and M groups. Time to collect pieces was significantly smaller ($p<0.0001$) in R compared to C condition only for Y and M groups. Group comparison: In both rhythm conditions, squat down speed of the S group was significantly lower ($p<0.0001$) than for Y and M

groups. In C condition only, Squat down speed of the Y group was significantly higher (p<0.0001) than for M group. Stand up speed for Y and M groups was significantly faster (p<0.001) than S in both rhythm conditions. In both rhythm conditions, amplitude to squat down of the S group was significantly lower (p<0.0001) than for Y and M groups. In R condition only, amplitude to squat down of the Y group was significantly higher (p<0.0001) than for M group. Time to collect pieces was significantly (p<0.0001) increased with age for both rhythm conditions. CONCLUSION: We observed that seniors had more difficulties to do the task but they were able to adapt their strategies by modifying the movement speed. Otherwise, young do all very fast with no adaptation to work rhythm. These observations should be relevant for the design of workstations adapted to ageing workers.

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O.33 EXERCISE III - INTERVENTION STUDIES, *Cosmos 3A*

O.33.1 The Effects of Computer Game Dancing on Voluntary Step Execution in Older Adults

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INTRODUCTION: Maintenance and regulation of postural balance require a substantial amount of information processing capacity [1]. It is not surprising that falls in older adults prevalently occur under attention demanding circumstances. Thus, cognitive elements should preferably be also part of a postural balance training program [2]. A training approach that combines cognitive and physical exercise is computer game dancing. It requires the player to make rapid step responses to a target location in response to visual stimuli. This involves controlled body weight transfer, fast steps as well as attention, and making quick decisions. It is unclear whether voluntary step execution can be improved in an attention demanding dual task condition. This study aimed to explore whether a physical exercise program enriched by computer game dancing is able to improve voluntary step execution of older adults under attention demanding conditions. METHODS: Nine subjects (mean age: 83.6 ± 3.4 years) underwent a progressive resistance and balance training twice weekly with additional computer game dancing for 12 weeks. A no training control group (n= 8; mean age: 85.0 ± 4.8) received usual care. A protocol developed by Melzer and Oddson [3] was used to measure stepping performance under both single and dual task conditions. RESULTS: Between group comparisons showed significant improvements in step initiation time under dual task conditions (p= .016), foot contact time under both conditions (p= .043; p= .043), and showed a trend of improvement in the remaining temporal parameters after training in favour of the training group. CONCLUSIONS: The results demonstrate that voluntary step execution under attention demanding conditions can be improved by computer game dance training and underpins the suggestion that successful fall prevention methods should aim to improve timing and coordination in stepping of older adults.

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O.33.2 SMILING randomized trial: Effect of a training program with chaotic perturbations on gait performance

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BACKGROUND AND AIM: The SMILING multicentric project aimed to develop and test a new gait and balance training device to prevent falls in older persons. The "SMILING" shoes generate mechanical perturbations while walking by changing each shoe's sole height and inclination in a chaotic pattern, thus challenging subjects' balance and forcing them to actively react to avoid falls. The objective of this trial was to determine whether a training program with these high tech "SMILING" shoes enhance gait performance in older persons at risk for falls. METHODS: Four sites in Israël, Italy, Slovakia, and Switzerland participated to this cross-over randomized-controlled trial. Eligible participants were aged ≥65 years, and either reported ≥1 fall in last 12 months or had moderate gait and balance impairment at Tinetti's POMA (score 22-26/30). Cognitively impaired subjects (Codex) were excluded. Participants (N=97) were initially randomised to active ("SMILING") or inactive ("Dummy") shoes for 4 weeks of training (biweekly 30-minutes sessions with walking tasks of increasing difficulties). After a 1-week wash-out period, subjects exchanged shoes and completed 4 additional weeks of training. Gait performance was assessed at baseline, weeks 4, and 8. RESULTS: Sixty-six participants (mean age 72.5±6.2, 80.3% women, 23.6% multiple fallers) completed the training program. Although participants improved in several gait parameters after completing the training program, there was no significant difference between periods of training with and without chaotic perturbations. However, secondary analyses stratified by baseline fear of falling showed significant improvements in gait speed, stride length and its variability among subjects with lower fear at baseline. CONCLUSIONS: Benefits from training with chaotic perturbations were limited to subjects without fear of falling. More intensive programs might be necessary to achieve improvement in other elderly persons at risk for falls.

O.33.3 The effects of physical exercise supplemented by a cognitive computer training on gait quality of older adults

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INTRODUCTION: Cognitive or cognitive-motor interventions have the potential to benefit physical functioning, e.g. influence complex walking tasks [1]. Some computer games showed in the past to positively affect global [2] or more specific cognitive functions, e.g. attention [3]. Spatial and temporal dual task cost characteristics of gait are associated with divided attention in older adults [4]. Unclear is whether there is a causal relation between divided attention and complex walking tasks. This ongoing trial (ISRCTN75134517) set out to investigate the additional effects of a computer based cognitive training program in combination with traditional strength and balance exercises on dual-task costs (DTC) of walking. METHODS: 43 seniors (24♀/19♂, 82.4± 7.8 [range 65-95] yrs) conducted two weekly sessions of strength and balance exercises for 45 minutes during 12 weeks. Half of the group additionally performed 10 minutes cognitive computer training on a desktop computer thrice weekly, to train alertness, selective and divided attention. Selected complex walking tasks were analyzed under single and dual task conditions with a GaitRite® system. RESULTS: A Mann-Whitney U test comparing the independent groups change scores showed that gait velocity ($p = .049$), cadence ($p = .072$) and step

length (left foot; p = .059) either improved more or showed a strong trend to a greater improvement in the cognitive-motor group under dual task walking conditions. This group also exhibited a trend towards decrease in dual-task costs for gait velocity (p = .062), and step length (left p = .070, right p =.092). The conventional strength-balance training group improved walking in single task test conditions but not under dual task testing. CONCLUSIONS: The preliminary results of our ongoing trial (ISRCTN75134517) suggest that a combined cognitive-motor intervention enhances selected complex walking tasks. Our goal is to recruit a total of 140 participants to gain enough power and further substantiate our observations.

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O.33.4 Dual tasking when walking improves with a 4-week training program in people with Parkinson's Disease: a single blind randomised clinical trial.

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BACKGROUND AND AIMS: People with Parkinson's Disease (PD) have difficulty walking whilst performing added tasks and can improve immediately after a single training session [1]. A pilot study has found improvements in 5 subjects after three 30min sessions [2], but the effects of a training program have not yet been determined. This study compared the efficacy of a 4 week, 12hr program of dual vs. single task walking training in people with PD to improve their ability to walk whilst performing added tasks. METHODS: Sixty-three people with PD were recruited into a parallel group randomised trial with concealed allocation, assessor blinding and intention to treat analysis. Of these, 32 were randomly allocated to dual and 31 to single task walking training. The primary outcome measure was step length recorded with an 8m GAITrite system under dual task conditions at 4 time points - baseline 1, 2, post and at 6mths follow up. Secondary outcome measures included other spatiotemporal gait parameters under single and dual task conditions, executive function, clinical gait performance and community mobility. Both groups undertook one-on-one progressive gait training. The dual task training group performed these gait tasks whilst also undertaking progressively difficult added tasks. Generalised linear models were performed to determine the effect of group and time on outcomes. RESULTS: There were no differences between groups in demographic, severity or gait measures at baseline (p > 0.056). There was an effect of time (p< 0.001), but not group (p > 0.113). Specifically, in both groups there was no difference in step length in the control period (baseline 1 vs. 2), but both dual and single task training groups improved their step length when performing dual tasks post training. At follow up, step length was shorter than post (p < 0.019), but greater than baseline (p < 0.01). There was a group x time interaction where the dual task training group showed greater improvements pre to post training in step length than the single task training group (9.7 vs. 4.2 cm). Six-minute walk distance improved in both groups and was maintained at follow up. Distance covered in 3mins when having a conversation improved in both groups post treatment (p < 0.001), but only maintained this level at follow up in the dual task group (p = 0.279). CONCLUSIONS: This is the first study to report the effect of a dual task walking training program compared to a single task program. A one-on-one, individualised training program of single or dual task walking training improved step length under dual task conditions in

people with PD and gait did not return to pre-training levels in either group. Dual task training effected greater changes in some measures of dual tasking when walking.

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O.33.5 Higher intensity treadmill training results in no deterioration in walking pattern or quality: a pilot RCT

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BACKGROUND AND AIMS: Few people following stroke regain full walking ability as impaired balance, slow speed and poor cardiorespiratory fitness are often still found at the end of rehabilitation. Concerns that treadmill training may adversely harm walking pattern has been suggested as a reason for clinicians not using treadmills. The aim of this study was to determine: the feasibility of treadmill training in stroke patients during rehabilitation; whether walking deteriorated; or if walking capacity improved following a high intensity treadmill walking program. METHODS: A parallel-group single-blinded randomised controlled trial with concealed allocation was undertaken across 2 sites. Of 89 people with first stroke undergoing inpatient rehabilitation screened, 30 were recruited (aged 67 +/-16years, 12 male). To be included patients had to be medically stable, referred for physiotherapy (PT) and score >1 on the Motor Assessment Scale, Item 5 (walking). Participants were randomly allocated into one of two groups; an experimental group receiving higher-intensity treadmill walking in addition to usual PT or a control group receiving usual PT only. The experimental group walked on the treadmill for 30 minutes, three times a week for six weeks, at an intensity of 40-60% heart rate reserve. Feasibility was measured by examining compliance and adverse events. Deterioration in walking was measured by examining pattern: (1) spatiotemporal gait parameters when walking over an 8m GAITrite system at usual pace, (2) angular kinematic parameters; and quality using a previously validated visual analogue scale. Benefit to walking was measured as capacity using six-minute walk test and speed. All measures were performed at baseline (Week 0), immediately after (Week 6) and at 3-months (Week 18) by assessors blinded to group allocation. RESULTS: Overall compliance was 89%, with no adverse events reported. There was no between-group difference in walking pattern and quality. By Week 6, the experimental group improved walking capacity by 62 m (95% CI 10 to 114), comfortable walking speed by 0.18 m/s (95% CI 0.07 to 0.29) and fast walking speed by 0.18 m/s (95% CI 0.03 to 0.35) more than the control group. By Week 18, the experimental group was still walking 0.26 m/s (95% CI 0.12 to 0.41) faster than the control group. CONCLUSIONS: Higher-intensity treadmill walking during rehabilitation after stroke is feasible and not detrimental to walking pattern and quality in those newly able to walk. In addition, the experimental group demonstrated greater improvements in walking capacity and walking speed than the control group. A larger, longer trial to ascertain a more precise estimation of the benefits of higher-intensity treadmill walking is warranted.

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O.34 FALLS & FALLS PREVENTION II - PSYCHOLOGICAL FACTORS, *Cosmos 3C*

O.34.2 Development and initial validation of the Iconographical Falls Efficacy Scale: Icon-FES

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BACKGROUND AND AIM: Fear of falling scales typically have a strong floor effect in active older people and use short, verbal phrases to state the overall context of a fear-related activity. We developed the Iconographical Falls Efficacy Scale (Icon-FES), which includes more demanding activities and uses pictures to provide more complete environmental contexts. METHODS: Two hundred and fifty cognitively intact and 50 cognitively impaired community-dwelling older people (70-90 years) were assessed on the Iconographical Falls Efficacy Scale (Icon-FES) in conjunction with the currently most widely accepted measure of fear of falling, i.e. Falls Efficacy Scale International (FES-I). RESULTS: Overall structure and measurement properties of the 30-item Icon-FES evaluated with item-response theory were good. The scale measured a single factor with two dimensions assessing fear about less and more demanding daily activities, explaining 23.3% and 29.4% respectively of the variance in the scale. The full range of responses (4-point scale) was used for every item. The internal consistency of the scale as a whole was high with a Cronbach's alpha of 0.96. Test-retest reliability (N=50) over a 1-week time-interval was excellent with an intra-class coefficient of 0.90 (95% CI=0.83-0.94). The Icon-FES distribution was considerably closer to normal (skewness of 0.88 (SEM=0.15), kurtosis of 0.30 (SEM=0.31)) compared to FES-I (skewness of 2.25 (SEM=0.15), kurtosis of 5.87 (SEM=0.31)), indicating absence of floor and ceiling effects. Construct validity of the Icon-FES was supported by its relation with FES-I ($r=0.716, p<0.001$) and its ability to discriminate between groups relating to demographic characteristics and fall risk factors (old age, female gender, poor balance, previous falls). A shortened 10-item Icon-FES showed similar psychometric properties to the 30-item Icon-FES. Excellent psychometric properties were also found in the sample of cognitively impaired older adults (MMSE <23). CONCLUSIONS: The Icon-FES is an innovative way of assessing concern about fear of falling using pictures to describe a range of daily activities and situations set within specific environmental contexts using pictures as visual cues. This initial validation study showed that the Icon-FES has excellent psychometric properties and is congruent with the FES-I. Significant attributes of the Icon-FES are its normal distribution and its ability to assess fear of falling in both high functioning older people and people with cognitive impairment.

O.34.3 Fear of falling in an older Irish population: prevalence and psychosocial predictors.

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BACKGROUND AND AIM: Fear of falling is an important and common syndrome affecting older adults. FOF is important because it may lead to activity avoidance, functional decline, restriction of social participation, decreased quality of life, increased risk of falling and institutionalisation. Indeed it has been suggested that the potential health problem of fear of falling is of equal importance to a fall. The reported prevalence of fear of falling in community dwelling older persons ranges from 20.8% up to 85.4%. While many of these prevalence studies have been random and population based, there is a lack of nationally representative data on fear of falling. The link between anxiety and fear of falling has been largely overlooked in the literature yet merits attention as it is possible that these two conditions are

just two different manifestations of the same disease. METHODS: A nationally representative sample of 8166 adults aged 50 years and older took part in wave 1 of The Irish Longitudinal Study of Ageing (TILDA). Structured interviews were conducted in the respondents' homes using computer-aided personal interviewing (CAPI) and included questions on social, economic and health domains. Fear of falling was measured by asking respondents "Are you afraid of falling?"(Yes/no). Respondents self-reported the number of falls experienced over a 12 month period. Depression was assessed using the CES-D 20 scale and anxiety using the HADS-A scale. Self-rated loneliness and generalised fear were captured as part of the CES-D scale. Respondents were also invited to attend for a comprehensive health assessment, either in a dedicated health centre or in their own home. As part of this assessment, respondents had their height, weight, hand grip strength and walking speed measured. RESULTS: Mean age of respondents 63.83 ± 9.79. The prevalence of fear of falling overall was 23.3% and was higher in women than men. Fear of falling increased with age and at all ages was more common in fallers than non-fallers. Univariate associations with fear of falling were older age, female gender, living alone, higher number of mediations, higher number of chronic diseases, a history of falls, depression, anxiety, loneliness, worry, poorer quality of life, lower levels of social participation, slower gait speed, higher BMI and lower hand grip strength. Multivariate associations were depression (OR 1.38), anxiety (OR 1.82), self-rated loneliness (OR 1.26), older age (OR 1.02), female gender (OR 3.13), lower levels of education (OR 1.11), history of falls (OR 1.99), higher number of chronic conditions (OR 1.14), generalised fear (OR 1.63) and slower gait speeds (OR 1.16). CONCLUSIONS: Fear of falling is independently associated with many socio-demographic, psychological and physical health status measures. Given its prevalence and importance, questions to assess fear of falling should be incorporated into the clinical assessment of all older adults

O.34.4 Cross-sectional relationship between fear of falling, activity restriction and dual task gait

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BACKGROUND AND AIM: Fear of falling (FOF) is a common problem in elderly adults and is associated with poor physical and psychosocial health status. It may cause individuals to be more cautious leading to positive fall prevention strategies or it may lead them to restrict their activities which can have debilitating social and physical consequences (2). Dual task walking requires greater attention than normal walking. As anxiety may reduce the cognitive resources available for gait and balance control (3), individuals with FOF may have increased gait disruptions during dual task gait. This study examined if gait disruptions were mediated by impaired overall health status or if they were independently associated with FOF and activity restriction. METHODS: A nationally representative sample of community dwelling adults (50 years) took part in wave 1 of The Irish Longitudinal Study on Ageing (TILDA). Participants were divided into 3 groups (i) no fear of falling (no FOF, n=3875) (ii) fear of falling and no activity restrictions (FOF alone, n=704) (iii) fear of falling with activity restrictions (FOF-AR, n=267). Participants walked while reciting alternate letters of the alphabet (A, C, E, etc) and gait parameters were obtained using a GAITRite mat and software. Mean gait variables of interest were gait speed, step length, step width and double support phase. Gait variability was assessed using the coefficient of variation of step length, step width, stride time and swing time. Multivariate regression analysis examined the impact of FOF and activity restriction on gait variables after adjusting for confounders such as age, gender, height, chronic conditions, executive function, anxiety, depression, visual impairment and gait speed. Statistical analysis took place in stata; significance was set at $p<0.05$.

RESULTS: Univariate analysis revealed that both FOF groups had significantly reduced gait speed and step length and increased variability in stride velocity and step length compared to the no FOF group ($p<0.05$). After adjusting for confounders, only increased step width remained for the FOF alone group ($p=0.017$) while increased double support phase was just outside significance ($p=0.069$). Both FOF groups had increased variability at baseline but this was fully explained by confounders. CONCLUSION: The FOF alone group adapted their gait to enhance balance and stability during dual task walking whereas the FOF-AR group did not. This ability may be due to a higher level of physical health, mental health and cognitive function, higher physical activity levels and continued participation in daily activities including walking. While there was no independent association between gait variability, FOF and activity restriction, the underlying gait instability in both FOF groups still places them at greater risk of falls than the no FOF group.

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O.34.5 Older adults motivating factors and barriers to exercise to prevent falls.

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BACKGROUND AND AIM: Falls and injuries related to falls often occur among older adults. Muscle strengthening and balance retraining have been shown to effectively prevent falls, achievable through individual or group exercise. In a joint project between a local hospital and three municipalities in the south east of Norway, exercise for older adults was applied in groups from 2006 to 2009. The results showed a 76 % drop-out in one of the municipalities. The aim of this study was to describe motivating factors and barriers for older adults to adhere in group exercise in the local community aiming to prevent falls, and explore means of how health professionals can stimulate adherence. METHODS: In this qualitative study semi-structured interviews were applied. Ten older adults ranged from 71 to 91 years of age participated. Mean age was 83 years. The interviews were taped and subsequently transcribed verbatim. The method used for data analysis was descriptive content, developed by Malterud (2003). This procedure consists of four steps. The motivation equation, which was developed by Phillips et al (2004), illuminates the connection between four subjective factors. These factors guide a person`s motivation to achieve change. RESULTS: Motivating factors to adhere in exercise was staying independent, maintaining current health status, improving balance and the ability to walk. Barriers were reduced health status, lack of motivation, unpleasant experience during previous exercise and environmental factors such as snow and ice. Adequate information initiating exercise was wanted from all health professionals. Many considered individual variation in functional skills within each group as a disadvantage. CONCLUSIONS: The knowledge gained form this study suggests a greater involvement from all health professionals in informing and motivating older adults to attend exercise groups. Physical therapists should strive to gain similar levels of physical function in the exercise groups.

Poster Sessions Titles and Authors

Session 1

A - Neurological Diseases I

P1-A-1 Computer vision based assessment of postural patterns during bilateral tasks in children with unilateral cerebral palsy performed in a clinical context: A pilot study

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BACKGROUND AND AIMS: Bilateral hand activity in children with cerebral palsy (CP) is evaluated using the Assisting Hand Assessment (AHA); a well standardized, albeit subjective assessment of movements based upon video-recordings. Computer-based video analysis software may provide objective assessments of such movements. In this pilot study we investigated if a video analysis tool could generate visual displays and quantitative variables of postural patterns that correlate with AHA scores. METHODS: Fifteen children (9 boys, 6 girls, median age 13 years, range 8-17 years) with unilateral CP were recruited, video recorded and scored using the School Kids AHA. Clips of video sequences (range 37-70 seconds), involving the three AHA tasks; reaching for cymbals, arm braces and a box with a key, were selected for software analysis. A variable reflecting lateral displacement of the spatial centre of movement (Centroid of Motion - CoMx) derived from differences between subsequent video frames were correlated with AHA scores using Spearman's rho. Visual displays were generated, observed and classified as Trunk Placement having lateral, central or mixed placement. RESULTS: Trunk placement correlated strongly with AHA total ($r= 0.83$; $p< 0.001$) and AHA arm use ($r= 0.82$; $p< 0.001$). A correlation was found between lateral placement of the CoMx and AHA total ($r= 0.63$; $p< 0.01$). CONCLUSIONS: These preliminary findings suggest that through further development, computer-based video analysis may provide quantitative assessments of bilateral hand activity in children with unilateral CP. Such assessments could be useful both in clinical as well as in research settings.

P1-A-2 The impact of peripheral neuropathy and dual tasking on postural control among elderly with and without Type 2 Diabetes Mellitus

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BACKGROUND AND AIM: The present study investigated 1) the potential influence of peripheral neuropathy (PN), either idiopathic or diabetic, on the performance of quiet postural stance conditions and 2) the eventual recommendation of a simple screening (like vibration perception threshold (VPT)) for peripheral nerve dysfunction in a fall risk assessment among elderly, even if they do not suffer from diabetes mellitus (DM). METHODS: 195 elderly were included in this study and entered in a 4-group-model: DM with PN (DM PN; n=75), DM without PN (DM-PN; n=28), controls with idiopathic PN (control PN; n=31) and controls without PN (control-PN; n=61). Posturographic sway parameters and limits of stability (LOS) were measured using an AMTI AccuGait portable force plate. The maintenance of the upright position was challenged by changing the base of support and/or visual feedback and/or the

addition of a cognitive dual task. A Bio-Thesiometer was used for detection of the VPT. Fall history of the past year was registered and a follow-up of fall incidences took place by collecting monthly fall calendars. Mini-Mental State Examination (MMSE) and Clock Drawing Test (CDT) were performed to evaluate cognitive abilities. RESULTS: Sway parameters within the two groups without PN (DM-PN and control-PN) and within those with PN (DM PN and control PN) were strikingly comparable, albeit that the values of the PN groups were obviously less favorable than those of the groups without PN. Results are intensified by more challenging foot positions and eyes closed conditions. Compared to single task conditions, the addition of a dual task did not seem to aggravate postural control. Elderly with PN (with or without DM) are significantly older and show a higher prospective fall incidence than elderly without PN (with or without DM). CONCLUSIONS: PN, irrespective of its cause, clearly interferes with the sway area. These results underline the importance of early determination of abnormal VPT's, even in healthy elderly. Therefore we recommend the integration of a simple screening for peripheral nerve dysfunction (like Bio-Thesiometry) in fall risk assessments among elderly. For this study population, an additional cognitive dual task during quiet standing does not imply an extra provocation.

P1-A-3 The role of peripheral neuropathy, cognition and walking speed on gait in Type 2 Diabetes Mellitus

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BACKGROUND AND AIM: Changes in peripheral neuromuscular transmission (peripheral neuropathy (PN)) and mental abilities (cognitive impairment and dementia) as complications of diabetes mellitus (DM) have -each separately- been suggested to debilitate motor performance like gait. This study investigates the potential influence of PN and cognition on gait performance in elderly with DM with the additional load of different walking speed. METHODS: 101 elderly (aged 60 years or older) entered this study; 28 elderly with DM and PN (DM PN), 28 elderly with DM but without PN (DM-PN) and 45 healthy elderly without DM or PN (noDM). Mini-Mental State Examination (MMSE) and Clock Drawing Test (CDT) were used to objectify participants' cognitive state. During three single task conditions (normal, slow and fast walking speed) and two dual task conditions (normal walking while enumerating animal names and normal walking while counting backwards) gait analysis was performed using a GAITRite Walkway. Additionally, retrospective fall incidence was registered in all subjects. RESULTS: Stride velocity, step length and stride length are the most discriminating gait parameters in all gait conditions (p-values range from <0,001 till 0,049). During fast walking, also the other gait parameters (cadence, step time, stride time and support base) are significantly different between the three groups. In the DM groups, the arithmetic dual task results in a less efficient gait pattern than the verbal fluency dual task. For the noDM group the type of dual task does not seem to matter. MMSE- and CDT-scores were significantly poorer for the two DM groups in comparison with the noDM group. Furthermore, statistical difference in CDT-score between DM PN and DM-PN could be noticed (p<0,05). Elderly without DM have a significantly lower fall incidence than elderly with DM, especially when DM is accompanied by PN (p<0,001). CONCLUSIONS: Gait alterations already occur in the early stages of DM, even before sensory

loss is clinically detectable and especially during fast walking. The potential interfering impact of cognitive deterioration seems to be of importance.

P1-A-4 Ambulatory activity monitering using accelerometers in hemiplegia

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BACKGROUND AND PURPOSE: An accelerometer is a unique tool to objectively measure free-living physical activity, but their reliability for CVA patients with hemiplegia has not been established. Therefore, the aim of this study was to assess relationships between the amount of physical activity with accelerometers and motor functions for CVA patients with hemiplegia. METHODS: Subjects were 23 CVA patients (aged 71 ± 10.0 [SD]) who stayed in Tottori University Hospital (cerebral infraction, 16 patinets; cerebral hemorrhage, 4 patients; others, 3 patients). Their upper and lower extremities were not restricted. They wore one accelerometer (Hitachi AirSenseTM) on each wrist over 24 hours. The accelerometer measured physical activity using total activity counts and mean levels of activity intensity for affected and non-affected sides. Before activity monitoring, motor functions were assessed using Brunnstrom stage, NIHSS (National Institute of Health stroke scale), FIM (Motor & Cognitive Functional Independence Measure), ABMS (the Ability for Basic movement Scale), STEF (Simple Test for Evaluating Hand Function), and MAL (Motor Activity Log). Relationships between physical activity and scores of each assessment were tested by simple Pearson's correlation. A P value of less than 0.05 was considered statistically significant. RESULTS: Total activity counts and mean levels of activity intensity over 24 hours for the affected side showed significant correlations with FIM ($r=0.775$, $p<0.05$), STEF ($r=0.723$, $p<0.05$), ABSM ($r=0.748$, $p<0.05$), MAL ($r=0.671$, $p<0.05$), and Brunnstrom stage for upper and lower extremities and finger ($r=0.673$, 0.792, and 0.775, respectively, $p<0.05$). On the other hand, total activity counts and mean levels of activity intensity over 24 hours for the non-affected side showed significant correlations only with FIM ($r=0.594$, $p<0.05$), ABSM ($r=0.510$, $p<0.05$), MAL ($r=0.427$, $p<0.05$). CONCLUSIONS: Ambulatory activity monitoring using accelerometers was found to be a reliable objective assessment of upper function for CVA patients with hemiplegia.

P1-A-5 Exercise interventions and walking performance in persons with Multiple Sclerosis - Preliminary results from a randomized controlled study

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INTRODUCTION: Multiple sclerosis (MS) is a degenerative progressive neurological disease which affects walking ability. Intervention strategies to attenuate loss in ambulatory status or to improve walking ability are crucial in order to maintain activity and participation in daily life. The most optimal intervention strategy to obtain this remains unclear. AIM: To assess the effect of two different training programs on walking ability in persons with MS. METHODS: The study was designed as a randomized controlled trial. Eligible patients were recruited from the outpatient neurological unit at St. Olavs

University Hospital in Trondheim from February to September 2010. Inclusion criteria were age over 18 years, diagnosed with MS, and with EDSS score ≤ 6. The participants were randomised to either treadmill walking (TW) or strength training (ST). Both groups trained 3 times a week for 8 weeks. The TW consisted of 3 different walking bouts: preferred speed, gait pattern emphasize, and a 10% increase in walking speed from preferred speed. The ST consisted of 5 different exercises for the lower extremities. Work load was 80 % of one repetition maximum (1RM), and 6 repetitions in 2 sets were performed in each exercise. Main outcome measure was walking performance evaluated by the GAITRite walkway system. Secondary outcome measures were walking work economy (WWE) measured as VO2 ml/kg/min and heart rate (HR). The participants were tested at baseline and the subsequent week after finishing training. RESULTS: Twenty nine persons were included, of whom 26 (17 females/9 males, mean age 48±7 years, body mass index (BMI) 27±5.2) completed the study and three dropped out. Preliminary results show no change in preferred (p=0.507 for TG and p=0.955 for ST) or fast walking speed (p=0.173 for TG and p=0.955 for ST) in any of the groups. Strength, measured as 1RM, improved significantly in the ST group (p≤ 0.003). WWE improved significantly in the TM group, with a reduction in energy expenditure from 12.8±2.5 ml/kg/min to 11.4±1.3 ml/kg/min (p=0.03), whereas the ST group reduced their energy expenditure from 13.4±1.9 ml/kg/min to 12.7±1.6 ml/kg/min (p=0.07). Group difference was significant (p=0.020). HR was significantly reduced in TM compared to ST (p=0.040) from 99±8 to 90±7 and 103±13 to 102±11, respectively. CONCLUSION: Preliminary results indicate that both strength training and treadmill training improve walking work economy in MS patients. However, this does not change preferred walking speed or improve the ability to walk faster.

P1-A-6 Is walking confidence associated with dual task ability or attention in people with PD?

Robyn M Lamont, Meg E Morris, Marjorie H Woollacott, *Sandra G Brauer*

BACKGROUND AND AIM: Gait difficulties in people with Parkinson's Disease (PD) are exacerbated when people perform attention demanding tasks while walking [1,2]. This is commonly referred to as dual task interference. Dual task interference has previously been associated with reduced performance on attention tests [3,4]. However, how attention and dual task ability relate to the inherently attention demanding task of walking in the community has not been investigated. This study aims to examine the relationship between community walking confidence, dual task walking ability, and attention in a sample of people with PD. METHODS: Sixty two people with idiopathic PD, who could walk independently with or without walking aids and scored ≥24 on the MMSE were recruited to the study. Walking confidence was assessed using the Ambulatory Self Confidence Questionnaire [5]. Movement was assessed with the UPDRS and the 360o turn test. Walking was assessed using the Dual Task Timed Up and Go (TUG) test and an 8m GAITrite system under single and dual task conditions. Dual tasks included calculation, language and conversation tasks. Attention was assessed by a neuropsychologist using the Trail-Making and Colour-word interference subtests of Delis-Kaplan Executive Function System (D-KEFS). RESULTS: Overall, community walking confidence was moderately & significantly associated with time taken to perform the TUG alone (r = -0.423, p = 0.001), and the 360o turn test (r = -0.341, p = 0.007). Although significant, a lower correlation was seen for the TUG with a concurrent motor task (r = -0.286, p = 0.026). Step length when dual tasking was the gait parameter that showed the strongest association with community walking confidence (r = -0.453, p = 0.000). Attention measures showed no significant association with walking confidence; however Trail-Making letter sequencing error (r = -0.562, p = 0.000) and Colour-word interference error (r = -0.490, p = 0.000) were moderately associated with confidence to stop suddenly while walking. Other attention measures showed lower, but significant associations with other items of walking confidence. CONCLUSIONS: Dual task walking ability, spatiotemporal parameters of gait and measures of attention do not demonstrate any strong direct associations with walking confidence in people with PD.

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P1-A-7 Community walking in people with Parkinson's disease as measured with self report and accelerometry

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BACKGROUND AND AIM: Gait difficulties in people with Parkinson's Disease (PD) are exacerbated when people perform attention demanding tasks while walking [1,2]. This is commonly referred to as dual task interference. Dual task interference has previously been associated with reduced performance on attention tests [3,4]. However, how attention and dual task ability relate to the inherently attention demanding task of walking in the community has not been investigated. This study aims to examine the relationship between community walking confidence, dual task walking ability, and attention in a sample of people with PD. METHODS: Sixty two people with idiopathic PD, who could walk independently with or without walking aids and scored ≥24 on the MMSE were recruited to the study. Walking confidence was assessed using the Ambulatory Self Confidence Questionnaire [5]. Movement was assessed with the UPDRS and the 360o turn test. Walking was assessed using the Dual Task Timed Up and Go (TUG) test and an 8m GAITrite system under single and dual task conditions. Dual tasks included calculation, language and conversation tasks. Attention was assessed by a neuropsychologist using the Trail-Making and Colour-word interference subtests of Delis-Kaplan Executive Function System (D-KEFS). RESULTS: Overall, community walking confidence was moderately & significantly associated with time taken to perform the TUG alone (r = -0.423, p = 0.001), and the 360o turn test (r = -0.341, p = 0.007). Although significant, a lower correlation was seen for the TUG with a concurrent motor task (r = -0.286, p = 0.026). Step length when dual tasking was the gait parameter that showed the strongest association with community walking confidence (r = -0.453, p = 0.000). Attention measures showed no significant association with walking confidence; however Trail-Making letter sequencing error (r = -0.562, p = 0.000) and Colour-word interference error (r = -0.490, p = 0.000) were moderately associated with confidence to stop suddenly while walking. Other attention measures showed lower, but significant

associations with other items of walking confidence. CONCLUSIONS: Dual task walking ability, spatiotemporal parameters of gait and measures of attention do not demonstrate any strong direct associations with walking confidence in people with PD.

This study was supported by NHMRC project grant ID#5121170, CIA Brauer.

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P1-A-8 Turning strategies in Parkinson's disease patients with freezing of gait

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BACKGROUND: In the early stages of Parkinson's Disease, turning is already characterized by a decreased head-pelvis rotation. Turning is the most freezing-provoking situation. Differences in head-pelvis rotation between freezers and non-freezers have never been investigated before. Aim of the study: To explore the axial movement impairment during turning in freezers compared to non-freezers with Parkinson's disease (PD) and healthy controls. METHODS: 13 Freezers (FR) and 14 non-freezers (nFR) (off-medication) matched for disease-severity and 14 age-matched controls (Con) were instructed to turn 180° to the left and right side around a retroreflective marker in a 3D-gait laboratory (Vicon). Turning width was restricted to avoid freezers to compensate by increasing their turning arc. Head-, thorax- and pelvis rotation as well as the position of the centre of mass in relation to the floor marker were measured at the turn onset and throughout the turn. The location and duration of FOG-episodes were also identified. RESULTS: At turning onset, the head preceded thorax and pelvic rotation in all groups but this cranio-caudal sequence disappeared when Freezing Of Gait (FOG) occurred during the trial. However, no differences in cadence, step length, step time and step width of the two steps preceding pelvic rotation were found between trials with and without FOG. The maximum head-pelvis separation was significantly greater in controls compared to freezers and non-freezers (35.4 vs 25.7 and 27.3°, $p<0.01$). Also, the moment of maximum separation was delayed in freezers compared to non-freezers and controls. This delay was correlated with increased neck rigidity ($R=0.62$, $p=0.02$) and worsened during FOG-trials. FOG occurred especially at the end of the turn, when the difference in rotation velocity between head and pelvis was the greatest. CONCLUSIONS: Turning in freezers was characterized by delayed head rotation and a closer coupling between head and pelvis especially in turns when FOG occurred. These changes may be attributed to delayed preparation for the transition of walking direction and as such contribute to FOG. These results support the possibility that teaching

strategies to normalize the impaired head-pelvis dissociation and the delayed counter-rotation might reduce FOG.

P1-A-9 Cueing and attention strategies for axial movement impairment related to freezing of gait in Parkinson's disease

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BACKGROUND: Impaired head-pelvis dissociation during turning was recently found to be related to freezing of gait (FOG) in Parkinson's disease (PD). The use of cueing and attention strategies has been shown to improve gait characteristics in PD. However, not much is known about the effect of these strategies on the normalization of head-pelvis rotations to reduce FOG. OBJECTIVE: To investigate the influence of cueing and attention strategies on FOG and head-pelvis dissociation during turning. METHODS: 15 freezers, 14 non-freezers (Hoehn and Yahr stage II or III) and 14 controls turned 180° to the left and right side during off. After this baseline condition, auditory unilateral cueing at a 10% below-baseline frequency and an attention strategy (initiating the turn with the head) were applied in a random order. Head rotation preceding the turn (anticipation), head-pelvis separation and the head-pelvis rotation velocity as well as FOG-occurrence were measured. RESULTS: In none of the outcome measures, group*condition interaction effects were found. When using the attention strategy, the turn was initiated earlier compared to the baseline or auditory cueing conditions. Controls had a better head anticipation than freezers and non-freezers in the baseline condition ($p=0.031$). Head anticipation occurred earlier and head pelvis velocity was greatest during the attention strategy in all groups ($p<0.01$). Maximal head-pelvis separation was significantly greater in controls compared to freezers in the baseline condition (31.8° vs. 25.1°) and was the largest during the attention strategy (43.6° vs. 28.2° and 23.5°, $p<0.01$) in all groups. The moment of maximal head-pelvis separation was normalized in patients with the attention strategy. In contrast, the moment of maximal head-pelvis separation did not improve in response to auditory cueing. FOG occurred in 52.8% of trials during baseline, compared to 3.8% while cueing and 34.6% during the attention strategy. CONCLUSION: Using an attention strategy, head-pelvis dissociation was normalized in PD patients with FOG. However, the decrease of FOG episodes was much greater when using auditory cueing while axial movements still occurred "en bloc". Hence, it seems that facilitating external generation through cueing is more important to reduce FOG than normalizing the "en-bloc" movement.

P1-A-10 A highly challenging, progressive and specific balance training program in elderly with Parkinson's disease -Theoretical framework and feasibility

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BACKGROUND AND AIM: Balance control is a task specific multi-joint skill relying on the interaction of several physiological systems (musculoskeletal, neuromuscular, cognitive and sensory system). There is a rising scientific framework of the interaction between these systems and their impact on balance disorders in PD. Nevertheless, previous balance interventions in PD-populations have mainly targeted balance performance through non-specific physical training [1]. In order to improve balance performance, there is a crucial need to test innovative training regimes, focusing on challenging aspects of balance training specifically related to PD impairments [1]. Therefore, a randomized controlled trial of a highly challenging, progressive and individually adapted training regime, emphasizing critical aspects of balance control in elderly subjects with PD was initiated. METHODS:In this training program, four main subsystems underlying balance control (stability limits, anticipatory postural adjustments, sensory integration, motor agility) are used to target symptom specific balance impairments, i.e. bradykinesia, postural adjustments, visual dependency and coordination, in individuals with PD. Intermittent presence of reactive postural adjustments is used as an indicator of the relevant level of difficulty. This 12-week intervention is performed three times/week in groups of six to seven participants, is divided into three phases, and supervised by two physiotherapists. Phase one introduces the principles of each subsystem separately, aiming to accomplish task specific motor learning. During phase two and three, movement complexity is increased by successively integrating the subsystems in combination with multitasking. To ensure highly challenging exercises, each task is individually adapted e.g. by changing area of base of support, increasing movement speed/amplitude, restricting vision and varying the grade of multitasking. Five subjects (one female), mean age 72 years (range 69 - 80) with mild to moderate idiopathic PD (Hoehn & Yahr 2-3) participated in a pilot study to investigate the feasibility of this training program. RESULTS: According to preliminary results, this balance training program is indicated to be feasible regarding; safety, intervention compliance, pain and general fatigue in elderly with PD. Suitable progression in terms of individually adapted difficulty level and task complexity was easily performed by experienced physiotherapist during training. CONCLUSIONS: This pilot study showed the training program to be feasible in elderly with mild-to moderate PD and shows great potential to improve balance performance. However, a randomized trial is needed to further investigate the effects of the intervention.

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P1-A-11 Community-based dance for people with Parkinson disease: An 18-month intervention study

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BACKGROUND AND AIM: Recent evidence suggests that 12 months of community-based exercise in the form of tango dancing effectively modifies the progression of disability in Parkinson disease (PD). However, no studies have examined community-based dancing for a period longer than one year. The aim of this study is to compare individuals who danced tango for 18 months to controls who received no

specific intervention, focusing on motor symptom severity and functional measures tested off anti-PD medication. METHODS: Participants were randomly assigned to the Tango or Control group. The Tango group attended community-based dance classes twice weekly for one hour for a period of 18 months. Participants in the control group were instructed to go about their daily lives and given no prescribed exercise. Assessments were conducted with participants off anti-PD medication at baseline and 18 months by a rater blinded to group assignment. The primary outcome measure was the Movement Disorder Society Unified Parkinson Disease Rating Scale-III (MDS-UPDRS-III) motor subscale. Secondary outcome measures testing functional performance included the following: Mini-Balance Evaluation Systems Test (Mini-BEST), gait velocity (comfortable forward (FWV), backward (BWV), and fast as possible (FASTWV)), timed up and go (TUG), and dual-task TUG (dual-TUG). Two-way repeated measures ANOVAs with group (Tango, Control) and time (0, 18 months) were utilized with appropriate post hoc analyses as warranted (p = .05). RESULTS: The Tango group (n=8, 5 males, mean age 68 ± 6 years) and Control group (n=12, 8 males, mean age 68 ± 9 years) were not different at baseline with respect to demographic variables or any outcome measures. Significant group by time interactions were found for the following measures: UPDRS-III (p=.03), Mini-BEST (p=.008), and dual-TUG (p=.02). At 18 months, the Tango group significantly decreased UPDRS-III scores while the Control group stayed the same. With respect to balance and dual-TUG, the Tango group improved while the Control group declined. No significant interactions were found for TUG (p=.71), FWV (p=.10), BWV (p=.15), and FASTWV (p=.81). CONCLUSIONS: Over 18 months, twice weekly tango dancing appears to reduce motor symptom severity and improve balance and the ability to walk while performing an additional task for individuals with PD, while those who did not dance showed a worsening on some measures. Community-based exercise programs such as tango dancing have the potential to modify progression of disability over a sustained period of time during which function would be expected to decline without such an intervention.

P1-A-12 Does age or gender influence the efficacy of exercise in Parkinson’s disease?

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OBJECTIVE: To investigate the effects of age and gender on the efficacy of exercise training in Parkinson's disease (PD). Background: Increasing evidence supports the benefits of exercise in PD. It is unclear whether the efficacy of exercise is influenced by age or gender. METHODS: PD patients were enrolled in a randomized, single-blinded, comparative study of 3 types of exercise: Higher intensity treadmill (HIT), Lower intensity treadmill (LIT), Stretching/Resistance (S-R). Exercise was performed 3X/week for 3 months. For this post-hoc analysis, all study subjects (N=67) were split into 2 subgroups based on gender or based on median age (67 years). ANOVA investigated the effect of PD subgroups on the change (post-pre) in PD outcomes across all 3 types of exercise. Pre and post-training measures included measures of cardiovascular fitness (Peak VO2), gait (6-minute walk) and muscle strength. RESULTS: Previously reported results showed that LIT training resulted in the most consistent improvements in mobility, both HIT and LIT improved cardiovascular fitness and S-R improved muscle strength. On the 6-Minute Walk, younger subjects increased their distance by 169.3(33.9) feet

(Mean(SE), 12% increase) while older subjects increased distance by 56.8(33.9) feet (4% increase) p=.02. Analysis of the 3 training subgroups showed that younger patients increased 6MW distance most following LIT training (216 ft; p<.01) and least following HIT (124 ft; p=.11). Age had no effect on efficacy of exercise training for fitness or muscle strength, and gender had no effect on any outcomes (mobility, fitness, strength) following exercise training. CONCLUSIONS: Younger PD patients showed greater improvement than older patients on the 6-Minute Walk following exercise training. Neither age nor gender had any effect on outcomes of cardiovascular fitness and muscle strength; in fact, gender had no effect on any outcomes following exercise.

P1-A-13 Efficacy of a multifaceted intervention program to increase physical activity in patients with PD: The Parkfit trial

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[1]Radboud University Nijmegen Medical Center, [2]University Medical Center Utrecht

BACKGROUND AND AIMS: Many patients with Parkinson's disease (PD) lead a sedentary lifestyle. Simply informing patients about the health benefits of physical activity is insufficient to change their sedentary lifestyle. We developed and evaluated a multifaceted behavioural program (ParkFit) aiming to increase the level of physical activity undertaken by patients with PD. METHODS: 586 PD patients were randomly assigned to the ParkFit Program or an active control group (ParkSafe Program). The level of physical activity was measured at baseline and at 6 months using a standardized interview-based 7-day recall (LAPAQ, primary endpoint), an ambulatory activity monitor (secondary endpoint) and an activity diary (secondary endpoint). RESULTS: were analysed according to the intention to treat concept. Results 562 patients (96%) completed both baseline and 6 months assessments. In the ParkFit group, patients increased their time spent to physical activities with 7% as assessed with the LAPAQ; patients in the control group became 1% less active. The difference between both groups was not statistically significant. When we specified the nature of the activities, patients in the ParkFit group increased their 'outdoor and sports activities' (+32%), while their time spent to household activities decreased (-14%). In the control group these differences were less than 4%. CONCLUSIONS: This short term outcome of the ParkFit trial suggests that patients with PD can increase their outdoor activities with a specific multifaceted program. This increase seems to be accompanied by a decrease in time spent to household activities. At the congress we will present the results of the ParkFit trial after 24 months intervention and the potential health consequences of a change in lifestyle.

P1-A-14 Should one measure balance or gait to best predict falls among people with Parkinson's disease?

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BACKGROUND AND AIM: Prior work has shown the ability of multi-item clinical balance tests to prospectively predict falls among people with Parkinson disease (PD). These tests require special training of the tester, involve subjective ratings of participant performance, and can be time-consuming to administer. The purpose of this study was to compare simple and quick measurements of gait velocity to multi-item balance tests with respect to their utility in prospectively predicting falls. METHODS: Fifty-five individuals with idiopathic PD (MDS-UPDRS-III = 45.7 +/- 11.4) were assessed off medication at baseline. Primary outcome measures included the mini-BESTest balance assessment tool and gait velocity for forward walking at a comfortable pace (forward), forward walking as fast as possible (fast), backward walking, and dual task walking (walking while performing a phonemic listing task). Participants performed three trials of each gait task on a GAITRite walkway (CIR Systems, Inc., Havertown, PA) and results from the three trials of each task were averaged. Participants also completed the freezing of gait questionnaire (FOGQ). Six months later participants reported the number of falls they had experienced since their baseline evaluation. Those with 2 or more falls in the six month tracking period were considered fallers and those with one or zero falls were classified as non-fallers. Ability of the various tests to discriminate between fallers and non-fallers was assessed using receiver operator characteristic curves followed by pairwise statistical non-inferiority comparisons (p=0.05) of the area under the curve (AUC) for each test. RESULTS: Of the 55 participants, 12 (22%) were classified as fallers. AUCs were 0.80 for the mini-BEST, 0.77 for the FOGQ, and ranged from 0.55 to 0.67 for the gait tasks. Non-inferiority tests showed that all gait tasks were inferior to the mini-BESTest and that all gait tasks except backward walking were inferior to the FOGQ. Among the gait tasks, backward walking was superior to all other gait tasks, dual task walking was superior to forward and fast walking, and forward was superior to fast walking. CONCLUSIONS: The mini-BESTest was superior to all measures of gait velocity for identifying future fallers. However, predictive abilities of the mini-BESTest and FOGQ were similar with the FOGQ being less sensitive but more specific than the mini-BESTest. Both the mini-BESTest and the FOGQ appear to be useful tools for use in identifying those at risk for falls. Gait velocity, even in challenging tasks like backward and dual task walking, is not as effective at identifying those at risk for future falls.

P1-A-15 Detecting freezing of gait and falls using motion recorder in Parkinson's disease patients during everyday activities

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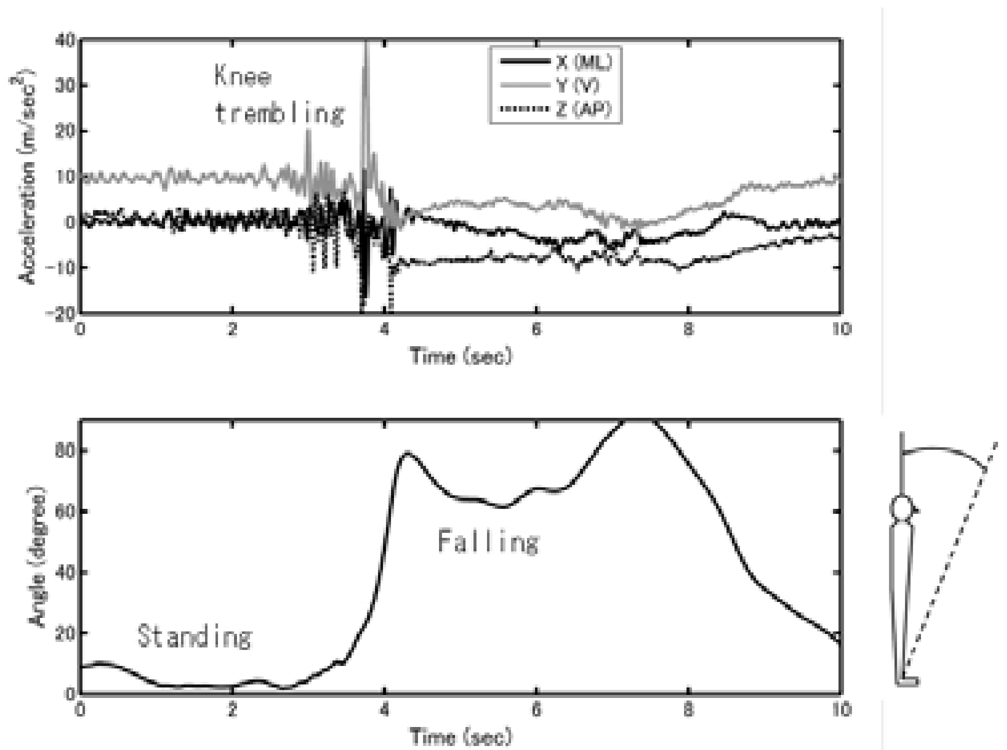
BACKGROUND AND AIM: Freezing of gait (FOG) and recurrent falls are a disabling feature of Parkinson's disease (PD), and have a significant negative impact on the patients' quality of life [1]. Recently, we found that FOG is the most common cause of falls in advanced PD, particularly in the off-state and transition-state between on and off-state [2]. However, falls and FOGs were determined by patients' self-reports (fall diaries). The aim of the present study is to objectively detect and elucidate characteristics of FOG and falls in PD patients during everyday activities. METHODS: Patients were selected from 36 patients who participated in our previous prospective study on falls. We developed a motion recorder (body-fixed 3D accelerometer) with a long-lasting battery. First, healthy volunteers simulated FOG and falls, and acceleration signals were analyzed. Then movements of recurrent PD fallers were recorded during their everyday activities. RESULTS: When healthy subjects simulated FOG and falls, the characteristic patterns of acceleration signals were recorded for forward falling. Falls were associated with impact acceleration and abrupt changes in trunk angle. Mimicked knee trembling was recorded as a rapid oscillation of acceleration. In PD patients, actual falls were detected by abrupt trunk angle changes with or without impact acceleration. Knee trembling was recorded when patients reported FOG-induced falls. CONCLUSIONS: Motion recording with our device is useful for detecting and analyzing FOG and falls in everyday life in PD fallers, and complements patients' self-reports.

Figure 1. Motion recording during everyday activities in a PD patient
The patient reported FOG and fall at the entrance hall.



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P1-A-16 Parkinson's disease : Measurement of anterior sagittal déviation of the spine, spontaneous and redressed

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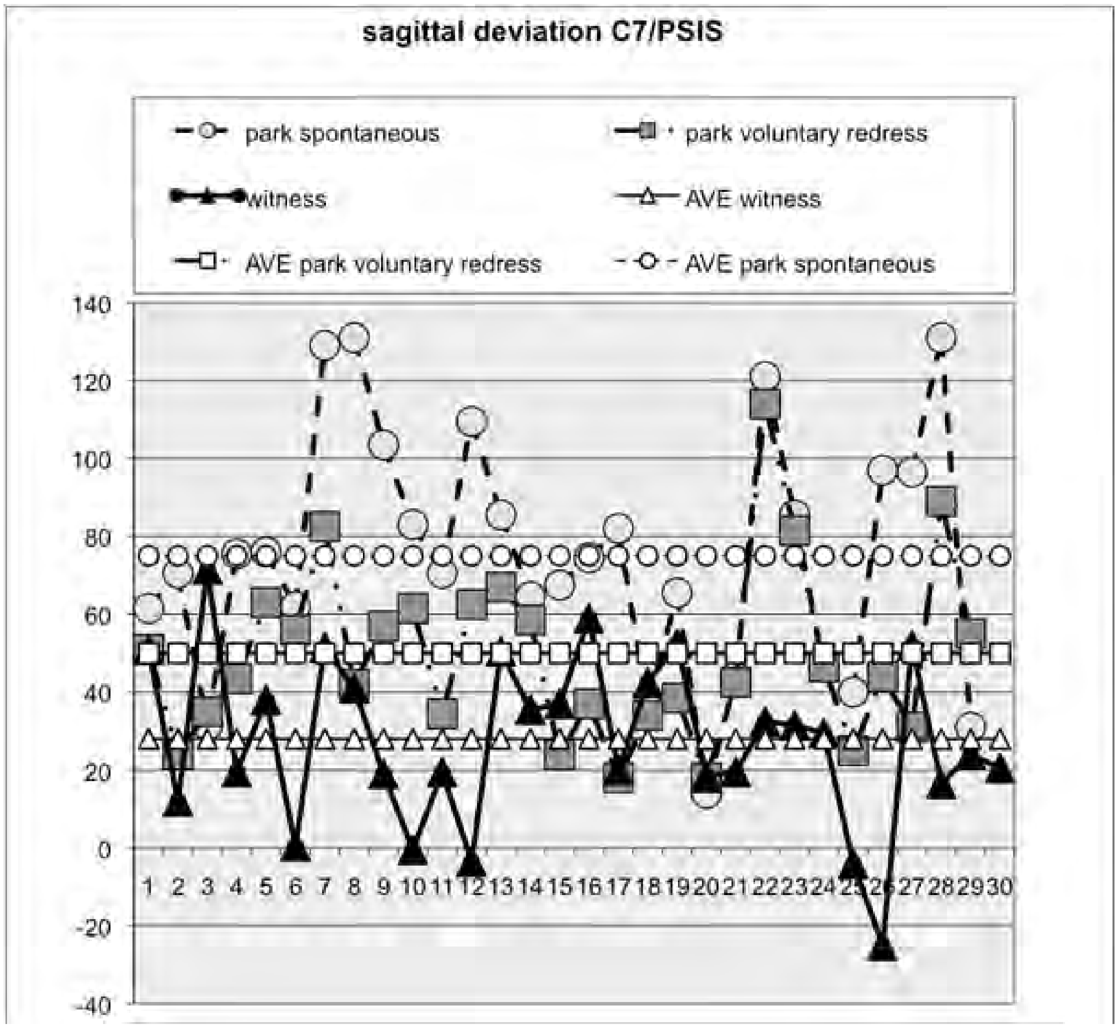
BACKGROUND AND AIM: Patients suffering from Parkinson's disease complain of chronic back pain appearing or getting worse after the onset of the disease.This study attempted firstly to quantify the deviation of the cervicothoracic junction relative to the lumbosacral junction in patients suffering from Parkinson's disease, in comparison with controls. Secondly this study aimed to assess the effects of a redressment of the spine (patients were asked to stand tall). METHODS: 30 controls (13 men, 17 women) mean age 59 years (range 43-78), 30 patients stage <3 Hoehn and Yahr (16 men, 14 women) mean age 66 years (range 47-81). A SAM 3D device (stereoscopic photography) was used to obtain 3D localization of the three points of interest: C7 for the cervicothoracic junction, the left and right PSIS (posterior superior iliac spine) for the lumbosacral junction. The patients were examined from behind, firstly in a normal posture and then when asked to stand tall. To take measurements a skin mark was made at the le vel of the spinous process of C7, and at the right and left posterior superior iliac spines. Then a measurement of these three points was made, thus giving three-dimensional coordinates (accuracy < 2mm). RESULTS: Control group. Measurement of the Spontaneous sagittal deviation: the anterior sagittal deviation of C7 compared to the midpoint between the posterior superior iliac spines was 28mm (standard deviation 21,5mm). Parkinson's patients. Measurement of the spontaneous sagittal deviation: the anterior sagittal deviation of C7 was 75,1mm (standard deviation 30,7mm). There was a significant difference between control and Parkinson groups (P <0.001). Measurement of the sagittal deviation after voluntary redressment : the anterior sagittal deviation of C7 was 49,7mm (standard deviation 22,1mm) the difference was significant (P <0.001). CONCLUSION: Patients with Parkinson's presented an anterior disequilibrium of 47,1mm in comparison with the controls (75,1 - 28). After voluntary redressment the anterior disequilibrium of the cervicothoracic junction was reduced to 21,7mm (75,1 - 49,7).



P1-A-17 **Dual task costs for checking boxes is a potential progression marker for Parkinson's disease**

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INTRODUCTION: Parkinson's disease (PD) is characterized by gait impairments (such as loss of walking automaticity) and cognitive impairments (such as reduction of executive function and attention). It is well known that, during dual tasking (walking and a challenging cognitive task), attention resources are allocated to more than one task, and gait abnormalities increase. However less is known about cognitive costs. In addition, most of the available studies did not test under maximal challenge, and did not use different dual tasking paradigms. Consideration of these aspects may be important as decreased compensatory reserve of the central networks may be subtle, and only manifest during specific challenging conditions. METHODS: We examined 34 PD patients, and 18 matched controls. The subjects performed a fast pace 20 m walk under single tasking and dual tasking conditions (checking boxes and subtracting serial 7s [1]). Dual task costs (DTC, %) were calculated using the formula: RESULTS: DTC for walking when checking boxes, and for walking when subtracting serial 7s were comparable between PD patients and controls, as were DTC for subtracting serial 7s when walking. DTC for checking boxes when walking were higher in PD patients than in controls (p=0.035), and correlated with motor (UPDRS III; Rho=0.39, p=0.022; Hoehn&Yahr; Rho=0.46, p=0.007) and cognitive measures (ΔTMT; Rho=-0.34; p=0.05). CONCLUSIONS: The observed difference of DTC for checking boxes when walking between PD patients and controls, and the correlation between DTC for checking boxes when walking with disease severity argues for the usefulness of this parameter as a trait and state marker of the disease. The result may be best explained by a bottleneck in sharing capacity between two motor tasks.

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P1-A-18 Energy flow analysis of the lower extremity during gait in persons with stroke

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BACKGROUND AND AIM: For many stroke survivors the decline in walking capacity and higher energy costs can limit functional mobility. Variations in mechanical energy patterns and exchange between lower limb and trunk segments indicate gait inefficiencies in stroke [1], but reveal little about muscle generated energy flow [2]. This pilot study evaluated mechanical energy expenditures (MEEs) during walking in chronic stroke and healthy groups to better understand movement control and the impact of walking speed. METHODS: Stance data from 8 subjects (29 to 80 yrs) with hemiparesis due to stroke and 6 healthy controls (50 to 73 yrs) walking at a self-selected speed were analyzed. Power curves for each lower limb joint were segmented into concentric and eccentric sources of muscle power and transfer/no-transfer modes to calculate MEEs (net amount of active energy produced) for no transfer (MEENT, linked segments joint rotate in opposite directions), concentric energy transfer (MEEC) and eccentric energy transfer (MEEE) conditions. MEEs were determined for the ankle, knee and hip joints of the affected and unaffected sides in stroke and the right side in healthy controls. RESULTS: Power profiles were qualitatively similar in terms of proximally and distally directed transfers although MEE magnitudes tended to be lower in stroke. Ankle MEEC were lower on the affected side (p=.008) and MEEE were lower on affected and unaffected sides (p<.047) compared to healthy control subjects. Less knee MEEC occurred on the affected side than the unaffected side (p<.007) and MEENT on the affected side was lower than in controls (p=.013). MEENT at the hip was also reduced on the affected side compared to controls. Classifying stroke subjects based on walking speed (<.6 m/s, >.6 m/s) suggests lower efficiency with slower walking. CONCLUSIONS: Stroke survivors generate, absorb and transfer less power than healthy controls. Further, a 'threshold' gait speed to maintain efficient transfers may be required below which efficient energy flow is markedly compromised.

ACKNOWLEDGEMENTS: We acknowledge support of the NSERC PGS Doctoral award.

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P1-A-19 Inefficiency of choosing the non-affected leg as the first swing leg in the sit-to-walk motion after stroke

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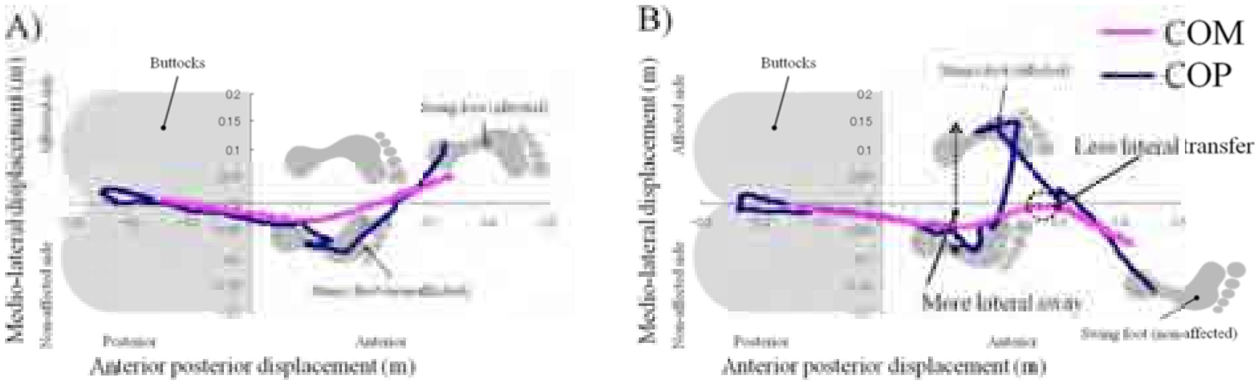
BACKGROUND AND AIM: As most stroke patients spend a lot of time sitting in chairs, many occasions require the patient to start walking from the sitting position. The sit-to-walk (STW) task is complex because it merges the sit-to-stand task with gait initiation. Therefore, STW carries a high risk of fall for stroke patients. In previous studies, the effectiveness of choosing the first swing leg was only investigated for the stand-to-walk task. The purpose of this study is to examine the differences in motor strategy between starting to walk with the affected leg vs the non-affected leg in STW, with a focus on the displacement of the centre of pressure (COP) and the centre of mass (COM). METHODS: Subjects (n=14) who had sustained stroke performed the STW starting with either leg. Of the subjects, 7 were comfortable to start walking on the affected leg while the other 7 favored the non-affected leg. The 5-m STW was measured using the VICON motion analysis system and six AMTI force plates. The difference in kinematic data between the two tasks was compared using the nonparametric Wilcoxon signed-rank test with $p<0.05$ as significant. RESULTS: Nine subjects could merge the sit-to-stand task with gait initiation, namely they maintained forward velocity at liftoff until gait initiation. There was no difference between the tasks in step length. When the non-affected leg was used as the first swing leg, a larger medio-lateral sway of the COP ($p<0.01$), smaller medio-lateral movement of the COM ($p<0.05$), larger medio-lateral peak velocity of the COM ($p<0.01$), and a shorter swing period was found ($p<0.01$). CONCLUSIONS: The results indicate that the lateral movement of the COP was large and that the COM movement of the stance leg was insufficient when patients started walking with the non-affected leg. Subjects were unstable when starting to walk before the lateral transfer of COM had been completed. Moreover, there was a risk of fall if the COM was transferred too rapidly to the affected leg. In STW, the stance leg increased the COM during gait initiation after liftoff. As most stroke patients depend mainly on their non-affected leg at liftoff, the COM shifts to the non-affected side. Therefore, it is more effective for stroke patients to start walking with the affected leg than the non-affected leg because it prevents an unstable lateral change of COM caused by an unsteady posture.



A) COP and COM movements in the horizontal plane when a patient starts walking with the affected leg.
B) COP and COM movements in the horizontal plane when a patient starts walking with the non-affected leg.

P1-A-20 Effect of chemodenervation of the rectus femoris muscle in adults with stroke presenting a Stiff Knee Gait: A meta analysis

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BACKGROUND AND AIM: Stiff Knee Gait (SKG) is characterised by a diminished knee flexion during swing and is commonly observed in patients with spastic paresis. Clinically, a SKG can result in problems with foot clearance leading to tripping, and an increased risk of falling. The overactivity of the rectus femoris (RF) is often cited as a major cause for SKG. An easy to perform treatment option for this overactivity is chemodenervation of the RF. However, in literature, the effects of chemodenervation on SKG and functional outcome of walking are scarce and inconsistent. The aim of this review is determining the effect of chemodenervation (Motor Branch Block (MBB) or Neuro Muscular Block (NMB)) of the Rectus femoris on peak knee flexion during swing and on functional outcome in adults with stroke presenting a SKG. METHODS: Pubmed, Embase, Cinahl, and Cochrane library were searched. No restrictions were applied on study design. Patients were adults suffering from a central neurological disorder. Interventions had to include MBB or NMB. Outcome measures had to include range of motion of the knee during swing phase. Data on peak knee flexion and functional outcome from stroke patients were extracted from the total population and pooled. RESULTS: In total eight studies were included. Peak knee flexion during swing improved in all included studies. The average improvement varied from 1.9 till 15.4 degrees. Data pooling of peak knee flexion in stroke patients showed a significant improvement of 7.4 degrees ($p \leq 0.002$) in the NMB studies and 11.3 degrees($p \leq 0.0009$) in the MBB studies. On the level of functional outcome, only walking speed could be pooled. Results on walking speed showed no significant difference. CONCLUSIONS: According to this review, chemodenervation of the rectus femoris significantly improves peak knee flexion during swing. The effect on functional outcome and patient satisfaction remains unclear.

P1-A-21 3D foot kinematics of a modified figure-of-eight walking test - A pilot study of feasibility

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BACKGROUND AND AIM OF THE STUDY: Common gait analysis provides objective outcomes for many different walking parameters during straight walking. However, a clinical assessment tool should also involve turns, which are required in most activities of daily living. One approach with good psychometric properties is the Figure-of-Eight (Fo8) walking test (Jarnlo et al. 1991, Jarnlo & Nordell 2003). Here a complex motor task is performed, where walking performance is influenced by external stimulation of spatial orientation. Outcome measures are time, total number of steps needed and number of steps missing the given Fo8 path. The test is sensitive to functional changes in different groups of patients. Using an optoelectronic measurement system to measure 3D foot kinematics, objective parameters are available to describe walking performance during this complex motor task. The aim of this study was to further develop the Fo8 test, to evaluate new parameters for clinical assessment, and to show the feasibility of this test in impaired older adults. METHODS: In this case-series 2 stroke survivors (64 / 67 years) performed the Fo8 assessment including 8-shaped walking trials in a 7 cm wide corridor, printed on a carpet with two circles with a diameter of 143 cm of the inner circle. While starting to walk from the intersection, beginning with the left foot in counter-clockwise direction, participants were advised to walk the Fo8 twice at preferred velocity. 3D foot kinematics were recorded by 8 VICON-cameras with a specified marker model, attached to the participants shoes. Miss-steps were defined as heel strikes with the heel marker missing the corridor. The number of miss-steps was calculated as well as the direction of the miss-steps. Further walking parameters to be defined are the deviation of steps from the corridor, step width, number of total steps needed and the single support time. RESULTS: Each participant showed different walking patterns (see Figure 1). Qualitative description of the walking patterns showed a lower number of total steps as well as steps missing the corridor and a lower step width in subject a) when compared to subject b). Subject b) did no step inside the corridor with the right foot, while the paretic left limb was the corridor seeking leg which showed different step patterns for right compared to left curve walking. CONCLUSIONS: This updated test scenario was feasible in stroke patients with mild to moderate walking impairment. Advanced evaluation of curved path walking performance was enabled by the optoelectronic tracking system. Trajectory visualization allowed a quick interpretation of gait parameters and the patterns of miss-stepping behaviour. The observed variability of step patterns refines the characterization of different walking strategies, which possibly can be explained by varying severity of impairment. Next steps will define quantitative parameters and will investigate psychometric properties of this test.

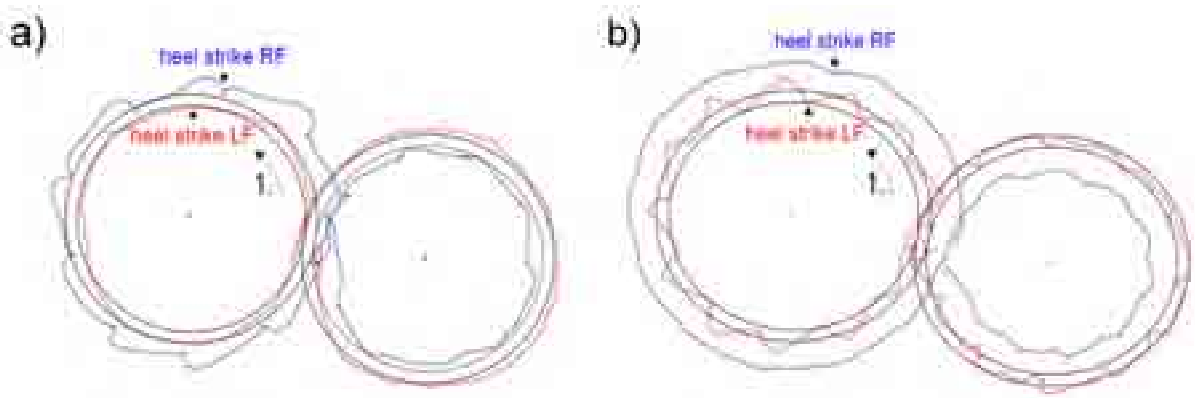

Figure 1: Walking patterns of 2 participants. Walking direction (1.).

B - Vestibular Function and Disorders

P1-B-22 Posturography on the follow up of peripheral vestibular disease

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INTRODUCTION: The limits of agreement represent the test-retest differences for 95% of a population. This method is used to assess the consistency of measurements; it also helps to identify the magnitude of the difference that can be considered "a real change" between recordings made at different times. This study was aimed to calculate the limits of agreement of repeated measurements of static posturography on 20 healthy adults, and to assess the use of those limits on the interpretation of changes observed during the follow-up of 30 patients with chronic, peripheral, vestibular disease, who performed a standardized program for vestibular rehabilitation (Cawthorne & Cooksey exercises). METHODS: Body sway during quiet upright stance was recorded using a force platform, at 40 Hz, under 4 conditions (eyes open/closed on hard/soft surface), at baseline and at weeks 4, 6 and 8 of follow-up. RESULTS: In healthy subjects, the 4 recordings and the 3 changes from baseline (at weeks 4, 6 and 8) showed no significant differences. Comparison with vestibular patients, at baseline, showed consistent differences only on the area of sway. During the follow-up of the patients, the most frequent individual differences from baseline exceeding the limits of agreement were also observed on the area of sway (without vision). Although the majority of the individual changes were not large enough to exceed the limits of agreement, the analysis of variance on the follow-up evaluations showed significant differences among the 4 recordings on the area, the length, and the average speed of sway. CONCLUSIONS: In healthy subjects, intra-subject repeated recordings of static posturography may be reliable at intervals of 4, 6 and 8 weeks. The area of sway (without vision) could be useful to follow-up the static balance of patients with chronic, peripheral, vestibular disease.

P1-B-23 Mechanical modelling of vestibular hair cell's amplifying mechanism

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INTRODUCTION: Vestibular hair cell is the basic sensory unit of nature's inertia sensor. It has high sensitivity over broad dynamic range by combination of negative stiffness and adaptation mechanism.[1][2] To examine these biophysical mechanisms with a mechanical point of view[3], we developed a mechanical model of vestibular hair cell. We measure the system response and stiffness and observe similar characteristics with hair cell. This results help to better understanding of vestibular hair cell function. METHODS: A mechanical model of stereocilia on hair cell consists of two inverted pendulums that demonstrate a pair of adjacent stereocilia. To make negative stiffness which induced by a transduction channels' sudden opening, use pair of magnet which make repulsive force. Adaptation mechanism is mimicked by using stepping motor similar with molecular motor on stereocilia. Stiffness and temporal response was measured using force sensor and motion capture system. RESULTS: Similar results from physiological stereocilia were observed. Negative stiffness region was observed near the origin and this region was shifted as motor made magnet moving side-to-side. And the spontaneous oscillation which known to induced by the interplay of the negative stiffness and the adaptation of the stereocilia also observed. Parameter study of the model well demonstrated the role of each system component. CONCLUSIONS: Integration of adaptation and negative stiffness mechanism of hair cell was mechanically mimicked by two inverted pendulums and interacting moving magnet pair controlled by stepping motor and results is similar to the physiological measurement.

P1-B-24 The change between walking on different circular path size

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BACKGROUND AND AIM: Either walking on a straight line or circular path, integration of normal equilibrium function, space orientation and cognitive function are needed. Also, visual and vestibular inputs play important roles in a constantly varying 3 dimensional environment to perform a smooth locomotion. We have found in the previous study that smaller circular gait, compared with straight line gait, is more significantly different in the sense of stance, double support. However, is there any change when walking on a larger circular path when comparing with the smaller one? To understand physiologically, normal individuals were studied walking on a larger and a smaller circle with different radius (r=0.5 and 1m respectively) under eyes opened and blindfolded conditions by means of gait analysis using tactile sensors. METHODS: 16 normal individuals (8 males and 8 females, average age of 34.3 y.o., range from 26-54 y.o.) were enrolled and gait analysis using of tactile sensors installed under both feet were performed. Gait analysis using of tactile sensors installed under both feet is applied to compute the deviation range compared to normal subjects. Mean time length of stance, swing, double support and area ratio (the area ratio between the sole of foot and the trajectory of centre of force, TCOF) were analyzed as gait phase-related parameters. Comparison of means were made using the two-tails t-test, with $p<0.05$ as the criterion for statistical significant. RESULTS: Longer duration of stance and double support for both clock- and counter-clockwise circular gaits with radius 0.5m compared to that with radius 1m, under eyes opened or closed conditions were found. For the duration of swing phase, the innermost leg was longer than the outermost under both eyes-opened and blindfolded. On the other hand, significantly larger area ratio was revealed under blindfolded condition on both large and small circular path. CONCLUSIONS: When walking on a smaller circle, compared to on larger, greater input will be generated in the vestibular system that is closer to the centre of the circle in order to keep the body in balanced. This resulted a longer duration of stance, swing and double support phases. Smaller circular gait leads to more effort for the outermost leg to cross over forwardly and centripetally that causes the imbalance of the trunk. This may cause the irregularity of the TCOF that ended to have greater area ratio, although smaller circular gait generates vestibular input more efficiently than that in the larger one.

P1-B-25 Change in gait characteristics the first three months following acute unilateral vestibular neuritis

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BACKGROUND AND AIM: Postural control in standing is often regained 3 months following acute vestibular neuritis. Few studies report changes in gait. Allum and Adkin (2003) found similar lower trunk sway for a simple gait task three months following acute vestibular neuritis as to a matched control group. Wilhelmsen and co-workers (2010) found decreased upper trunk acceleration and increased difference between upper and lower trunk accelerations in persons with chronic vestibular disorders following an exercise period. The aim of this study is to assess changes in gait speed, cadence, step length and trunk accelerations and regularity the first 3 months following acute vestibular neuritis. We hypothesize improvements in all gait variables, and a larger decrease in the upper than lower trunk accelerations as an indication of improved head stability. METHODS: The study is a part of an ongoing randomised controlled trial. The first 13 persons undergoing comprehensive gait assessment (12 men and 1 woman, mean age 54.1 ±14 years) were included in the analyses. Gait was assessed the first week and 3 months following disease onset. Persons walked back and forth a 10 m walkway at preferred, slow and fast speeds. The middle 6.2 meters were measured. Two six degrees-of-freedom inertial sensors (MTx, XSens, Enchede, NL) were attached to the lower trunk and between the scapulas and accelerations in anterior-posterior (AP), mediolateral (ML) and vertical (V) directions measured. An in-house software, TRASK, was used to process data and calculate variables. Walking speed was measured by an electronic timing system synchronised with the accelerometers. Gait variables were compared at a normalised speed of 1.2 m/s across subjects. RESULTS: Preferred gait speed increased from 1.11±0.25 to 1.27±0.14 m/s ($p=0.01$). Regularity in trunk accelerations between steps increased in AP ($p=0.068$), ML ($p=0.017$) and V (0.036) directions, while cadence ($p=0.81$), step length ($p=0.96$) while upper trunk accelerations ($p=0.23$) or difference between trunk accelerations measured at the lower and the upper back did not change ($p>0.23$). CONCLUSION: Gait speed and regularity improved, while the other gait variables were unchanged, suggesting a compensation of gait three months following the onset of the

vestibular neuritis. Lack of change in the difference between accelerations in the lower and upper trunk may indicate that head stability is not regained.

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P1-B-26 Vestibular and somaesthetic graviception synthesis in the posterolateral thalamus responds to properties of internal model of verticality

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Internal models serve sensory processing, sensori-motor integration and motor control. They could be a way to construct and update a sense of verticality, by combining vestibular and somatosensory graviception. We tested this hypothesis by investigating self-orientation relative to gravity in 39 normal subjects and in subjects with various somatosensory loss showing either a complete deafferentation of trunk and lower limbs (14 paraplegic patients after complete traumatic spinal cord injury) or a gradient in the degree of a hemibody sensory loss (23 hemiplegic patients after stroke). We asked subjects to estimate, in the dark, the direction of the Earth vertical in two postural conditions: upright and lateral whole body tilts. For upright conditions, verticality estimates were not different from the direction of the Earth vertical in normal (0.24°±1; p=1.42) and paraplegic subjects (0.87°±0.9; p=0.14). The within-subject variability was much greater in hemiplegic than in normal subjects (2.05°±1.15 vs 1.06°±0.4; p<0.01), and greater in paraplegic than in normal subjects (1.13°±0.4 vs 0.72°±0.4; p<0.01). These findings indicate that, even if the vestibular graviception is intact, the somaesthetic graviception contributes to the sense of verticality, leading to a more robust judgment about the direction of verticality when vestibular and somaesthetic graviception yield congruent information. As expected, when normal subjects were tilted, their verticality estimates were biased in direction of the body tilt (5.55°±3.9). This normal modulation of verticality perception (Aubert effect), was preserved in hemiplegics on the side of the normoesthetic hemibody (ipsilesional) (6.09°±6.3), and abolished both in paraplegics (1.06°±2.5) and in hemiplegics (0.04°±6.7) on the side of hypoesthetic hemibody (contralesional). This incongruence did not exist in deafferented paraplegics who exclusively used vestibular graviception with a similar efficacy no matter what lateral body position. The Aubert effect was not an on-off phenomenon since the degree of hemiplegics' somatosensory loss correlated with the modulation of verticality perception when they were tilted to the side of hypoesthetic hemibody (r=-0.55; p<0.01). The analysis of anatomical correlates showed that the Aubert effect required the integrity of the posterolateral thalamus. This study reveals the existence of a synthesis of vestibular and somaesthetic graviception for which the posterolateral thalamus plays a major role. This corresponds to a primary property of internal models and yields the neural bases of the Aubert effect. We conclude that humans construct and update internal models of verticality in which somatosensory information plays an important role.

P1-B-27 Aging of the postural vertical

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A postural vertical (PV) tilted backward has been put forward as a reason explaining the backward disequilibrium often observed in elderly fallers. This raises the question of a possible ageing process of the PV involving a backward tilt of verticality perception increasing with age. We have explored this hypothesis by measuring PV in pitch using the wheel paradigm in 87 healthy subjects aged from 20 to 97 years. The possibility that this physiological ageing accelerated in the second part of life was also analysed. Two indices were calculated: the mean orientation (PV-orient) and the dispersion (PV-uncert). The correlation between age and PV-orient was $r = -0.2$ ($p < 0.05$). Added to the fact that PV was twice as shifted backward in the 38 seniors over 50 years (-1.15 degrees +/- 1.40 degrees) as in the 49 young adults under 50 years (-0.45 degrees +/- 0.97 degrees ; $t = 2.75$, $p < 0.01$), this indicates the existence of a physiological ageing process on the direction perceived as vertical by the whole body, with a slight backward shift of PV throughout the life span. The correlation between age and PV-uncert was $r = 0.35$ ($p < 0.001$) in all subjects and $r = 0.59$ ($p < 0.001$) in seniors. This indicates that subjects get less and less accurate in their perception of the postural vertical with age, especially very old subjects who show great uncertainty in determining with their body the direction of the vertical. Taken together, these findings indicate that the internal model of verticality is less robust in elderly people. This may play a part in their postural decline.

P1-B-28 Postural response to unexpected changes - the effect of vestibular compensation

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BACKGROUND AND AIM OF THE STUDY: After a peripheral vestibulopathy residual chronic instability is one of the most disabling sequela. The evolution to a balanced situation varies from one patient to another. The factors upon which a vestibular compensation is adequate to allow the patient to perform an appropriate postural response to unexpected support-surface movements still being clearly unknown. The aim of this study was to determine the characteristics of postural responses to unexpected changes in the support-surface on patients with different degrees of unilateral peripheral vestibular deficit and to analyse the differences in these responses between patients achieving a clinical compensated status and those without. The other objective of this study was to figure out which is the best clinical data to predict the vestibular compensation status of a patient with vestibular deficits. METHODS: We studied 27 patients (16 men and 11 women) with a mean age of 57.7 years (31-89) with unilateral peripheral vestibular deficits secondary to: vestibular neuritis (15 patients), Meniere's disease (6 patients), neurinoma (2 patients), trauma (2 patients) and benign recurrent vertigo (2 patients) Neurocom equipment was used to create unexpected support-surface movements and the Sway Star system to measure the angle and the angular velocity of the body during the stimulus. Both systems were connected by a trigger to determine exactly the beginning and end of the stimulus. Patient stood on a support surface platform and unexpectedly received a series of 3 short and 3 long pulses in the forward and backward direction with eyes open and eyes closed. They also received 5 toes up and 5 toes down pulses with eyes open and eyes closed. The variables studied were the range of peak to peak excursion in pitch and roll directions, the area of the displacement angle, the range of peak to peak velocity excursion in pitch and roll directions and the mean path velocity. RESULTS: Wen using the rotatory test results to classify the patients as compensated or not compensated, there were two groups of 9 and 18 patients each. We have found significant differences of the body angle in the roll direction although all the stimuli were made in the pitch direction. However, wen using the caloric test, the cardiovascular risk or the patient's clinical course to classify the groups, no differences were found. CONCLUSIONS: The rotatory test is the best diagnostic method to predict vestibular compensation status of patients with vestibular deficits. Patients who suffer vestibular deficit with an uncompensated status, have more difficulties to give an appropriate postural response in the roll direction to unexpected support-surface movements

P1-B-29 Persistent vertigo in a patient at the fall clinic: Keep bppv in mind!

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INTRODUCTION: Vertigo is a common problem in elderly patients presenting at a fall clinic. Diagnostics may be difficult, because of multiple potential causes of vertigo. We describe the case of a man with recurrent falling because of syncope and vertigo starting after a head trauma. METHODS AND MATERIALS: Case report: 78-year old man who fell more than 30 times in the previous year because of syncope and vertigo. Head rotation (particularly to the left), hyperextension of the neck, turning to the left side when lying in bed, bending over and coming upright provoked short attacks of vertigo. Attacks started a few seconds after moving the head, continued for less than 1 minute and were most prominent in the morning. No explanation for this vertigo was found during neurological examination. Orthostatic hypotension and possible hypersensitivity of the carotid sinus were determined. After discontinuing solifenacin, chlortalidone and non-pharmacological measures to prevent disorders in blood pressure regulation, syncope disappeared but vertigo with incidental falling continued. Therefore, additional diagnostic tests were performed. RESULTS: A holter registration occasionally showed bradycardia during daytime, however no association with vertigo could be demonstrated. Massage of the carotid sinus caused a significant fall in blood pressure confirming hypersensitivity of the carotid sinus, however asymptomatic. Finally, a Dix-Hallpike manoeuvre provoked symptomatic vertigo with nystagmus, suggesting benign paroxysmal positional vertigo (BPPV). An Epley manoeuvre was performed after which vertigo improved and no more falls occurred. CONCLUSION: In this patient, disorders in blood pressure regulation and BPPV both contributed to vertigo. BPPV should be considered when key symptoms and signs are present (short attacks, latency time, diurnal variation, nystagmus), particularly when a there is a history of head trauma. The Epley manoeuvre is an easy and effective method to treat patients with BPPV.

P1-B-30 Correlation dimension (Dk) estimates identify differences in nonlinear head dynamics of healthy subjects and bilateral vestibular loss (BVL) patients

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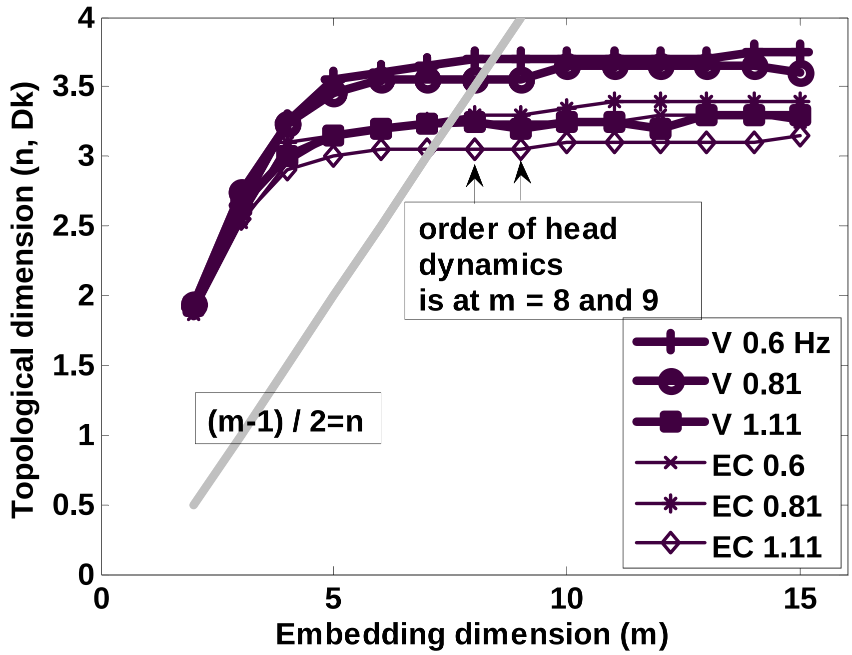
BACKGROUND AND AIM: It has been shown that head stabilizing responses to small amplitude perturbations in healthy subjects demonstrate nonlinear dynamical behavior that may be indicative of the shifts between different control strategies. The head can be stabilized to either a stable ground frame of reference or to the moving platform frame of reference. These two control strategies are dependent on both the frequency and magnitude of the available sensory information. We hypothesized in this study that the control strategy selected to stabilize the head will change the order and the complexity of the head dynamics. Dk estimates of the head kinematics were computed through the data collected from healthy and BVL subjects. Dk estimates give information about the nonlinear characteristics (topological) of the dynamics as well as the kinematic degrees of freedom used in the control of the posture. METHODS: Four healthy and four BVL adults, seated on a sled with their trunk fixed to the seat, received randomized 180-sec sinusoidal a-p perturbations at 0.6, 0.81 and 1.11 Hz. Peak displacement was 114 mm. Subjects either kept the head still with eyes closed (EC) or aligned a head-fixed laser with an earth fixed horizontal line (V). Head angular displacement (HAD) and angular velocity (HAV) was measured. The nonlinear analysis consisted of computing the Dk estimates from HAD signals by using the method of time delays (T). The optimum T for expanding the reconstruction of the attractor has been found by using the average displacement method. RESULTS: An ANOVA performed on RMS of HAD and HAV showed that BVL subjects were not different from healthy subjects at all frequencies and conditions. Dk estimates computed for all subjects were between 3 and 4 pointing to a complex dynamics with a fractal structure, which has a higher order of dynamics than a double-inverted pendulum [Figure 1]. A 3-way ANOVA test was performed on Dk estimates of healthy and BVL subjects separately across subjects, frequencies, and conditions. Dk estimates of healthy or BVL subjects were similar with respect to the frequencies. BVL subjects showed significant inter-subject differences ($p<0.0005$). Order of the head dynamics were similar in the healthy subjects ($p>0.05$) but were significantly different in BVL subjects with regard to the visual conditions ($p<0.0000$). CONCLUSIONS: Although linear metrics did not reveal differences between the head kinematics of healthy and BVL subjects, nonlinear metrics demonstrated differences between the BVL subjects across the eyes open and closed conditions. BVL subjects demonstrated a lower order dynamics with a less complex structure when eyes are closed, which may be pointing to a co-contraction strategy generated through the the somatosensory system (platform fixed strategy). Correlation dimension estimates are a more sensitive measure than linear measures for differentiating small differences in complex systems.



P1-B-31 What kind of abnormal gait performance is caused by acoustic neuroma?

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INTRODUCTION: Peripheral vestibular lesion should cause gait abnormality in addition to nystagmus, postural abnormality, abnormal special orientation, and decreased mental function. In previous study, we have reported that this gait abnormality is shown by increment of coefficient of variation of gait phase related variables, irregularity of trajectories of center of force and so on by the use of tactile sensor. Our next concern is what kind of additional abnormal gait performance is to be detected by three dimensional whole body gait performance analysis in those cases. MATERIALS AND METHODS: Seventeen acoustic neuroma patients (seven males and ten females with an age of 64.1±11.1) were enrolled for the present study. Seven age and height matched healthy subjects served as a control. Fifteen markers were placed from subject's head to feet, and subjects were asked to walk straight freely at a distance of about four meters with eyes open or closed. Variables are gait shift, head movement, walking speed, stride length, stride duration, % stance phase, forefoot motion, and foot flexion angle. RESULTS: In AT group, greater walking shift, lesser foot flexion angle and shorter stride were shown. In addition to those changes, pitch and roll movement became greater under gait with eyes closed. No significant change was found in toe clearance, highest position of foot and head movement in yaw plane. CONCLUSION: Thus by 3-D gait analysis, it has been shown that acoustic neuroma does affect gait performance, although mild. These changes could reflect vestibulo-spinal abnormality caused by the tumor.

P1-B-32 QOL in recovery from vestibular neuronitis and comparison with body balance function

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In the stabilometry test for vestibular neuronitis, the total locus length and sway area decrease over time. In this study, we examined the severity of subjective symptoms and semicircular canal paralysis, and evaluated the relationship between recovery and the shift in the center of gravity. The subjects were 49 patients who were hospitalized for vestibular neuronitis. The subjects included 28 men and 21 women, and had an average age of 50.5 years old. A stabilometry test was performed periodically in the standing position from the early stage of development of symptoms, at which time an examination showed gaze nystagmus. The perimeter area was used for analysis with the eyes closed. The period from onset of symptoms until the patient had no problems in everyday life (the recovery period) was classified as less than one month, one to three months, and three months or more. This period was frequently three months or more in female subjects, but less than one month in many males; and did not differ among age groups. The recovery period was three months or more in half of patients with loss of semicircular canal function, but less than one month in half of patients with functional fall. The period did not differ in patients with forward right side and left side neuritis. However, based on the sway area, left side vestibular neuritis improved earlier than right side vestibular neuritis. There was no clear relationship between the recovery period and the sway area, and changes in the sway area were not dependent on semicircular canal function at the time of the first examination. The subjective symptoms improved regardless of persistent loss of semicircular canal function, but the change was not reflected by improvement of the sway area. Moreover, changes in symptoms were not in agreement with improvement in the stabilometry test, which is a static examination. These results suggest that development of the compensatory function of unusual posture in recovery from vestibular neuronitis does not depend on semicircular canal function, and that static examination of balance does not adequately explain recovery of QOL. Therefore, examination of dynamic body balance and its association with function are required in a future study.

P1-B-33 The effects of visual stimulation on visual dependency measures in patients with visual vertigo

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BACKGROUND: Patients with a vestibular disorder may develop an over-reliance on visual cues for balance, i.e. visually dependence, which leads to an exacerbation of symptoms when in busy, dynamic visual environments. Customised vestibular rehabilitation incorporating exposure to optokinetic stimulation (OKS) has been shown to improve subjective visually-induced dizziness. However, whether OKS exposure induces a reduction in visual dependency in this patient group is unknown. The purpose of this study is to examine the effects of customised vestibular rehabilitation incorporating OKS on visual

dependency measures in patients with visually-induced dizziness. Moreover, an intensive treatment programme, which showed improvements in visual dependency in healthy adults was performed to investigate whether it could be tolerated by patients. METHODS: Twelve patients with a peripheral vestibular disorder and visually-induced dizziness were randomly allocated into either Group C who received customised vestibular rehabilitation in isolation or Group OKS which combined customised vestibular exercises with exposure to optokinetic stimulation. Both groups attended treatment sessions for five consecutive days and were then provided with a progressive customised home rehabilitation program. Response to the treatment was assessed at baseline (Day 1), at the end of the five-day treatment, and at both four-week and eight-week follow up. Assessment included tests for visual dependency (rod-and-disc test and visual roll-motion posturography) and the Functional Gait Assessment (FGA) to assess the patient's ability to perform complex gait tasks (i.e. walking with eyes closed). Subjective questionnaires concerning symptoms, symptom-triggers, perceived handicap from symptoms, and psychological state, were also used to evaluate treatment outcome. RESULTS: Both groups showed significant improvements for depression, and perceived handicap scores post-treatment ($p<0.05$). FGA scores significantly improved for both groups ($p<0.05$). Results showed significant reductions (i.e. improvements) in subjective vertical tilt with the rod-and-disc test for the OKS group only ($p<0.05$) indicating reduced visual dependency. Drop out rates were, group C = 2; group OKS = 3 subjects. CONCLUSIONS: Although customise exercises in isolation provide improvements for subjective symptoms and functional gait, only customised vestibular rehabilitation incorporating OKS exposure provides improvements in visual dependency. Furthermore, five-day intensive OKS exposure appears to be moderately well tolerated by patients with visual vertigo and can be considered as an alternative form of treatment provision.

C - Orthopedic Diseases and Injuries

P1-C-34 Relationship between knee joint angles and muscles during landing from one rotation jump

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BACKGROUND AND AIM: Anterior cruciate ligament (ACL) injury is a common and traumatic knee injury. The female athlete has more a risk of the ACL injury. A majority of these injuries are non-contact, many of which occur in response to a cutting maneuver or during an uncontrolled landing from a jump. Therefore, appropriate alignment maintenance during landing from a jump appears pertinent to reducing knee valgus load. Most studies have reported landing from a vertical jump or a drop jump but few studies have reported landing from a rotation jump. The purpose of this study was to analyze knee joint movement which was focused activation of muscles and range of motion during landing from one rotation jump. METHODS: The subject was eleven healthy female university students (mean age; 19.8 ± 1.0 years, weight; 50.2 ± 2.6 kg, tall; 157.1 ± 3.9 cm). The subject was to jump one right-handed rotation. The subject was instructed to fold their arms across their chest, to land as naturally as possible with both feet on the landing platform and to keep about 2 seconds with landing posture. The

electromyography (EMG) signals of the following muscles were determined simultaneously on the left leg of all individuals: the vastus medialis (VM), the vastus lateralis (VL), the semimembranosus (SM) and biceps femoris (BF). EMG activity was captured by an EMG system (SX230; Biometrics Ltd. UK). The sampling frequency of the EMG was 2000Hz. For this subject, the three dimensional (3D) lower limb kinematic data were recorded for the both leg during landing from one rotation jump (MA8000; ANIMA Corp. Japan). These data were measured the knee joint angles. The sampling frequency of the 3D was 125Hz. We used the data of 0.2 second intervals from initial contact. RESULTS: A significant negative correlation was found between the valgus knee angle and the flexion knee angle ($r = -0.678$, $p = 0.022$). A significant positive correlation was found between the flexion knee angle and the activities of the VM ($r = 0.619$, $p = 0.042$). Others were found non-significant correlation. CONCLUSIONS: This subject was one rotation jump but the relationship between valgus and flexion was showed the same results that were reported landing from a vertical jump or a drop jump. The greater knee flexion increased the activation of VM. Therefore, the activation of VM at the greater knee flexion positions leads to internal rotation against the femur as for the tibia and is suggested to prevent the greater knee valgus positions. However, this subject had not reported a significant correlation between the knee angle and the activity of hamstrings. We will report the timing of the activity of hamstrings.

P1-C-35 Gait asymmetry after lateral and posterolateral approaches for total hip arthroplasty

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BACKGROUND: In Norway, the most common approach in total hip arthroplasty is the lateral approach, where the gluteus medius muscle is detached from its insertion, and then re-fixated. Also common is the posterolateral approach, where the piriformis and gemelli muscles are detached and reinserted. Theoretically, the lateral approach and subsequent gluteal weakness could lead to Trendelenburg gait, whereas the posterolateral approach could increase the risk of dislocation. A Cochrane review from 2008 concluded that existing studies did not provide sufficient evidence to make any firm conclusion on which approach was better. Few studies have investigated the differences between the lateral and posterolateral approach using kinematic gait variables. Our aim was to investigate the eventual differences in trunk asymmetry in gait after total hip replacement with lateral or posterolateral approaches. METHOD: As part of a larger randomised controlled trial, a sample of patients was tested before and 3 months after total hip replacement. Testing procedures included walking 7 meters overground at three different walking speeds wearing a kinematic sensor attached over the lumbar area. The sensor registers movement in vertical, medio-lateral and antero-posterior directions. Trunk asymmetry was examined by calculating the difference between stride regularity and step regularity, where a low score indicates low asymmetry. All calculations were performed at the same walking speed. RESULTS: 8 patients were randomised to surgery with a lateral approach (63 percent women, mean age 68 (SD 6)), and 8 patients were randomised to posterolateral approach (38 percent women, mean age 72 (SD 4)). The participants in the posterolateral approach group showed tendencies for reduced trunk asymmetry at 3 months, whereas the participants in the lateral approach group showed tendencies for increased trunk asymmetry. Only anteroposterior trunk asymmetry was significantly different ($p=0.04$).

DISCUSSION: Due to the small sample size, our results should be interpreted with caution. It appears, however, that there is a difference with regards to antero-posterior trunk asymmetry. This suggests that trunk asymmetry does not manifest itself as Trendelenburg gait for these patients, which would be recognized as medio-lateral trunk asymmetry. Instead, difference in trunk asymmetry is present in the direction of propulsion, possibly suggesting that initial gluteal weakness was not a predominant problem for these patients. CONCLUSION: With regards to trunk asymmetry, the total hip arthroplasty patients in our study seemed to benefit most from the posterolateral approach.

P1-C-36 The effect of orthotic design and the number of heel-wedges on in-shoe plantar pressures during walking: Implications for Achilles tendon rupture rehabilitation.

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BACKGROUND AND AIMS: Rupture of the Achilles tendon it is a common and debilitating injury, which is increasing in incidence. Traditionally, this injury is managed without weight bearing. However, recent advances have led to the development of immediate weight bearing rehabilitation protocols [1]. These protocols use a range of orthotic designs and a variable numbers of heel-wedge inserts. Currently, there is no literature directly comparing the different rehabilitation methods. The primary aim of this investigation was to evaluate plantar pressure measurements and temporal gait parameters, under different pre-defined conditions, within healthy participants. The secondary aim was to draw inferences from this data regarding the treatment of Achilles tendon rupture. METHODS: Fifteen participants with no lower limb pathology were evaluated. Each participant walked along a pre-marked, six-metre walk-way at normal speed. Pressure data was obtained using in-shoe pressure inserts, with an F-Scan system. Range of ankle movement was also collected using an electrogoniometer. Three orthotic designs were evaluated, containing three, two, one and no heel wedge inserts. The sequence of trials was randomised for each participant. Five cycles were recorded. Since the Achilles tendon connects the gastrocnemius and soleus muscles to the calcaneus to permit transmission of plantarflexion torque, data analysis was focused upon forefoot and heel pressure production, as a percentage of the contralateral limb [2]; the foot areas were defined as the distal 40% and proximal 30% respectively. In addition, the duration of terminal stance and pre-swing phases as a proportion of the total stance component were analysed. Analysis was performed using a two-way analysis of variance to determine the independent effects of the orthotic design and the number of heel-wedge inserts, and the interaction between these two factors. RESULTS: Statistical analysis demonstrated that the type of orthotic design and the number of heel wedge inserts has a significant effect on all measured parameters. Rocker-bottom styled orthotics combined with a higher number of heel-wedge inserts, reduced forefoot pressures, increased heel pressures and decreased the amount of time spent in the terminal stance and pre-swing phase of the gait cycle ($p<0.05$). These findings were in contrast to the in-shoe carbon fibre orthotic design. Each of these parameters were also significantly correlated ($p <0.05$). CONCLUSIONS: The purpose of an orthotic for patients with a rupture of the Achilles tendon is to facilitate weight bearing but within a protected range of movement. However, the findings of this study suggest that the balance between protected weight bearing and functional loading require further research within a clinical context.

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P1-C-37 Correlation of foot and ankle ability measure with balance performance in ankle sprain patients

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BACKGROUND AND AIM: Ankle sprain is the most common sport related injury. The rehabilitation of ankle sprains aims to regain good physical function so as to guarantee the ability to handle daily life activities and sport related actions. Balance training has been shown to decrease the risk of ankle instability and ankle sprain recurrence (McGuine 2000). However, it is still unclear if a good balance performance in patients after an ankle sprain goes also along with a good physical function. Additionally it should be investigated if anteroposterior (AP) and/or mediolateral (ML) balance control are necessary for a good physical function. The present study aims to identify the relationship between physical function and balance performance. The specific objective was to assess which balance parameter correlates best with a clinical measure using the Foot and Ankle Ability Measure (FAAM) questionnaire. METHODS: Twenty-seven patients with an ankle sprain were included after having been 4 weeks in an air cast. All patients filled in the FAAM questionnaire, a self-reported questionnaire, which consists of an activity of daily living (ADL) related and a sports related subscale. Furthermore, patients balance performance in a stable and unstable (Airex mat 6 cm) condition has been assessed by the mean of an AMTI force plate. Subjects performed 6 trials of quiet standing in single-leg stance on the injured limb, (3 stable, 3 unstable conditions). The center of pressure (COP) excursion in ML and AP directions, and its speed were calculated. Correlation between balance parameters and FAAM subscales were calculated using Spearmans rho. RESULTS: COP displacement in AP direction was negatively correlated to the FAAM sport-subscale for both, the stable and unstable conditions (R=-0.45, p=0.02; R=-0.41, p=0.03 respectively). No significant correlation was found between COP displacement in AP direction and FAAM ADL subscale. COP displacement in ML direction was not correlated with the FAAM subscales. COP speed recorded in a stable condition was correlated with the ADL subscale (R=-0.45, p=0.02) and the sport subscale (R=-0.50, p=0.01). For the unstable conditions, no significant correlation was found between speed and FAAM subscales (Table 1). CONCLUSIONS: Good balance control in AP direction is related to individual's sport related functional level. However, a good AP control does not go along with the self reported capacity to handle ADL and a good ML balance control does not mean that ankle sprain patients report a good physical function. Only COP speed is related to both FAAM subscales, at least when assessed in a stable condition. Larger COP oscillations per unit of time in a stable condition (and therefore a patient who is less stable) go along with less physical function. These results indicate that COP speed is more related to physical function than ML or AP COP excursion and thus deserves further attention while assessing the effect of treatment strategies.

Table 1: Correlations between the FAAM subscales (ADL and sport) and the COP excursion in **A)** ML and **B)** AP directions, and its **C)** speed. Balance was measured in a stable and unstable (Airex mat) for both the injured and non injured ankle. R indicates Spearmans rho, *P* indicates *P*–values.

A

	ML – non injured	ML - injured	Airex mat ML – non injured	Airex mat ML - injured
FAAM ADL	R=-0.246 *P*=0.22	R=-0.088 *P*=0.66	R=0.167 *P*=0.40	R=0.188 *P*=0.35
FAAM sport	R=-0.116 *P*=0.56	R=0.007 *P*=0.97	R=0.227 *P*=0.26	R=0.262 *P*=0.19

B

	AP – non injured	AP - injured	Airex mat AP – non injured	Airex mat AP - injured
FAAM ADL	R=-0.101 *P*=0.62	R=-0.281 *P*=0.16	R=-0.190 *P*=0.34	R=-0.374 *P*=0.06
FAAM sport	R=-0.058 *P*=0.77	R=-0.448 *P*=0.02	R=-0.306 *P*=0.12	R=-0.409 *P*=0.03

C

	speed – non injured	speed - injured	Airex mat speed – non injured	Airex mat speed - injured
FAAM ADL	R=-0.200 *P*=0.32	R=-0.446 *P*=0.02	R=0.088 *P*=0.67	R=-0.204 *P*=0.31
FAAM sport	R=-0.162 *P*=0.42	R=-0.504 *P*=0.01	R=0.080 *P*=0.69	R=-0.186 *P*=0.35

P1-C-38 Assessing gait adaptability in people with a unilateral amputation on a treadmill with visual context

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BACKGROUND AND AIM: Gait adaptability, including the ability to avoid obstacles and to make visually guided steps, is essential to move safely through our cluttered world. This aspect of walking ability is important for regaining independent mobility, but difficult to assess in clinical practice. The aim of this study was to investigate face and construct validity of an instrumented treadmill with visual context to assess prosthetic gait adaptability. METHODS: A control group of able-bodied people (CO, N=12) and a convenience sample of people with a trans-tibial (TT, N=12) and trans-femoral (TF, N=12) amputation participated. Participants walked at self-selected speed on an instrumented treadmill with visual context (ForceLink, Culemborg) to evaluate their gait adaptability in terms of anticipatory and reactive obstacle avoidance performance (obstacles presented four steps and one step ahead, respectively; Figure 1A,B) and stepping accuracy to regular and irregular patterns of visual stepping stones (Figure 1C). In addition, several clinical tests were administered, including timed walking tests and fall-incidence and fear-of-falling reports. RESULTS: Obstacle avoidance performance and stepping accuracy were significantly lower in TT and TF groups compared to the CO group (face validity). Anticipatory obstacle avoidance performance was moderately correlated to timed walking tests scores (construct validity). Reactive obstacle avoidance and stepping accuracy performance were unrelated to timed walking tests. Gait adaptability scores did not differ between groups stratified for fall incidence or fear of falling. CONCLUSIONS: Gait adaptability can be validly assessed using an instrumented treadmill with visual

context, even though self-selected treadmill walking speeds differed significantly between the three examined groups, which may have diminished between-group differences in gait adaptability. Moderate correlations with clinical tests imply that this assessment provides unique, objective information about walking ability in people with lower-limb amputation.

Figure 1. Gait adaptability assessments on a treadmill with visual context

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P1-C-39 Peak knee flexion angles during stair descent for TKA patients

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BACKGROUND AND AIM: Individuals with total knee arthroplasty (TKA) are found to descend stairs with less peak flexion in the operated knee (88°) than in the contra lateral knee and compared to healthy subjects` knees (100°). The TKA allows an average passive flexion of 102°, leaving a 14° margin that would admit normal knee flexion during stair descent. Where previous studies mainly have focused on characterizing kinematics during stair gait, it remains unexplained why there is a significant difference in knee flexion between TKA group and control group. Although there is evidence of reduced strength, reduced passive range of motion (PROM), different joint mechanics, fear of movement, and the effect of these factors on peak knee flexion during stair descent (PKFSD) have not been directly investigated. From a clinical point of view, a better understanding of what lies behind reduced PKFSD in individuals with TKA would prove resourceful. The aim of this study was to find if factors mentioned above contribute to explain expected reduced PKFSD. METHODS: We compared PKFSD in 23 individuals with unilateral TKA and 23 healthy controls less than 65 (36-65) years of age. TKA group was ranging post-operatively from 10-30 months after the surgery. Subjects walked 6 times up and down a three-step custom made module without hand rails. Whole body kinematics was captured with an eight camera system (Qualisys©) compiled into 3D (Qualisys Track Manager) and analyzed for knee flexion angles (Visual 3D, C-Motion). PROM was registered with the camera system, pain was assessed by a 0-10 numerical rating scale. Tampa scale of kinesiophobia (TSK) was utilized to quantify fear of movement. KT1000TM was used to assess anterior knee joint laxity (AKL). Biodex© was used to quantify isokinetic concentric quadriceps strength at 60 °/sec., where highest peak force was recorded. RESULTS: The TKA group demonstrated a reduced PKFSD compared to their healthy knee and the control group. The healthy knee exhibited a reduced PKFSD compared to the control group. A multiple regression analysis showed that PROM and number of months post-operatively contributed significantly to explain the relationship with PKFDS, whereas factors as strength, TSK, pain, and AKL showed no relationship. CONCLUSIONS: As for strength we reasoned that not enough force was utilized during stair descent to provoke any differences despite the significant difference in the isokinetic test. A low score on TSK and pain might explain the absence of relationship with these items. As AKL was not significantly different between the legs within in the TKA group nor between the groups it delivers no contribution in this regard. As to the relationship between number of months post-operative and PKFSD, it could be assumed that a longer exposure to ADL give higher PKFSD. PROM also contributes significantly to explain the relationship with PKFSD, which we suggest relates somehow to the available knee excursion.

P1-C-40 Quantitative assessment of ACL reconstructive surgery in adolescents on 3D knee kinematic data

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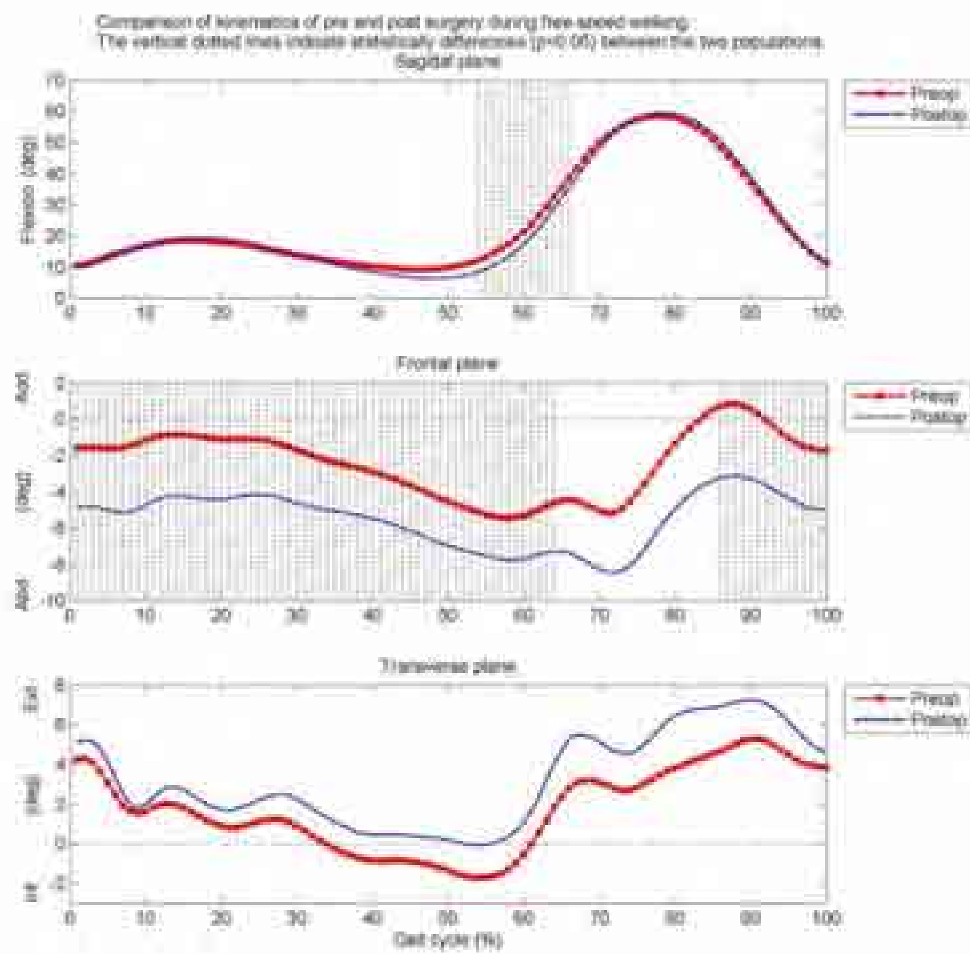
BACKGROUND: The incidence of anterior cruciate ligament (ACL) injuries in adolescents has increased in the past decade. ACL reconstructive surgery can restore knee stability and reduce the risk of secondary injuries, however it continues to be controversial and little is known on the impact of the treatment on knee function.The study of knee joint movement patterns concerning the impact of ACL surgical treatment in adolescents has not previously been studied in the literature. OBJECTIVE: Prospective assessment of ACL reconstructive surgery in adolescents (pre and post-operation) on three-dimensional (3D) kinematics of the knee joint during walking. METHODS: 3D knee kinematics (flexion/extension, abduction/adduction and internal/external rotation) was measured in 25 adolescent participants (16.2 years old ±1.4) with an ACL deficiency pre and 6 months post-reconstructive surgery during walking. Each participant underwent ACL reconstruction (using hamstring tendon graft). Kinematic data were recorded using the KneeKG system (Emovi inc.) during treadmill walking at self-selected comfortable speed. Repeated measures of ANOVA were used to compare pre-operated ACL with post-operated ACL during the entire gait cycle (1-100% of the gait cycle (GC)). Additional analysis was performed to test whether group mean sub-phases (loading, mid-stance, terminal stance, push-off and swing phase) statistically differ between the two groups. RESULTS: Group mean gait sub-phases comparisons in sagittal plane revealed decreased flexion for post-operated versus pre-operated ACL during mid-stance (10-30% GC) ($p<0.001$) and toe-off (50-60%GC) ($p<0.05$). Mean frontal plane for post-operated ACL displayed significant shift ($p<0.01$) towards higher knee abduction throughout entire gait cycle in comparison to pre-operated ACL. Mean transverse plane showed significant shift ($p<0.01$) towards external rotation for the post-operated ACL compared to pre-operated ACL during the entire gait except the loading phase (1-10%GC). Point-by-point analysis of knee kinematics of participants post-operation in sagittal plane reveals reduced knee flexion during push off and early swing phase of the gait cycle (as shown in figure). In the frontal plane, analysis showed significant shift towards higher knee abduction (valgus) post-operation almost throughout the gait cycle (shown in figure). Transverse plane analysis

showed no differences between the two groups (shown in figure). SIGNIFICANCE: Our findings demonstrate that 3D knee biomechanical assessment is sensitive enough to detect changes in the function of the knee joint post ACL reconstructive surgery in adolescents. Identified alteration can be explained by different aspect of the surgical treatment. Future work will focus on assessing a match control group to better understand the impact of the surgery on 3D knee kinematics and seek improvement in surgical techniques and rehabilitation.



P1-C-41 A probabilistic approach to identify worker vulnerability to knee osteoarthritis development

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PURPOSE: Biomechanical gait analysis provides information on knee functions and can offer an opportunity to monitor joint biomechanics variations to prevent irreversible damage to the joint. This study investigates a probabilistic analysis of biomechanical data to assess the vulnerability of knee osteoarthritis (OA) of workers exposed to physically demanding occupations. METHODS: Three groups of participants took part in this study. One group is knee overloaded workers (OW) composed of 24 healthy active workers (19 men and 5 women) with no diagnosis for knee OA but were exposed to occupational knee overloading. The second group is control group, composed of 25 asymptomatic (AS) subjects (12 men and 13 women, all workers unexposed to overloaded work). Finally, knee OA group contains 29 knee OA patients (7 men and 22 women). 3D knee kinematics data on the frontal, sagittal and transverse planes were recorded from each participant walking on a conventional treadmill at a self-selected comfortable speed. A knee marker attachment system, KneeKG , was installed on the participant's knee to record the 3D kinematics during two trials of 25 sec. The kinematic data were normalized for each subject, and the mean pattern was used as a representative gait cycle (for each subject) for the purpose of classification. We used Bayes classification theory to investigate whether overloaded workers are prone to developing knee OA by comparing their kinematic data to that of knee OA patients and AS subjects. The analysis considered the data from each plane, i.e., the gait angles from the frontal, sagittal, and transverse planes. RESULTS: The table displays the Bayes classification into AS and OA classes for each of the three biomechanical planes. The most discriminant data is from the frontal plane (abduction/adduction angle) in which the 24 OW subjects, 22 had biomechanical knee patterns similar to OA and only 2 similar to AS. The other planes do not produce conclusive results. CONCLUSION: By Bayes risk analysis it can be concluded that OW frontal plane knee kinematic data is similar to the OA patients. This suggests that knee OW might be vulnerable to knee OA development.

	AS class	Knee OA class
Flexion/extension	17	7
Abduction/Adduction	2	22
Internal/External Rotation	13	11

Table: Classification of the three planes kinematic data: Frontal (abduction/adduction), sagittal (flexion/extension) and transverse (internal/external rotation): Number of workers that are similar to the Asymptomatic (AS) class versus the number of workers that are similar to the knee OA class.

P1-C-42 Step time asymmetry when descending stairs 3 months after anterior cruciate ligament reconstruction

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BACKGROUND AND AIM: There is ample evidence that strength and functional abilities may decrease after anterior cruciate ligament (ACL-) rupture and after reconstructive surgery. Persons with a reconstructed ACL commonly report difficulties in descending stairs and steep hills during the first months of post operative rehabilitation. These difficulties are probably caused by a combination of decreased muscle strength, pain, and swelling of the knee. Decreased muscle strength may lead to difficulties in "holding back" when lowering down the non-operated leg. Difficulties in holding back together with possible discomfort or pain may result in shorter step time when the operated leg is the stance leg. In this study, we investigate step time differences in ACL reconstructed persons when descending stairs. METHODS: Persons meeting for a 3-month check-up after ACL reconstruction were recruited to walk down a flight of stairs (11 steps) 4 times; twice at preferred speed and twice at slow speed, the latter to accentuate any difficulties in descending stairs. Vertical velocity was measured with a triaxial kinematic sensor fixed to the lumbosacral area. Step times (heel strike to heel strike) were calculated by an in-house program (TRASK) utilizing change in vertical velocity to identify foot strikes, and change in mediolateral position to separate left and right foot strikes. Paired sampled t-tests were used to analyse differences between step time of the injured and uninjured leg. RESULTS: 13 persons participated (5 woman, 8 men) (mean age 25, SD 9.01). At preferred speed there was a mean difference of -0.03 seconds between step times of the operated leg and the non-operated leg (95%CI -0.05 - -0.01, p=0.005). At slow speed the mean difference was -0.13 seconds (95%CI -0.20 - -0.06, p=0.001). CONCLUSIONS: It appears that ACL reconstructed persons tend to have shorter step times on the operated leg when descending stairs, 3 months after surgery. This supports the existing evidence that strength and function are affected after ACL surgery. Measuring step times during stair descent may be a feasible and sensitive measure in early rehabilitation after ACL surgery, as it is less strenuous than for example hop tests and isokinetic strength testing, and as such may lend itself as a functional outcome measure during the first months after surgery.

D - Cognitive, Attentional and Emotional Influences

P1-D-43 Effects of divided attention on stair descent mobility for older adults

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BACKGROUND AND AIM: Staircases are encountered frequently daily, but are also a leading cause of falls and trauma (especially during descent) for older adults. Descending stairs requires good mobility including cognitive ability in order to attend to and process sensory information and plan the descent. Using dual task paradigms, it has been established that gait by itself requires attention and general executive functioning, but little is understood about dual task costs (particularly visual interference) during stair descent for healthy younger and older adults. The objective of this study was to address the cognitive factors of planning and visual attention by using a dual task protocol during the approach, transition and steady state periods of stair descent in younger and older individuals. METHODS: Sixteen younger (24.9 ± 3.8 years) and 16 older (70.3 ± 5.9 years) adults descended a five step staircase at their self-selected speeds. Conditions included no visual stimulus, or a simultaneous visual Stroop task

presented on screens at the bottom of the staircase during descent at: initiation of approach; contact at the top of the staircase in preparation for descent (transition); contact on the second step down (steady state). Trials were randomised. We measured forward trunk centre of mass velocity, minimum clearance over all step edges (three Optotrak 3020 motion sensors), and Dual Task Cost (DTC) as the difference between response times to visual Stroop during stair descent and at baseline (from voice recordings). A 2-way ANOVA for repeated measures was used to evaluate the differences ($p<0.05$) across conditions and between age groups. RESULTS: DTC was significantly higher for older subjects across conditions. The younger subjects decreased DTC at transition and steady state as compared to approach, while older subjects only decreased DTC during steady state and showed similar, higher DTCs for approach and transition. A significant difference was found between older and younger adults for forward velocity during the first step at each point on the staircase. Clearance was significant higher for the older subjects in all conditions and the older subjects showed a slightly higher foot clearance at transition for the dual task condition. CONCLUSIONS: Our results showed that dual tasking influenced both gait and cognitive performance in both groups with older adults generally walking slower, with higher foot clearances and greater DTCs. Interestingly, older adults specifically differed from their younger counterparts at transition when less attention would be expected to be required given that planning should be already completed. The results suggest that attention and planning requirements differ between older and younger, fit, healthy subjects, particularly at the point of transition to stair descent.

P1-D-44 Selective attention is related to bimanual skill learning

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BACKGROUND AND AIM: Understanding the role of attention on motor skill learning might inform motor training. This study aimed to examine the relationship between attention and bimanual skill learning ability. METHODS: This is a cross-sectional study involving twenty healthy adults aged between 19 to 59 years recruited by convenience. They were trained to practice a novice bimanual dexterity task with the Purdue Pegboard for 20 trials. Before training, subjects were tested on 2 attention functions -Walking While Talking Test for divided attention, and Stroop Test for selective attention. RESULTS: There was strong to moderate relationship between the Stroop Test Levels 1 to 3 and learning plateau (Pearson's correlation coefficients $r > -0.70$) and rate ($r > 0.49$) of the motor skill learning. Divided attention was not correlated with the skill learning. The association of age with learning rate and learning plateau was moderate to strong respectively. CONCLUSIONS: Learning the bimanual skill was related to one's selective attention aside from age. The weak association between divided attention and the bimanual skill learning might be limited by the attention evaluation tools or nature of the task training. Nevertheless, we confirmed the significant role of selective attention in the acquisition of certain motor skills as in this study.

P1-D-45 The effect of anxiety on motor learning during a postural task

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BACKGROUND AND AIM: Fear of falling is associated with reduced balance confidence, inhibited activity and increased risk of falling in the elderly [1]. Balance training, proven to be a successful strategy for fall prevention, also leads to increased confidence about balance [2]. An underlying premise of many balance training protocols is the acquisition of new movement skills, or motor learning. Our work explored whether anxiety about falling interferes with the acquisition of a balance-relevant motor task. Our work is motivated by the possibility that the effectiveness of balance training programs may be compromised among those who fear falling. METHODS: Twenty participants (22.0 ± 2.7 years) were randomly divided into groups that practiced a postural task while in a Non-Anxious (NA) or Anxious (A) condition. In the NA condition, subjects stood directly on a translating platform, while in the A condition, subjects stood on two wooden pedestals that were 13.5cm x 41cm x 9cm high and placed side-by-side on the translating platform. The balance task was to minimize the effect of a 45s 0.5 Hz, pseudo-random amplitude, sinusoidal, Anterior-Posterior (A-P) platform translation on body motion. The amplitudes of the first and last 15s of each trial were random (max ±6.35cm) but were identical between trials and participants for the mid 15s to allow for consistent performance assessment. Participants practiced for 36 trials on Day 1 (Acquisition; Aq) and returned for three Retention (R) and three Transfer (T) tests on Day 2 which were completed in the same or different NA/A condition, respectively. Movement of the body at the head, shoulders, hip, knees, and ankles was recorded; COM was calculated. Performance changes during Aq were assessed using a 2 group x 36 trial x 6 landmark RM-ANOVA on Day 1. R and T performance was compared with the last three trials of Aq (Trained; Tr) to assess learning using a 2 group x 3 phase x 6 landmark RM-ANOVA. RESULTS: A-P movement of the body at all landmarks but the ankle decreased during Aq for all subjects ($p<0.05$) and this change was consistent for Tr, R and T phases ($p>0.05$). Correlation between the movements of the platform and of the head, however, was higher for those who trained in the A condition during Tr, R, and T ($p<0.01$; Fig. 1). CONCLUSIONS: All subjects learned to minimize the general effects of the perturbation. The ability to counteract the specific translation sequence as implied by a lower correlation magnitude, however, was reduced in the A group. This suggests that although motor learning occurred while training in an anxious condition, acquisition of an optimal motor pattern was impaired and this effect was persistent. Accordingly, it is possible that the presence of anxiety may diminish the full benefit of balance training when individuals are anxious or afraid about falling.

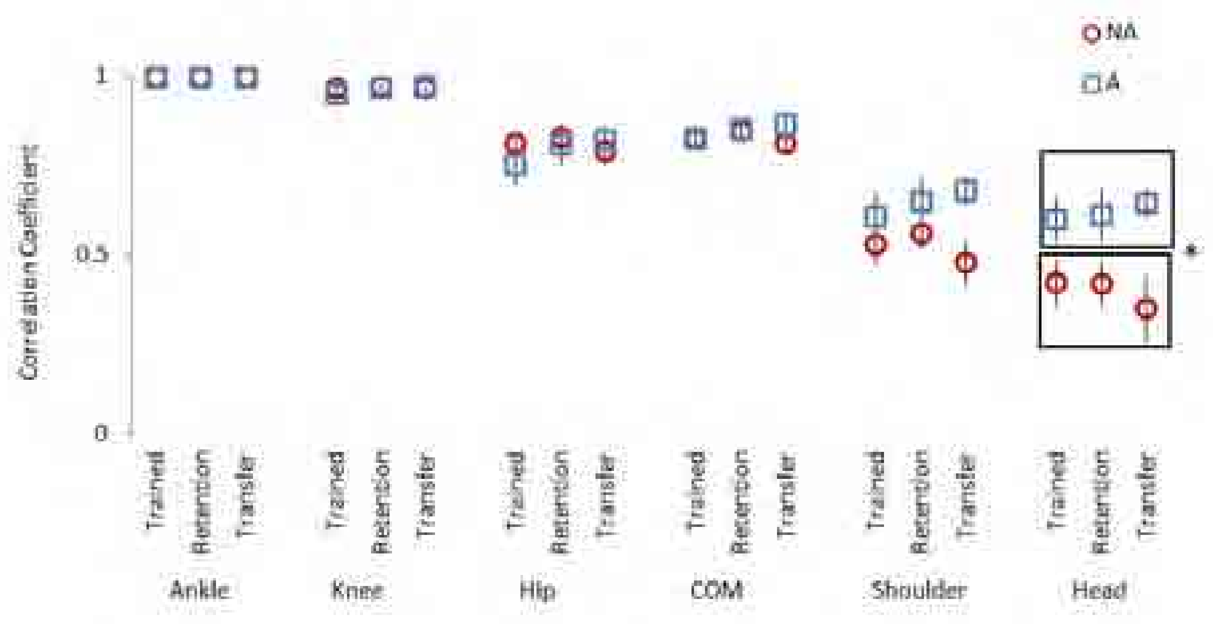

Fig. 1: Correlation between the A-P movement of the platform and the A-P movement of body landmarks for those who trained in the NA and A conditions for Trained, Retention and Transfer phases. Correlation was significantly greater ($p<0.01$) between the movement of the platform and the movement of the head for those who trained in the A condition.

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P1-D-46 Taking approach-avoidance research a step further

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BACKGROUND AND AIM: Psychology and biomechanics are complimentary fields that are rarely integrated. Our research investigates the relationship between the psychology of social processing and the biomechanics of everyday postural activities, viz. step initiation. We performed an experiment to investigate how socially inviting and threatening facial expressions differentially influence the spatio-temporal organization of step initiation and execution. We predicted that socially inviting expressions would facilitate forward stepping ('approach') and that socially threatening expressions would facilitate backward stepping ('avoidance'). METHODS: Healthy female participants (N=26) stood on a force plate directly opposite a computer screen which displayed a succession of facial images.The images differed based on gender (males/females) and emotional expression (happy/angry/neutral). Participants performed backwards or forwards steps based on the perceived gender of the face (instructions randomized across participants), regardless of emotional expression. In congruent trials, the instructed step direction corresponded with either approaching a happy face or avoiding an angry one; in

incongruent trials the instructed step direction corresponded with either avoiding a happy face or approaching an angry one. The steps were taken on a force plate. Center-of-pressure (COP) excursions were recorded at 100 Hz. RESULTS: Our results demonstrate that multiple parameters of the COP-trace were influenced by the social cues. Especially the initiation times of the steps and the early postural adjustments were sensitive to the experimental manipulations. CONCLUSIONS: Even though emotional expression was a task-irrelevant stimulus feature (because participants had to base their step direction on gender), this feature clearly influenced kinematic properties of the directional steps. This finding is consistent with the emerging insight that social and affective processing is coupled with postural behavior.

P1-D-47 Attention and postural control in patients with conversion paresis

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BACKGROUND AND AIM: Motor conversion disorder (MCD) is a poorly understood syndrome affecting voluntary motor functioning. MCD is characterized by paresis, tremors, numbness, and loss of muscle control, among others. It is generally believed that MCD is a psychiatric syndrome related to stress and trauma, often acquired during early childhood. Studies have shown that symptoms in MCD, as well as in other psychogenic movement disorders, are highly susceptible to the direction of attention. The aim of this study was to assess the control of balance in these patients, under three attentional manipulations. METHODS: We investigated postural control using a stabilometer housing a force platform in nine MCD patients and nine case-controls during three task conditions varying in attentional direction (eyes open, eyes closed, and distraction). The distraction task involved silently counting backwards in steps of 7, so as to remove attention from balance performance. Participants had to maintain quiet upright stance during 30 s in each condition. Postural sway was recorded at 100 Hz. RESULTS: The amount of body sway was significantly greater for the MCD group than the control group for the eyes-open condition. Furthermore, this difference was even greater during the eyes-closed condition. Importantly, the difference between the groups disappeared during the distraction condition. Finally, the above effects were modulated by the number of prior aversive life events. CONCLUSIONS: An important finding was that mental distraction (counting backwards during standing) resulted in near-normal postural behavior in the MCD group. This provides strong support for the notion that sub-clinical postural abnormalities in psychogenic movement disorders are partly accounted for by attentional disruption of balance; possibly hypervigilance to the own bodily sensations.

P1-D-48 Perception of Human Motion performed under Microgravity condition: an fMRI study.

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BACKGROUND AND AIM: The Earth's gravity vector is a ubiquitous constant on which our internal representations of action are built since birth. The SNC integrates the gravity vector to plan and execute movements. We hypothesize that perception of human motion (HM) is also drived by the gravity vector. The aim of this study is to investigate the HM performed under microgravity condition by means of a behavioural experiment and a functional MRI investigation. METHODS: 45 subjects, all naïve to microgravity environment, participated to this study: 39 for the behavioural experiment only and 16 for both behavioural and fMRI experiments. The subjects were asked to categorize stimuli of HM depicted in animated point-light video (Johansson, 1973) into "performed on Earth" (1G movements) or "performed in Space" (0G movements). Movements seen were all natural and usual actions of everyday life i.e. belonging to the motor repertoire of each subject. fMRI images were acquired on a 3-T MEDSPEC 30/80 AVANCE whole-body imager (Bruker, Ettlingen, Germany). RESULTS: The behavioral experiment showed that subjects could categorize with an equivalent accuracy and an equivalent reaction time whatever the gravity condition (1g movement: 77.36 %, 1870 ms; 0g movement: 72.85 %, 2107 ms). However, the evolution of the percentages of correct answers with respect to the reaction time showed a different dynamics for 1G and 0G movements. This difference led us to investigate the cerebral activity of the subjects while they were watching videos of 1G and 0G movements. The fMRI study showed, for the "0G vs. 1G" contrast a lower activity of the right middle occipital gyrus (EBA, Downing et al., 2001) and a higher activity in both the left inferior frontal gyrus (IFG) and the right anterior insula (aIns). CONCLUSIONS: As far as the behavioral performances are concerned, perception of HM does not seem to be affected by the absence of gravity. On the other hand, the cerebral activities showed a shift from a natural perception of the human body for 1G movement (EBA) to the need of projecting its own body image in an environment with unknown gravity constraints. These new data make the microgravity a tool of choice to answer appropriately to the current debate tends to unravel the body schema to the body image in the brain.

P1-D-49 Directional bias in the body while walking through a doorway: Its association with cognitive and motor factors

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INTRODUCTION: Recent studies indicate that cognitively intact individuals experience frequent rightward collisions while walking through narrow doorways [1,2]. Such directional bias has been attributed to pseudoneglect (a cognitive factor), wherein individuals slightly neglect the right hemispace. However, these studies did not exclude the possibility that rightward collisions resulted simply from the participants' choice to step through the doorways with the right foot (a motor factor). The present study therefore conducted three experiments to clarify whether rightward collision truly resulted from pseudoneglect. METHODS: Participants walked through the perceived center of a relatively wide doorway. Measurements of the deviation of the upper-body midpoint from the center of the doorway demonstrated that the foot used to step through a doorway had a very strong influence on the directional bias. RESULTS: Some participants showed rightward deviation irrespective of which foot was used to step through the doorway, suggesting the involvement of some cognitive factors (Experiment 1). However, the findings overall disproved the involvement of pseudoneglect. No significant correlations between the directional bias in the walking task and that in the bisection task were obtained.

Furthermore, both the movement of one hand (Experiment 2) and covert attention to one side of the door (Experiment 3) caused contralateral deviation of the body. These results were partly inconsistent with the predictions based on pseudoneglect but were consistent with predictions based on an attentional cueing hypothesis. CONCLUSIONS: We concluded that attentional cueing is likely to be a plausible cognitive function that leads to the directional bias in the body during walking.

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P1-D-50 **Changes in metabolic factors during dual task performance while walking**

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BACKGROUND AND AIM: The role of cognition in gait was examined in studies using dual task research paradigm and it is well accepted that additional cognitive load changes patterns of locomotion. To date, research using dual task paradigms focused mostly on performance quality when additional cognitive loads were superimposed on motor tasks. On the other hand, metabolic factors have been examined in studies that looked at the effects of physical exercise on cognition. However, the link between dual task performance and metabolic cost has not been investigated enough. The aim of this study was to examine the metabolic cost of performing a secondary cognitive task while walking (i.e.dual-task) in different speeds, compared to their counterpart single tasks. METHODS: Twenty five young healthy adults (age 25.7±3.05 years;56% men) participated in the study. The experimental protocol consisted of 6 trials. In the first 2 trials subjects were asked to sit for 5 min; once while performing a secondary cognitive task (calculation;working memory) and once without performing any additional task. The remaining 4 trials were walking tasks where subjects walked over-ground on a GaitRite (self selected comfortable speed) and on a treadmill (highest walking speed -0.5km/h) for 500 meters; with and without performing a similar (not identical) version of the cognitive task. During the whole experiment cardio-pulmonar parameters were recorded and monitored using the K42 system (Cosmed, Italy) and subjects' responses for the cognitive task were written. RESULTS: Findings showed that adding cognitive load while sitting caused a statistical significant increase in VO2 consumption ($t(24)=-3.67;p=.001$), heart rate ($t(24)=-2.72;p=.012$) and breathing frequency ($t(22)=-5.07;p=.001$). During over-ground walking subjects used different strategies to cope with dual-tasking; 13 (52%) significantly decreased their gait speed, 6 (24%) significantly increased their gait speed and 6 (24%) did not change their gait speed. In the group that decreased gait speed, VO2 consumption decreased significantly ($z=-2.55;p=.011$) as expected. However, breathing frequency increased significantly ($z=2.49;p=.013$). During treadmill walk breathing frequency increased significantly during dual task ($t(22)=-3.2;p=0.004$). Change in performance of the cognitive task was not related to strategy used during over-ground walking or metabolic changes and was changed between conditions. In each walking condition 54% of the subjects improved their

performance of the cognitive task. CONCLUSIONS: The results of the current study add a new insight into dual task paradigm.The different strategies used to cope with the additional load points to the complexity of dual-tasking. Moreover,changes observed in metabolic factors indicate that dual task affects many aspects of human function and this should be further studied in elderly and clinical populations for future planning of intervention or training.

P1-D-51 Using computer game dancing to influence attention skills of elderly

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INTRODUCTION: Spatial and temporal dual task cost characteristics of gait are especially associated with divided attention in older adults [1]. Young action game players improve attention skills [2]. This study evaluated whether a computer dancing game training is able to improve attention skills in aged individuals. METHODS: Eleven seniors [5♀/6♂, 70.4 ± 4.3 [range 65-81] yrs] naive to computer games danced three weekly sessions performing six dances that each lasted 90-seconds and had different beats per minute during four weeks. Electrophysiological data (EEG) served to investigate changes in the pattern of brain activations due to training. Brain activity was recorded pre- and post-training. N200 and P300 amplitudes (as a measure for executive control) and attentional stimulus evaluation in a Flanker task were main outcomes. RESULTS: N200 at site Pz (incongruent) changed in amplitude: p=0.049, dSES=0.542 (Mpre=-1.113, Mpost=-1.694). P300 at Pz (congruent) changed in amplitude: p=0.009, dSES=1.084 (Mpre=4.495, Mpost=5.922). N200 at site Pz (congruent) and P300 (incongruent) showed no change. The results of the paired t-tests showed that the elderly improved significantly on the Flanker task: total reaction time (RT) in ms pre/post = 328.18/311.18, t(10) 4.011, p =.002, r = .79 ; RT congruent pre/post = 311.36/292 t(10) 4.264, p =.002, r =.80 ; RT incongruent pre/post = 349.64/334.73, t(10) 3.605, p =.005, r =.75 . CONCLUSIONS: The data suggest that elderly video dance game players enhanced their attention skills following four weeks of dancing. The enhanced attention skills improved behavioural measures; e.g. allowed making faster correct responses to targets.

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P1-D-52 Do fear avoidance beliefs affect deep abdominal muscle activation after exercises for chronic low back pain?

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BACKGROUND AND AIM: Activation of transversus abdominis has been related to low back pain. The aim of this study was to investigate associations between fear avoidance beliefs before and deep abdominal muscle activation after supervised exercises for patients with chronic low back pain. METHODS: 108 patients with chronic nonspecific low back pain who received 6-8 weeks with supervised exercises participated in this study. Fear avoidance beliefs for physical activity and work were measured before intervention. Deep abdominal muscle activation during abdominal drawing-in maneuver and in anticipation of rapid arm flexion was measured before and after intervention. RESULTS: High fear avoidance beliefs for physical activity (> 16 on the subscale) were negatively associated with transversus abdominis slide after the intervention period. There were no associations between fear avoidance beliefs for physical activity and abdominal muscle onset, transversus abdominis- or obliquus internus contraction thickness ratio. Fear avoidance beliefs for work were not associated with any of the abdominal muscle activation parameters. DISCUSSION: This study suggests that there is some negative association between fear avoidance beliefs for physical activity before intervention and transversus abdominis recruitment measured by lateral slide after intervention. Fear avoidance beliefs for physical activity might be more relevant to exercise outcome than fear avoidance beliefs for work.

P1-D-53 Relationship between working memory capacity and postural control

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BACKGROUND: In previous studies, dual task has been studied for a many reports can be seen when standing posture ability imposed dual task. However, the standing posture control of the dual task is reported to be inhibited and, standing posture control is reported facilitation, and there is not constant. On the other hand, The ability to control standing posture of the dual task, given not only the task, it may depend on the ability of individual WM. Focuses on the individual's capacity WM, the present study, we examined the ability of the position and attitude control ability. METHODS: The subjects were seventy-four healthy young volunteers who agreed to participate in this study (25.8±4.3 years). The subjects were organized into two groups based on scores of the reading span test Japanese edition (RST): the first group was composed of those who had high score (n=29) and the second group, low score (n=34), and, were excluded the middle scorers (n=11). Postural sway was measured for 30 seconds. Index item assumed it a length (LNG) and requested to maintain a standing position with stroop test, detected the error number of the results and assumed it an index. Measured the following four conditions, 1) standing, 2) standing with dual task, 3) one leg standing, 4) one leg standing with dual task. Statistical analysis was performed using Prism (MDF.,Ltd.). A used two way ANOVA, then Bonferroni's test was used post hoc analysis. A p-value of less than 0.05 was considered significant. RESULTS: Comparison of LNG in the high group and low WM group were found a significant increase of LNG in the low group (p <0.01).Also showed a significant difference compared with the condition in the condition of LNG difference of standing posture (p <0.01). Standing posture the condition in both groups post hoc analysis, there were no significant differences in LNG of standing posture condition, with dual task condition at high and low between the two groups. However, one leg standing with dual task condition showed a significant increase only in the condition (p <0.01). In addition, a showed interactions between factors (p <0.01). CONCLUSIONS: Previous studies using a dual task, compared to a simple task in a difficult condition has been reported to show a significant increase in sway standing posture (Woollacott 2001). Conditions compared to standing posture, showed a significant increase in body sway one leg foot standing difficult. However, results showed interaction of LNG in the high group

and low group of the WM score, as well as the difficulty of the posture, suggesting that also involved the effects of individual WM capacity. This indicates that a change in sway standing posture is not only by changes of posture conditions, suggesting that the influence of individual WM capacity.

P1-D-54 Ability to mentally rotating a pictured foot stimulus is correlated with stability of upright posture

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BACKGROUND AND AIM : Evidence is increasing that mentally rotating pictured stimuli of body parts involves the same movement representation used to control the body parts. A typical finding was that quickness of mental rotations (MRs) of body stimuli reflected the degree of simulated movement as well as biomechanical constraints of the body part. Currently, such a relationship is evident only for hand and foot movements. The present study investigated whether quickness of mental rotations of body stimuli was also correlated with the stability of upright posture. METHODS : Twenty-four able-bodied young adults (18-33 yrs) participated. Testing was approved by the Ethics Committee of the Tokyo Metropolitan University. Written informed consent was obtained according to the Declaration of Helsinki. The participants performed MRs with two types of stimuli: two body-related stimuli (foot and hand). For each of body-related stimuli, a single stimulus appeared with one of four orientations and was kept until the participant indicated the laterality of the foot or hand. The RTs for the each task were measured. Stability of upright posture was evaluated with single-leg standing on a force platform while opening the eyes. The participants were asked to stand as still as possible while looking at a fixed eye-level target. They performed three trials, each lasting 60 seconds. Postural stability was expressed in terms of total length (LNG) of the trajectories of the center of pressure. ANALYSIS:The Pearson's correlation coefficient was computed between the postural sway value (i.e., LNG) and RTs and each of the two MR tasks (foot, hand). For further analysis, eight participants (a third of the total participants) who performed the task quickly (a faster group) and eight participants who performed it slowly (a slower group) was selected; a comparison of the LNG was made between the two groups with an unpaired t-test. RESULTS : Significant correlations were found between the RTs for the foot MR and the LNG ($r=0.46$, $p<0.05$) but not between the RTs for the hand MR and the LNG ($r=0.25$, ns). The significant difference in the sway value was found between the fastest and the slowest group on RTs for the foot ($p<0.05$), but not that of the hand based on unpaired t-test. CONCLUSIONS : The results showed that the quickness of MRs of the foot stimuli, but not that of hand, was significantly correlated with the stability of upright posture with single-leg standing. Furthermore, the participants who performed the MRs quickly were more stable than those who performed it slowly. These findings suggest that the ability of mentally rotating a pictured foot stimulus was relevant to the stability of upright posture. Future studies should examine whether the MR task of a foot stimulus is effective as a clinical practice to improve the upright postural stability.

P1-D-55 Flexibility and dual task: The role of aging and executive functioning

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BACKGROUND: There is growing evidence of the involvement of executive control in walking and balance in old age. The goal of this study was to assess flexibility in aging and in dual-tasking effects. We hypothesized that the effects of flexibility in dual task are more pronounced with regard to gait and/or postural control in healthy older adults than in healthy young adults. METHODS: Nineteen healthy older adults (mo=73.31 ± 5. 77) and fourteen healthy young adults (my=24.9 ± 1.94) performed tests of cognition, postural control, and walking (Trail Making Test, static posturography, 10-meter-walk on an electronic carpet) under single- and dual-task conditions. Based on the neuropsychological test known as Trail Making Test A and B (TMT A et B), participants stepped on targets with increasing sequential numbers (Walking TMT N et A) and alternating sequential numbers and letters (W-TMT B). Three posture trials were examined in single and dual-task conditions. In the dual task, participants executed each TMT A and TMT B while standing on the posturographic platform. RESULTS: We were able to observe the effects of aging on walking, postural stability and flexibility. Taken as a whole, the population showed no impact of flexibility on postural performance under dual-task conditions. Gait speed and cadence nonetheless decreased for all W-TMT tests in the healthy older adults. Moreover, we noted some degree of correlation between TMT B-A time of execution and gait and cadence on the one hand in the single-task trial, and on the other hand in the W-TMT A and B tests CONCLUSION: Flexibility contributes to the usual walking abilities. The adaptable nature of resource allocation developed over a life-span is age-related. This study validates assessment of flexibility through W-TMT B testing.

P1-D-56 Impact of executive function on gait and balance in older adults with cognitive impairment

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BACKGROUND AND AIM OF THE STUDY: The modification of the static and dynamic postural parameters shown in older adults in a double-task (DT) exercise could also serve as a good means of characterizing impairment of executive functions (EF) (Yogev-Seligmann, 2008). The objective is to determine the influence of the different executive functions in a complex double-task exercise on walking and balance in an aged person, in connection with his or her cognitive capacities. METHODS: 35 older adult autonomous volunteers, without any pathology likely to influence walking or posture were given a psychometric test (MMSE : Folstein et al, 1975; BREF : Dubois et al, 2000; 5 mots de Dubois : Dubois, 2002; Trail Making-test TMT : « Army Individual Test Battery » 1944). We divided the participants into 3 groups according to the levels of EF performance: 9 patients low EF (EF and memory impairment), 17 high EF (7 memory impaired and 10 healthy older adults) and 9 middle EF (EF impairment only). They were evaluated on a 10m walk along an electronic walkway system and by a posturographic test (force platform) in single task (ST). In a first DT, the walking parameters were recorded on Walking Trail-Making Tests (W-TMT) similar to the Persad protocol (Persad et al, 2008). Three walkways of increasing

complexity were used: W-TMT N with numbers only, W-TMT A with numbers and distracters, W-TMT B where the participants choose a path connecting alternatively a number to a letter in an upwards progression. In a second double task, the participants were asked to maintain their balance on a force platform while visually carrying out the 2 parts of the Trail-Making Test projected on a wall (P-TMTA and P-TMTB); they had been provided with an eye tracker. RESULTS: In ST, from a postural standpoint we observed a difference between low EF patients and the other groups (rate of oscillation (p≤10-3) and length (p≤10-4), but we did not note any difference between the groups with regard to walking. Execution time for the paper TMT is correlated only with walking speed (pace) for the W-TMT (R (tmta, w-tmta) = 0.44 ; R (tmtb, w-tmtb) = 0.41) for all the groups. The cost of DT W-TMTB calculated from double stance time is more discriminating (p≤10-5) than the walking speed parameter (p≤0.04) in specifying the EF capacities of the different subjects (low EF vs. other groups ; middle EF vs. other groups). Only for low EF subjects (p≤0.04) the complexity cost of DT calculated from speed is higher in locomotion than in balance. CONCLUSIONS: While examination of walking in ST does not allow for detection of cognitive pathologies, DT exercise allows for specification of the type of impairment (mnesic or dysexecutive), and even for identification of the most pronouncedly altered EF.

P1-D-57 How specific are cognitive deficits in short-term visuospatial memory in MCI patients?

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BACKGROUND AND AIM OF THE STUDY: MCI is characterized by impairments in constructive abilities, short-term spatial memory deficits, and disorders of spatial orientation (topographical disorientation) (Iachini et al, 2009). The aim of the study is to determine whether short-term visuospatial memory deficit in dual tasking (locomotion, posture) could constitute a good indicator in detection of MCI patients. METHODS: 35 older adult autonomous volunteers, without any pathology likely to influence walking or posture, were given a psychometric test (MMSE, BREF, Dubois, WAIS, electronic version Corsi Block Test) and an instrumented 10m walking test (GaitRite). We divided the participants into subgroups by applying the Petersen criteria (Petersen et al, 2004): 14 healthy older adults (HO), 7 amnesic MCI (aMCI), 9 non-amnesic MCI with executive function impairment (naMCI), 6 multi-domain MCI (multiMCI). In dual task (DT), we used a recently devised psychometric instrument (Walking Corsi Test: W-CBT) to assess the specific contribution of spatial memory to the complex task of retrieving route knowledge (Piccardi et al, 2011). The participants were asked to maintain their balance on a force platform while visually carrying out the task involving the Corsi block-tapping Test projected on a wall (P-CBT). Cognitive performance was evaluated by an eye tracker on spans of increasing complexity (from 3 to 6) on all subjects. RESULTS: In single task (ST) from a postural and locomotor standpoint, we noted no significant difference between the groups. The cognitive CBT and W-CBT test performances were significantly less satisfactory in the multiMCI (m = 4) in comparison with the other naMCI (m = 4.6), aMCI (m = 4.6) and HO (m = 4.8) subjects. Short-term visuospatial memory capacities were more strongly altered in the W-CBT (MWalCT = 4.0) than in the CBT (MCBT = 4.8) and P-CBT (MP-CBT = 4.5) tests. In the P-CBT test, the strategies put into place when the cognitive task became increasingly complex (span

growing from 3 to 6) trended towards diminution of the posturographic parameters (length, speed) in all the pathological groups, whereas the healthy subjects did not present any significant differences for these parameters between ST and DT. CONCLUSIONS: In all the tests, alterations of multi-domain MCI performances (vs. those of the other groups) show that the cognitive functions involved in the double-task CBT associate working memory with the other executive functions. The postural strategies observed in DT (P-CBT) are shared by all the pathological groups (aMCI, naMCI, multiMCI). They entail involuntary postural hypercontrol that may be an early motor-based indicator of cognitive disorders.

P1-D-58 Gait, motor proficiency and emotional-behavioural disturbance in Autism Spectrum Disorders

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BACKGROUND: Autism and Asperger's disorder (AD) are highly prevalent childhood neurodevelopmental disorders, defined by the presence of communicative, social and stereotyped repetitive behaviours. Currently autism is distinguished by early language delay, although the new Diagnostic and Statistical Manual of Mental Disorders 5 (DSM-5) proposes to combine both diagnoses as Autism Spectrum Disorders (ASD). Disordered movement is a feature of both disorders, with clinical descriptions often including subtle gait or postural abnormalities. Balance proficiency has been found to be associated with emotional-behavioural symptoms in children with ASD [1] . The aim of this study was to investigate the associations between gait patterns, motor proficiency and emotional-behavioural symptoms of children with autism spectrum disorders (ASD). METHOD: Spatio-temporal data from a three-dimensional gait analysis system were captured from a reference group of normally intelligent children (n=24, 10.1±1.6years), a group with high functioning autism (HFA; n=24, 9.2±2.9years) and a group with AD (n=27, 10.4±1.6years). All participants completed five walking trials at self-selected speed, and a conventional biomechanical model calculated spatiotemporal data for 2 left and 2 right strides of each trial. Motor proficiency was assessed with the Movement Assessment Battery for Children (MABC). Emotional and behavioural symptoms were assessed with the Developmental Behavioural Checklist - Parent Report (DBC). RESULTS: The groups did not differ in stride time, stride length (normalised) or speed (normalised). Stride width differed; with the AD group significantly wider than the control group. Step-to-step variability in stride width was also increased in both clinical groups. For the combined ASD group, stride length variability was positively correlated with the Balance subscale of the MABC (rho= .32, p = .027) and with the Total DBC score (rho = .32, p = .036). Stride width variability was also positively correlated with the Balance subscale (rho = .35, p = .017) and total MABC score (rho = .30, p = .038). CONCLUSION: These findings provide further evidence of the subtle gait abnormalities in children with ASD. The significant associations between gait and emotional-behavioural disturbance further suggest that children with greater behavioural symptoms may be those with greater motor impairment. The combination of motor and behavioural impairments may have a higher impact on a child's daily

activities and social participation, reinforcing the need for multidisciplinary assessment and management of these complex disorders.

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P1-D-59 Gait in children with Attention Deficit Hyperactivity Disorder

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BACKGROUND: Attention Deficit Hyperactivity Disorder (ADHD) is the most common childhood-onset psychiatric disorder affecting the development of fronto-striatal circuits and the cerebellum. In addition to psychosocial complications, individuals diagnosed with ADHD commonly experience motor difficulties. Although up to 50% of children are reported to display significant motor problems, little is known about the impact on gait function. This study aimed to compare gait of children with ADHD to typically developing children, and to examine the association of ADHD symptoms with gait. METHOD: Children with ADHD (n = 14; mean age 124months [SD=24.53],) and a typically developing (n= 13; mean age129.15 months [SD=33.68]) group walked at self-selected slow, preferred and fast speeds on an electronic walkway system. Participants completed a total of 15 walking trial; 5 trials per walking condition. Groups were matched on age, intellectual functioning, height and weight. The Conner's Parent Rating Scale was used to measure severity of ADHD symptoms (e.g. Inattention). RESULTS: The ADHD group walked with an increased cadence compared to the TD group in the baseline preferred speed condition ($t(25)= 2.106$, $p = 0.045$). At self selected fast speed, the ADHD group were faster ($t(25)= 2.31$, $p = 0.030$), and had a higher cadence ($t(25) = 2.733$, $p = 0.011$) with reduced double support time ($t(25)= 2.04$, $p = 0.05$). Severity of ADHD symptoms, specifically Inattention, was significantly correlated with speed ($rho = 0.443$, $p = 0.02$) and cadence ($rho = 0.471$, $p = 0.013$) in the fast walking condition. CONCLUSION: The gait pattern of children with ADHD was characterised by increased cadence at preferred speed and a 'hyperkinetic' faster gait pattern in the fast walking condition. These findings may be consistent with clinical descriptions of increased motor 'fidgetiness and restlessness' and hyperactivity noted in the DSM-IV.

P1-D-60 Threat of falling alters posture and allocation of attention

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BACKGROUND AND AIM: Maintaining balance can be made more difficult by numerous factors: vestibular imbalance, absence of vision, or introduction of a parallel cognitive task. In extending the concept of dual-task interference in allocation of attention, we hypothesize (1) that the mere "threat of

falling", even in the absence of any change in inherent task difficulty, is enough to change the strategy for postural control, and (2) that changes in the allocation of attentional resources would depend on the subjects' sensorimotor and cognitive abilities. METHODS: Experiments were carried out in two groups of subjects: vestibular-defective patients tested in the compensated stage after unilateral vestibular loss (n=9), and healthy controls (n=11). Postural control was analyzed first under a double task condition (postural and cognitive). The postural task consisted of maintaining balance during horizontal fore-aft sinusoidal translation. The cognitive task was a memory task including a spatial cue. The "threat of falling" was introduced by then testing the subjects on a platform raised off the ground, and used as an additional means to modulate the allocation of attentional resources. RESULTS: Data indicate that the "threat of falling" results in a change in postural strategy for both groups of subjects. In addition, fear of falling disturbs the realization of a dual task in patients. Such a disturbance was reported on the mental task, not on the postural task which is still maintained consistent with a "posture-first" strategy. CONCLUSIONS: For the patients' group, competition for attentional resources during the double task and in the threatening situation become crucial and could contribute to the underlying nature of their balance deficits. These data highlight the role of cognitive function in the recovery of postural function after vestibular loss. All these changes could be envisioned as alterations of the internal model. Therefore, clinical testing requiring the mobilization of attentional resources (dual-task, threatening situations, imagination...) would assess more fully the balance functional recovery following vestibular loss and help to guide the rehabilitation process.

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P1-D-61 Effects of secondary verbal cognitive task and deteriorated sensory conditions on step characteristics of older adults

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BACKGROUND AND AIM: Community dwelling older adults are often faced with the challenge of walking-while talking amid conditions of limited availability of sensory information from the natural environment, which can compromise their stability. The visual, vestibular and somatosensory systems provide important sensory inputs for postural control. The ability to integrate this information from multi-sensory systems is a critical function of the central nervous system and is an important component for walking safely in the natural environments. Age-related deterioration in sensory function reduces the ability to extract information from the environment. Alterations in step characteristics can reflect instability while walking. Step characteristics such as increased step width and decreased step length are strategies to compensate for postural instability. The aim of this study is to investigate the effect of a secondary verbal cognitive task and deteriorated sensory conditions on step width and length average and variability in older adults. METHODS: Step width and length characteristics of 10 older adults (age = 74.00 ± 5.46 years) were measured under normal and dual-task walking conditions using OPTOTRAK cameras. The average distance between the feet at the point of contact and co-efficient of variation was measured. The first two steps of each trial were removed to eliminate the acceleration phase. The dual-

task condition involved walking while performing serial subtraction by 3's from a given number. On randomly selected trials visual and vestibular inputs were deteriorated using blurred goggles and galvanic vestibular stimulation (GVS) at threshold level, respectively. Data were analyzed using 2(dual-task) x 2(visual deterioration) x 2(vestibular deterioration) ANOVA. RESULTS: Step width increased with GVS irrespective of dual task and goggles ($p < 0.05$). Step length reduced in dual task condition irrespective of goggles and GVS ($p = 0.001$). Step width variability increased with blurring goggles irrespective of the dual task and the GVS ($p < 0.05$). Step length variability increased with blurring goggles only under dual task condition irrespective of the GVS ($p < 0.05$). CONCLUSIONS: Increase in step width in the presence of vestibular deterioration is known and can be attributed to a compensatory strategy for mediolateral instability. Decreases in step length during the dual-task condition in healthy older persons can be attributed to a cautious strategy adopted when the attention was divided while walking even at a self-selected pace. Accuracy of peripheral visual input is critical in elderly for efficient foot-placement in the mediolateral direction. However, efficiency of foot-placement in the anteroposterior direction appears to be visually dependent only while walking under attentionally challenging conditions. Relevance of the findings to fall-risk management needs further investigation.

P1-D-62 Effects of a standardised physical training on cognitive performance in patients with dementia

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BACKGROUND AND AIM OF STUDY: Population-based, longitudinal Studies show an association between high physical activity and reduced cognitive decline during long-term observation. The limited number of interventional studies showed heterogeneous effects and limited comparability during short-term observation periods. Patients with diagnostically confirmed dementia were hardly included in such studies. The aim of the study was to document the effects of a standardised physical training on cognitive performances in patients with dementia. METHODS: Study design: Randomised controlled trial (RCT). Study participants: Frail, sedentary patients (n=122) with diagnostically confirmed mild to moderate stage dementia. INTERVENTION: A progressive strength and functional training (intervention) was compared to a low-intensity group training (control) at baseline (T1), at the end of the 3-months intervention (T2) and at a 3 months follow up (T3). Both groups were treated in a patient-centred-approach. MEASURES: Cognitive performance was assessed by established, valid measures using the CERAD test battery (Consortium to Establish a Registry for Alzheimer´s Disease) and Trail Making Test (TMT). For statistical analysis data adjusted for age, gender and education (z-values) were used. RESULTS: In general, cognitive performances did not decline in most tested sub-performances during the observation period, as could be expected for patients with dementia. In memory associated tests a time- but not group associated increase could be documented for : CERAD, Word list, immediate Recall: p=0.008; Word list, delayed recall: p=0,006; recall symbols: p=0.035; recall symbols, savings: p=0.014. Those time-related differences remain significant during follow up. (T1-T3) for: word list, delayed recall: p=0,002; word list, immediate recall: p=0,001; recall symbols: p=0.027. CONCLUSION: Unspecific physical training positively effected cognitive performances in some subdomains in both study groups with partly sustainable effects during follow up in patients with moderate stage dementia.

P1-D-63 Dynamic prioritization in response to instructions during dual-task walking in people with Parkinson's disease

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BACKGROUND AND AIM: Gait impairments in people with Parkinson's disease (PD) are exacerbated by the performance of concurrent tasks. Under such dual-task (DT) conditions, it is not clear if people with PD retain dynamic prioritization, which refers to the capacity to flexibly shift task performance and prioritization. The purpose of this study was to examine the capacity to shift task performance and prioritization in people with PD. We hypothesized that people with PD, compared to healthy individuals, would demonstrate limited capacity to shift task performance and prioritization in response to instructions. METHODS: Ten individuals with PD, on medication (mean [SD] age=71 [6] years, Hoehn & Yahr stage=2.0 [0.5]) were compared to 15 healthy young adults (HYA; age=24 [4] years) and 5 healthy older adults (HOA; age=67 [14] years). All participants walked under single task (ST; walking only) and DT (while performing a choice reaction time task) conditions. In DT conditions, participants were asked to prioritize either walking (DT-walk) or the cognitive task (DT-cog). Walking was assessed using gait speed, and cognitive task performance was assessed using response latency and accuracy. Dual task costs (DTCs) for each variable were calculated as the difference between ST and DT performance expressed as a percentage of ST performance. The capacity to shift was defined as the difference in task performance between DT-walk and DT-cog conditions. The Wilcoxon signed rank test was used for statistical analyses. RESULTS: People with PD walked more slowly and responded to the cognitive task more slowly and less accurately than HYA and HOA (all $p<.008$). Instructions affected gait speed and cognitive task response latency (both $p<.001$), with the greatest effect in HYA. Gait speed DTCs were greater for people with PD and HOA than for HYA ($p=.003$). Instructions affected DTCs for gait speed and response latency (both $p<.001$), with the greatest effect in HYA. The capacity to shift was smaller for people with PD and HOA compared to HYA ($p=.03$). People with PD showed greater variability in shifting task performance in response to instructions. CONCLUSIONS: Individuals with PD, like HYA and HOA, demonstrated changes in DT gait speed and cognitive task response latency in response to instructions. This suggests that individuals with PD retain dynamic prioritization, or the ability to flexibly prioritize tasks and modify task performance, in response to instructions under DT walking conditions. The observed magnitude of shifting was smaller in people with PD and HOA compared to HYA. A reduced ability to shift task prioritization and the variability in individual shifting strategy has implications for the type of DT gait training used in this population. If some people with PD have a reduced capacity to shift task performance in response to instructions, a different intervention approach may be more effective.

P1-D-64 Ronnie Gardiner Rhythm & Music Method in patients with Parkinson's disease - A pilot study

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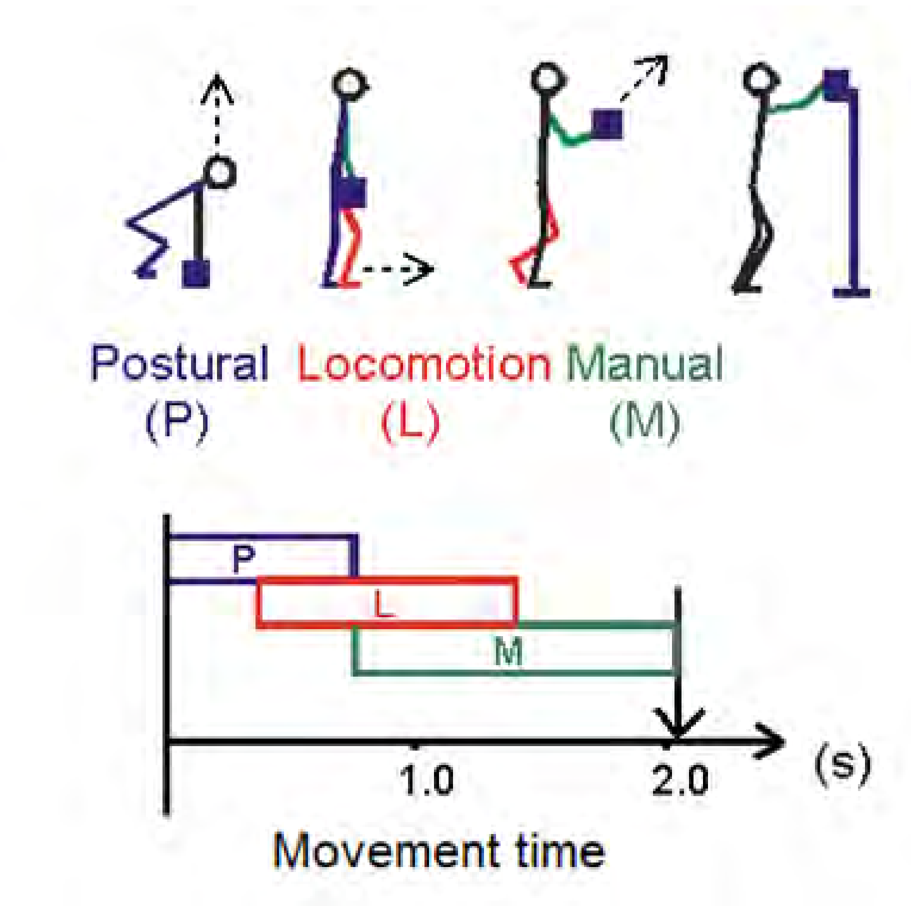
BACKGROUND AND AIM: Patients with Parkinson's disease (PD) may benefit from rhythm as an external cueing strategy and music has during a long time been used in rehabilitation in PD patients. The Ronnie Gardiner Rhythm & Music (RGRM) Method is a specific form of active music therapy. The method aims at stimulating functional skill redevelopment and engages sensory processes, attention, multisensory integration and cognition and has been used in Sweden since 1993 in patients with neurological disorders. There is, however, scarce evidence on the efficacy of the RGRM Method in patients with PD. The aim of this study was to evaluate the effect of the RGRM Method regarding motor function, cognition and quality of life in patients with PD and to calculate the number of subjects required for a larger study, as no previous studies have been performed. METHODS: A small-scale randomized single-blinded control design with pre- and posttest evaluation was used for this pilot study. Eighteen patients with mild to moderate PD, age 59-76, were included and randomized into intervention group (n=12) and control group (n=6). Motor function was assessed by the Unified Parkinson Disease Rating Scale motor part, the Timed-Up-and-Go and the Posturo-Locomotion-Manual (PLM) test. Cognitive function assessments included a selection of tests from the Cognitive Assessment Battery: Text recall test, Symbol Digit Modalities test, Clox and Cube, Naming 30 items, Stroop Color-Word test and Parallel Serial Mental Operations. Quality of life was assessed by the Parkinson Disease Questionnaire with 39 items. The intervention program was conducted twice a week during 6 weeks. The leader-centered program consists of exercises using a unique form of notes and schedules, specially created for this method, to be followed to the beat of music. The notes and schedules can be varied in different ways in order to challenge the brain. The control group did not have any activity. Non-parametric tests were used for statistical analysis and power analysis was performed based on results from the PLM test. RESULTS: Sixteen patients, 10 women, 8 men, completed the intervention period. There were 2 drop-outs from the control group. The intervention group improved significantly over time in motor and cognitive function, and quality of life. The control group also experienced some improvements; all of them, however, non-significant. The difference between the intervention group and the control group did not reach statistical significance. The power calculation based on results from the movement analysis, showed that 90 patients will be required to show a true difference of means in a future study with a similar design. CONCLUSION: The present study suggests that the RGRM Method may be a useful treatment for PD patients with mild to moderate symptoms. Large, well designed randomized controlled trials are needed to verify if the method provides effective rehabilitation for patients with PD.



P1-D-65 Fear of falling in the elderly related to ICF and relevant gender theories

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BACKGROUND AND AIM: The prevalence of Fear of Falling (FoF) is higher among elderly women than in men. In short term FoF may serve as a protective factor. In long term it may lead to unwanted consequences such as activity restriction and functional decline. The objective of this study was to explore possible gender differences regarding FoF and future fall events in community-dwelling seniors 75+, expressed in terms of femininity/masculinity and gender role identification, and relate the findings to the components of the International Classification of Function and Disability (ICF). We hypothesized that the component 'Environmental factors' would have an influence on the factor FoF in both men and women. METHODS: A total of 230 physically active seniors (166 women and 64 men) were included, mean age 79.5 (SD 3.7). A cross-sectional design was used with baseline data collection followed by a prospective 12 months collection of fall events. Baseline assessments included performance-based assessments, questionnaires and sensory functions, in total 44 variables. FoF was assessed by the question "Are you afraid of falling" with a 5-category response scale. A log linear analysis was used to investigate associations between FoF, future falls and gender. A structural equation model with a confirmatory factor analysis was used to find relationships between FoF, and the components 'Personal

factors' (e.g. age), 'Environmental factors' (e.g. living conditions), 'Activity & Participation' (e.g.gait), Body Function & Body Structure (e.g. vision) and Non-definable (self-rated health), in men and women. RESULTS: The log linear analysis showed strong relationship between FoF and gender. Almost halft of the sample (48%) reported FoF, of which 87% were women, p<0.001. There was, however, no relationship between FoF and future falls (53% men with FoF and 49% women fell) or between future falls and gender. The confirmatory factor analysis gave support for the ICF as a conceptual model. The structural equation model showed that the components 'Personal factors' and 'Activity & Participation' were those that had a significant influence on FoF in men and women both, however, in different ways. 'Environmental factors' had no influence on FoF, neither for men nor women, as was hypothesized. Using gender theories as explanatory model, it is suggested that there may be biological, psychological and social reasons for this inequality in FoF among men and women. CONCLUSIONS: Having FoF meant neither a lower nor higher risk for future falls in men and women. As has previously been shown by others, the prevalence of FoF was significantly higher among women. The women did, however, not fall more often than men. ICF proved to be a useful tool to map factors associated with FoF. 'Personal factors' and 'Activity & Participation' had a strong influence on FoF in men and women, but in different ways. 'Environmental factors' had no influence on FoF, as was hypothesized.

P1-D-66 The effect of manipulated balance efficacy on risk taking balance behaviour

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BACKGROUND AND AIM: Balance efficacy is an individual's confidence in his/her ability to maintain balance and avoid falling when performing activities of daily living. Mismatches between balance efficacy and actual balance ability may predispose individuals to engage in more risky or cautious behaviour. The current study was designed to experimentally manipulate balance efficacy in order to investigate its influence on risk taking balance behaviour. METHODS: Young adults (n=61) walked in tandem steps a distance of 6-m wearing opaque goggles to occlude vision. Participants were then randomized to either a high balance efficacy (n=22; provided with feedback that performance on this task was within the top 20% for their age and gender), low balance efficacy (n=17; provided with feedback that performance on this task was within the bottom 20% for their age and gender), or control (n=22; provided with no feedback) group, regardless of their actual performance. Following the feedback, participants performed the same tandem walk task. Participants rated their balance efficacy prior to each task and their perceived stability following each task. To examine the effects of manipulated balance efficacy on risk taking balance behaviour, after receiving the feedback, participants were asked to choose one of the following 3 tasks that they wanted to perform after they completed the second tandem walk task: tandem walking on a slippery surface with 1) full support (i.e., harness), 2) assistance from 2 spotters, or 3) no assistance at all. Although not aware of it at the time, participants did not have to complete the task selected. RESULTS: The results showed a significant group by time interaction for balance efficacy (p<.01). Follow-up analyses showed that after receiving feedback, balance efficacy significantly increased for individuals in the high balance efficacy (18.6%) and control (8.2%) groups while balance efficacy did not significantly change for those in the low balance efficacy group. With respect to risk taking balance behaviour, chi-square analysis showed that more individuals in the high balance efficacy group selected the riskiest task (i.e., no assistance) compared to the low balance efficacy or control groups while more individuals in the low balance efficacy group selected the least risky task (i.e., full support) compared to the high balance efficacy or control groups. CONCLUSIONS: The results showed that verbal persuasion in the form of positive comparative balance feedback did manipulate balance efficacy and subsequent risk taking behaviour. Negative comparative feedback did not manipulate balance efficacy but did influence risk taking behaviour; it is possible that other factors besides balance efficacy contributed to this change. Future work will examine the impact of manipulated balance efficacy on risk taking behaviour in older adults and individuals with balance problems. This study was supported by a grant from NSERC.

P1-D-67 The relationship between self-presentational concerns and balance-related outcomes in older women

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BACKGROUND AND AIM: Balance confidence is associated with a number of important health-related outcomes in older adults including balance ability and fall risk. Researchers have begun to investigate the influence of other factors such as emotions and cognitions on balance ability. Anecdotal evidence suggests that self-presentational concerns may be associated with balance-related outcomes such as balance ability and balance confidence. Therefore the purpose of this study was to examine the relationship between performance on a functional balance task, balance confidence and self-presentational concerns in older women. METHODS: Participants were 175 healthy, community dwelling women aged 60 years or older. A series of questionnaires assessing balance confidence, social anxiety, social physique anxiety, and self-presentational efficacy were completed. Participants also completed the timed-up-and-go (TUG) as a measure of functional balance performance. Bivariate correlations were conducted to investigate simple relationships between study variables. In addition, a hierarchical regression predicting TUG performance from balance confidence and self-presentational concerns (social anxiety, social physique anxiety, and self-presentational efficacy) was conducted. RESULTS: A negative relationship between balance confidence and TUG performance ($r = -.40$, $p < .001$) and self-presentational efficacy and TUG performance ($r = -.33$, $p < .001$) was found. In addition, balance confidence was negatively related to social physique anxiety ($r = -.31$, $p < .001$) and social anxiety ($r = -.37$, $p < .001$) and positively related to self-presentational efficacy ($r = .53$, $p < .001$). The regression analysis showed that balance confidence and self-presentational efficacy were significant predictors of performance on the TUG ($F(4, 170) = 9.78$, $R2adj = .17$, $p < .001$). CONCLUSIONS: Concerns over the impressions made on others are related to balance and balance confidence. In addition, after accounting for balance confidence, self-presentational concerns are related to actual balance. The present findings highlight the importance of considering other psychological factors such as self-presentational concerns when measuring balance-related outcomes. Research is needed to examine the causal relationships to such outcomes. Investigating variables other than balance confidence related to functional balance

performance in older adults may provide novel ways to impact such an important health-related variable in the aging population.

P1-D-68 Cross-sectional associations between cognition and Timed Up-and-Go in a population based study

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BACKGROUND AND AIM: The Timed Up-and-Go (TUG) test assesses functional mobility and is recommended as part of a routine falls assessment in older adults (1). While TUG is primarily seen as a mobility task, it also involves a substantial cognitive component. Two studies reported that global cognitive deterioration and reduced executive function were independent predictors of poorer TUG performance (2, 3) however research examining associations with other cognitive domains is lacking. This population based study examined the cross-sectional associations between global cognition, executive function, processing speed, attention, memory and TUG performance. METHODS: A nationally representative sample of community dwelling adults (aged 50 years) took part in wave 1 of The Irish Longitudinal Study on Ageing (TILDA). Participants (n=5845) completed an interview (which contained sociodemographic, health and psychological questions) and a health assessment of mobility (TUG) and cognition. Cognitive assessment included tests of global cognition (MMSE, MOCA), executive function (colour trails test, verbal fluency), processing speed (choice reaction time), attention (sustained attention reaction time) and memory (prospective memory, immediate and delayed recall, picture memory). Linear regression was used to examine if each cognitive test was independently associated with TUG performance before and after adjusting for age, height, sex, BMI, education, chronic conditions, medications and depressive symptoms. Statistical tests took place in stata; significance was set at $p<0.05$. RESULTS: Univariate regression analysis indicated that all cognitive tests were significantly associated with TUG performance ($p<0.05$). After adjusting for confounders, all cognitive tests from each domain except the picture memory test remained significant predictors of TUG ($p<0.05$). Similar results were obtained when analysis was repeated for participants aged <65 and ≥65 years ($p<0.05$). CONCLUSION: These results highlight the strong associations between a decline in all domains of cognitive function and poorer TUG performance. Co-existing declines in mobility and cognition increase the risk of institutionalisation (4) and dementia (5). TUG may represent a useful screening tool to detect not just mobility impairment but also possible cognitive impairment. Clinically, an individual who presents with poor TUG performance should be referred for a comprehensive geriatric screening to include cognitive assessment.

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P1-D-69 Fall prediction in community-dwelling elderly: Can risk assessments be improved by evaluating combined clinical balance and psychological measures?

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BACKGROUND AND AIM: A review of the literature shows that clinical balance tests cannot be used alone to reliably predict fall risk in community-dwelling elderly. The predictive value of clinical tests may be improved with the use of postural threat and/or cognitive load. Research has shown that postural threat affects performance of clinical balance tasks in young adults. Evidence also suggests that dual-tasks may have an advantage over single-task balance assessments in predicting falls. It is currently unclear whether postural threat and/or dual-tasking will affect clinical balance measures in older individuals. Fear of falling and low balance confidence have been associated with increased fall-risk. However, these measures have shown poor fall prediction abilities; use of state-specific measures may better predict fall-risk. Changes in state-specific confidence and anxiety have been correlated with changes in performance of clinical balance tasks in young adults. The objectives of this study were: 1) to evaluate standard clinical balance and general psychological measures in their ability to predict prospective falls 2) to compare the predictive ability of clinical balance measures performed under postural threat and/or cognitive loading and 3) to determine the value of including state-specific psychological scores with balance measures for prediction of falls. METHODS: Fifty-two individuals aged 66-86 participated. Clinical balance measures included the Berg Balance Scale (BBS) and the Timed-Up-and-Go (TUG) as well as one-leg stance (OL), functional reach (FR) and sit-to-stands (STS) performed under postural threat and/or cognitive loading conditions. Psychological measures included general fear of falling (FOF) and the Activities-Specific Balance Confidence Scale (ABC) as well as state-specific measures of balance confidence, anxiety, and fear of falling. Prospective falls were assessed for 1 year. RESULTS: Univariate regression analysis revealed non-significant AUC values for the BBS, TUG, FR, OL and STS. Multivariate analysis revealed significant AUC values for the combination of FR, OL, and STS (0.70-0.76). Univariate analysis revealed non-significant AUC values for the ABC and general FOF. Significant AUC values were found for state-specific balance confidence (0.69) and anxiety ratings (0.72), when tasks were performed under combined threat and load. AUC values improved from 0.63 with FR only to 0.72 with FR and confidence combined. CONCLUSIONS: None of the clinical balance scales/measures could, alone, predict fall status. However, the combined scores on three simple tasks could prospectively discriminate fallers from non-fallers. Generalized psychological measures were unable identify fallers but state-specific ratings were able to do so. Including task-specific psychological scores with balance measures improved the precision with which we were able to identify community-dwelling elderly individuals likely to fall.

P1-D-70 Balance confidence and fear of falling avoidance behavior are most predictive of falling in older adults: A prospective analysis

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BACKGROUND AND AIM: There are many physical and psychological factors that have been shown to be related to balance impairment and falling. Among the psychological factors that may be related are balance confidence and fear of falling, which is a common sequela of falls. Few studies, however, have used a prospective design to determine which of these variables is most predictive of future falling. Therefore, the purpose of this study was to determine which commonly used measurement tools (physical and psychological) predict future fall events. 64 subjects (age 72.2 ± 7.2; 40 women) with and without pathology (25 healthy, 17 with Parkinson's disease, 11 with cerebrovascular accident, 6 with diabetes, and 5 with a cardiovascular diagnosis) participated in this study. Eight subjects were lost at the one year follow-up (unable to make contact = 7 cases; death = 1). METHODS: At the initial assessment, the number of falls in the preceding year (fall history) was recorded for all subjects. In addition, all participants completed the following measurement tools: Berg Balance Scale (BBS), Dynamic Gait Index (DGI), Self-Selected Gait Velocity (SSGV), Timed Up and Go Test (TUGT), Sensory Organization Test (SOT) using computerized dynamic posturography, Fear of Falling Avoidance Belief Questionnaire (FFABQ), Falls Efficacy Scale (FES), and Activities-Specific Balance Confidence Scale (ABC). Participants were then contacted one year after the initial assessment to determine how many falls had occurred in the ensuing year. Using multiple regression, fall history and all of the other measurement tools were entered as predictor candidates using the stepwise method to predict the number of falls in the year after the initial assessment. RESULTS: Only three variables were included in the final model in the following order of entry: ABC (38.7% of the variance), FFABQ (5.6% additional variance) and TUGT (4.9% additional variance). Together, these variables explained 49.2% of the variance for falls in the subsequent year. When ABC was removed from the model, only the FFABQ (33.2% of the variance) and FES (6.8% additional variance) were included in the final model. Neither history of falling nor the remaining physical balance tests (ie, BBS, DGI, SSGV, SOT) were predictive of falls. CONCLUSIONS: Balance confidence was the best predictor of future falling, followed by fear of falling avoidance behavior. Interestingly, a history of falling or physical balance tests did not predict future falling. Taken together, these results suggest that psychological factors may play a bigger role in falling than physical factors. In addition, these findings suggest that patients may have a better sense of their balance and risk for falls than a balance test that provides a physical snapshot of their balance capacity.

P1-D-71 Visuospatial attention influences on toe clearance during obstacle crossing

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BACKGROUND AND AIM: Visuospatial attention is required when one searches for an object in space in order to interact with the environment successfully and efficiently. Avoiding an obstacle during gait involves visuospatial attention to identify the obstacle along the path and to safely clear the barrier. Toe-obstacle clearance is a sensitive indicator to predict the risk of tripping and falling. In this study, we

included a visuospatial attention task while walking and crossing over an obstacle, which allowed us to examine how these tasks interact. We hypothesized that toe-obstacle clearance would reduce while performing the visuospatial attention task during walking. METHODS: Seven young participants performed obstacle crossing gait with and without the visuospatial attention task at self-selected walking speed. Subjects were instructed to identify a briefly presented (500ms) stimulus (shown as an "E" or "3") as quickly and accurately as possible among distractors (2s and 5s) within a circular visual display projected onto the ground immediately prior to the obstacle. Ten trials for each condition were performed. The obstacle was set as 10% of the subject's height. Reflective markers were placed on bony landmarks, and 3-D body movement data were collected with a ten-camera motion capture system. Toe-obstacle clearance was identified for the toe marker during each trial. Student's t-test was applied to detect the difference between group's means. RESULTS AND DISCUSSION: Toe-obstacle clearances were found to be reduced while performing the visuospatial task during gait for both the leading (with task: 13.1cm vs. without task: 14.9cm; $p = 0.174$) and trailing (with task: 12.5cm vs. without task: 17.6cm; $p < 0.0001$) limbs as compared to obstacle crossing without the task. This suggests that an increased demand in visuospatial attention during obstacle crossing could affect our perception of obstacle height and control of foot trajectory. Such effect seems to be more significant while the trailing limb is crossing over. CONCLUSIONS: Increasing the visuospatial attention demand during obstacle crossing led to a reduction in toe-obstacle clearance in young adults. This implies that age-related declines in visuospatial attention could be a plausible contributing factor to the increased risk of tripping in the elderly.

P1-D-72 Response inhibition during a reaction time task: A marker for falls risk in older people?

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BACKGROUND AND AIM: Impaired stepping behaviour is common in older people, especially in people at risk of falls. Additionally, it has been shown that fallers perform worse when cognitive load is increased. The choice stepping reaction time (CSRT) test is a measure of stepping performance and has been related to falls in older people. The present study uses a previously validated 'exergame' dance pad for the measurement of CSRT. We aimed to determine whether an inhibitory CSRT task provides additional value over a standard CSRT task in discriminating fallers from non-fallers. METHODS: A cross-sectional study in 105 independent-living adults (age 79.5±4.8 years) was conducted. All participants were cognitively intact (MMSE≥24) and free of physical limitations that would affect their stepping performance. They underwent a range of tests associated with fall risk and completed two tests of CSRT using a custom-made dance pad and a 58cm computer screen placed on the ground 1m in front of them tilted upwards (Figure 1). First, participants were instructed to step on the corresponding arrow of the mat as displayed on the screen (CSRT). The same was repeated with a no-go inhibitory task in 25% of the trials, indicated by the arrow's colour on the screen (INHIB). Reaction (RT) and movement times (MT) of both stepping tasks were recorded. Participants who reported one or more falls in the past 12 months were classified as fallers. RESULTS: Thirty participants (29%) fell at least once in the previous year. Mean RTs for CSRT and INHIB were 804±109ms and 898±121ms. Both tasks were significantly correlated to

measures of physical function (Timed up & go r=-0.55, 5 Sit-to-Stand r=0.50, 6m-walk r=0.49) and fear of falling (Icon-FES r=0.32). Mean RTs were slower in fallers compared to non-fallers for both CSRT (842±134ms and 789±94ms respectively, t=-2.14 p=0.034) and INHIB (940±125ms and 880±116ms respectively, t=-2.28, p=0.025). Movement times did not differ between fallers and non-fallers (CSRT: 289±91ms and 276±62ms respectively, t=-0.70, p=0.488; INHIB: 285±75ms and 270±67ms respectively, t=-0.99, p=0.326). Univariate logistic regression analyses showed that CSRT and INHIB were both significantly associated with previous falls (OR =1.62 (1.04-2.51), OR=1.65 (1.06-2.57), respectively) for each SD change. Additional analyses using ROC curve derived cut points for CSRT (798ms) and INHIB (888ms) showed a moderate diagnostic accuracy in discriminating fallers from non-fallers (AUC=63% (50-75%) and 65% (53-77%) respectively). CONCLUSIONS: The current study suggests that both step tests (CSRT, INHIB) can discriminate fallers from non-fallers. However, considering a similar diagnostic accuracy of both tasks, the inhibitory CSRT task appears to have no additional value over a standard CSRT task in a sample of independent-living older adults.

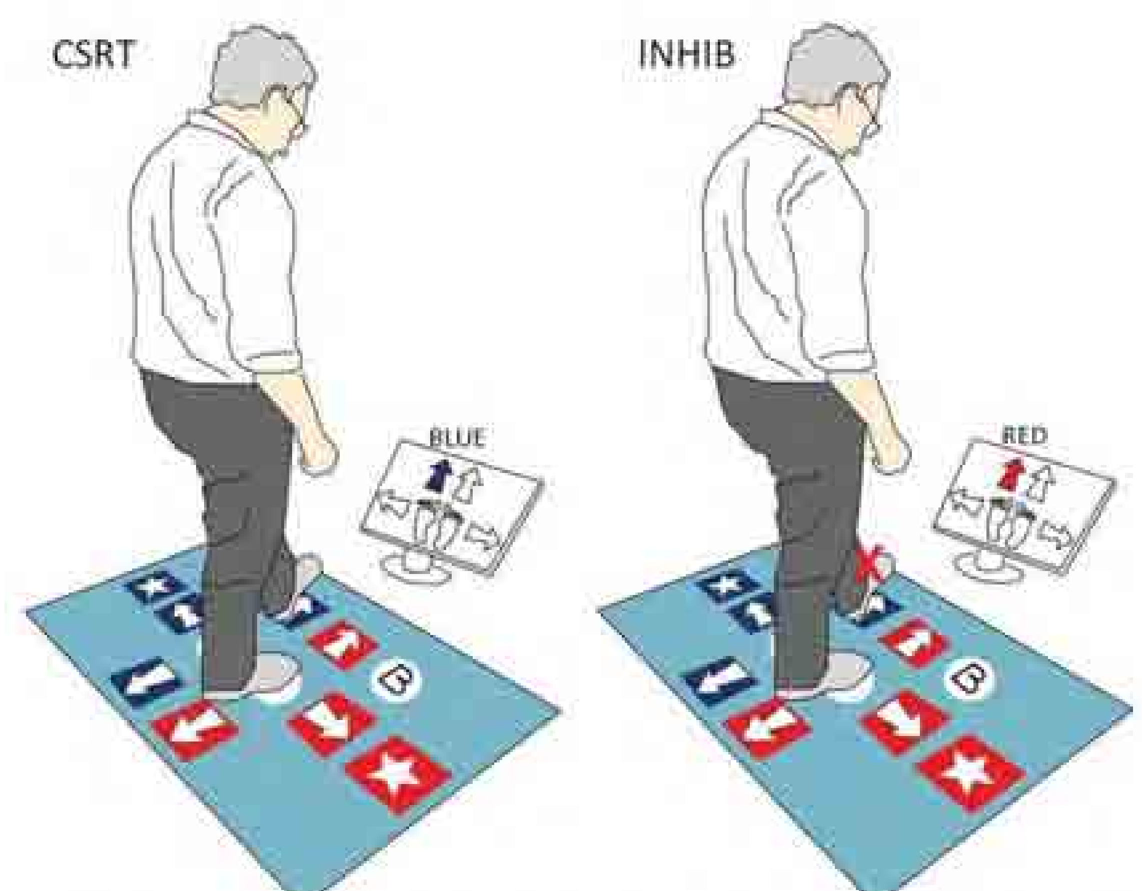

Figure 1: left – plain CSRT task, right – CSRT task with additional inhibitory task (the participant should NOT step onto the front left arrow)

P1-D-73 A training program to improve gait while dual tasking in patients with Parkinson's disease: A pilot study

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BACKGROUND AND AIMS OF THE STUDY: Impairments in the ability to perform another task while walking, i.e., dual tasking (DT), are associated with an increased risk of falling. Here we describe a program that we developed specifically to improve dual tasking performance while walking based on motor learning principles and task specific training. We examined feasibility, potential efficacy, retention, and transfer to the performance of untrained tasks in a pilot study among seven patients with Parkinson's disease (PD). METHODS: Seven patients (Hoehn & Yahr stage: 2.1±0.2) were evaluated before, after, and one month after four weeks of DT training. Gait speed and gait variability were measured during usual-walking and during four different DT conditions. The four week program of one-on-one training included walking while performing several distinct cognitive tasks. RESULTS: Gait speed and gait variability during DT significantly improved after the completion of the training. Improvements were also seen in the DT that were not specifically trained and were retained one month after training. For example, gait speed during a verbal fluency task improved from 0.97±0.16 m/s to 1.18±0.15 (p=0.02) and gait variability decreased (i.e., better) from 2.6±0.75 to 1.9±0.40 (p=0.01). CONCLUSIONS: These initial findings support the feasibility of applying a task specific DT gait training program for patients with PD and suggest that it positively impacts on DT gait, even in untrained tasks. The present results are also consistent with the possibility that DT gait training enhances divided attention abilities during walking.

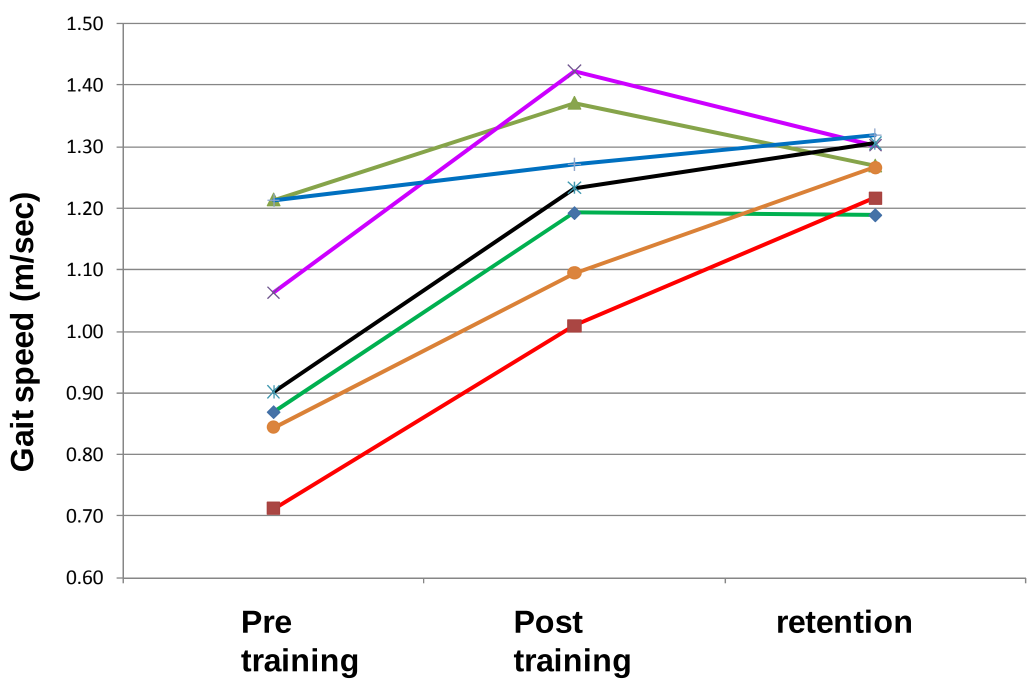

Figure 1: Example of the effects of dual task (DT) training on DT gait speed among the individual subjects. Gait speed measured during the pre-training, post-training and retention evaluations are presented for each participant (i.e., each line represents a different subject) for the serial 3 subtraction DT condition. Note that for all subjects, DT gait speed was higher at post-training and 1 month later, compared to baseline, pre-training values.

P1-D-74 Gait characteristics respond selectively to test protocol: Influence of distance, dual task and pathology

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BACKGROUND AND AIM: Gait speed, stride variability and step width reflect discrete aspects of locomotion. Gait speed can be reliably captured over a short distance; gait variability is measured over a longer distance to increase stride count; while optimal testing for step width has yet to be defined. These characteristics are also measured under dual-task conditions which aim to preclude compensation through cognitive mechanisms. Both distance and dual task may have a selective effect on these gait characteristics as may pathology. We aimed to compare the effect of a continuous versus an intermittent walking protocol on gait speed, stride time variability, and step width under single and dual task conditions in early Parkinson's disease and controls. METHODS: Participants walked at their preferred pace for 2 minutes (continuous protocol) and 12m trials (x3) (intermittent protocol) under single task and dual task conditions. Gait was measured using a 7m instrumented walkway (GAITRite). For dual task conditions participants performed a concurrent digit span normalised for task difficulty. Variability was calculated as within subject SD of individual steps pooled within condition for stride time. Group differences were analysed using a mixed model ANOVA. RESULTS: Seventy-one controls and 55 PD participated, with mean (SD) single, intermittent gait speeds of 0.95 (17.2) m/sec and 0.70 (21.1) m/sec respectively. For both groups gait speed was slower under continuous ($p<0.001$), and dual task ($p<0.001$) conditions, but there was no interaction between groups ($p = .882$). Stride time variability increased for both groups under continuous walking ($p <0.01$), and a significant interaction (group*walk; $p = 0.05$) showed this was more marked for PD. Both groups were also more variable under dual task ($p<0.001$). Step width increased under dual task conditions ($p<0.001$), however a significant interaction (group*task; $p<0.01$) showed controls widened their steps under dual task conditions more than PD participants. CONCLUSIONS: Protocol has a selective effect on gait characteristics. Gait speed is sensitive to distance, suggesting that short walks may over-estimate ability. Greater distance is also important for stride time variability, especially for pathology in which the effect is more marked. Dual task mediates both speed and variability although we did not see a selective effect for pathology, possibly because testing was in early PD. In contrast, distance is less important for step width. However an inability to compensate cognitively (under dual-tasks) and pathology have a selective effect on step width revealing controls and PD adopt different strategies to maintain postural control while walking under dual task

conditions. These results point to the need to carefully select a test protocol for optimal measurement of individual gait characteristics.

P1-D-75 Gait variability in older adults and Parkinson's disease: An evaluation of test-retest reliability, stride number and single and dual-tasks.

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BACKGROUND AND AIM: Gait variability is emerging as a sensitive and discriminative measure of gait under both single and dual task conditions. It has also been reported as an outcome measure in clinical trials where it is has been used as a proxy measure of gait stability and falls risk. However, the test-retest reliability of gait variability is unclear along with the effect of gait characteristic, stride count, and dual task on reliability. These raise important questions that need to be addressed in order to give clear guidelines for the use of variability use as an outcome measure. We aimed to evaluate the test-retest reliability of gait variability under single and dual task conditions in PD and older adults and determine the recommended stride count required. METHODS: Gait variability was measured twice, one week apart, in 52 participants (25 people with PD: 12f/13m, 68yo, 1.69m, 76.3kg, UPDRS III 26, tested on levodopa medication; 27 older adults: 20f/7m, 72y, 1.63m, 73kg). Participants walked at their preferred pace under two conditions (Single task: just walking; Dual task: walking whilst performing a concurrent digit span recall task which was normalised for task difficulty). Gait was measured using a 7m instrumented walkway (GAITRite) which was positioned to form part of the 25m circuit allowing data to be sampled repeatedly throughout the 2 minute trial. Variability was calculated as the within subject standard deviation of individual steps pooled within each condition for: stride velocity and length, stride, stance and swing time, and step width. Reliability was assessed visually with Bland-Altman plots prior to calculating limits of agreement relative to the mean and intraclass correlations. RESULTS: Test-retest reliability of gait variability ranged from poor to excellent (ICCs .141 - .799; Limits of Agreement 18% - 69%). Step width variability was the most reliable measure and stride length the least. Increasing the number of steps improved reliability however there was no further improvement beyond 20 strides. Test-retest reliability was greater for single task walking than dual task in both groups. However, variability was less reliable for PD compared to controls under dual task conditions. Variability of all outcomes decreased in the second test for both groups irrespective of single or dual-task condition. Bland-Altman plots revealed those who performed worst in the first test improved most in the second test CONCLUSIONS: Gait variability ranges from poor to excellent in older adults and people with PD depending upon the variable and number of strides. We make the following recommendations to obtain reliable estimates of gait variability and improve the psychometric properties of gait variability: include at least 15-20 strides; include at least one practice trial; and express performance as the percentage change.

P1-D-76 Age-related changes in postural dynamics: Contributions of delayed visual feedback and cognitive task load

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BACKGROUND AND AIM: Age-related changes in the usage of visual feedback information adversely influence balance. The purpose of this experiment was to determine the manner in which cognitive load and temporal salience of visual feedback influence the stability of upright stance. METHODS: Thirty healthy young (n = 15) and older (n = 15) adults participated in this study. Visual feedback of the centre of pressure (COP) and a fixed-target were provided on an LCD monitor. Participants were required to position their COP as close to the fixed-target as possible. The cognitive dual-task consisted of a simple arithmetic task. Visual feedback conditions consisted of eyes-open (no COP feedback) and delayed visual feedback (DVF) conditions (0, 300, 600, 900 ms). High and low-pass filtering (fc = 0.3 Hz) were used to compute the variability of anteroposterior (AP) Center of Pressure (COP) trajectories on fast (> 0.3Hz) and slow (< 0.3Hz) timescales. RESULTS: The results demonstrated that while sway variability increased with visual delay in both groups, older participants exhibited greater sway variability across all DVF conditions. In addition, cognitive load had a differential effect on AP COP variability in the two age groups. Combined DVF-cognitive task performance decreased AP COP sway variability in the young group. Older adults, in contrast, did not benefit from cognitive dual-task performance. CONCLUSIONS: This finding likely reflects the insufficient or inappropriate allocation of attentional resources in older adults. Continued research is required to elaborate on age-related differences in postural control to unravel the complex interaction between visual feedback and the performance of supra-postural cognitive tasks.

E - Sensorimotor Control

P1-E-77 The relationship between sensorimotor capacities, gait speed and efficiency during gait on an uneven surface

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BACKGROUND/AIM: Patients with diabetic peripheral neuropathy (PN) have greater difficulty walking safely on uneven surfaces than patients with diabetes without PN or healthy controls (1). However the relative importance of lower limb sensorimotor functions at the ankle and hip with regard to gait on an uneven surface has not been explored. Therefore, the objective of this research was to examine how lower limb sensorimotor functions involved in frontal plane control influence gait speed and efficiency on an uneven surface. METHODS: 33 older persons with a spectrum of sensorimotor function ranging from normal to moderately severe diabetic PN were recruited. Specific sensorimotor function measured included: normalized maximum voluntary contraction strength (MVS) and maximum rate of torque development (RTD) of the hip abductors and adductors using a custom dynamometer (BioLogic Engineering, Inc.)(2), normalized ankle invertor and evertor MVS and RTD using a closed chain protocol with subjects standing on a force plate (AMTI OR6), and ankle inversion/eversion proprioception thresholds measured as the subject stood with the right foot in a cradle that rotated incrementally more, or less, based on subjects accuracy of response to the rotating stimulus (3). After these measurements, patients walked over a 10m uneven surface at a casual gait speed. Kinematic data were measured at 100 Hz using an optoelectronic camera system (Optotrak 3020, Northern Digital Corp., Waterloo, Ont.). The strength of the relationships between sensorimotor function and gait speed, and efficiency (defined as step width to step length ratio), were determined by Pearson correlation coefficients (R). Sensorimotor functions with significant relationships to gait speed and efficiency were introduced as potential predictor variables in a stepwise fashion, using age, BMI and confidence (ABC scale) as co-variables. RESULTS: R values ranged from 0.326 to 0.665. Regression analysis identified four predictors for gait speed: hip adductor RTD, ankle invertor RTD, balance confidence, and hip abductor MVS. Ankle invertor RTD was the only significant predictor for gait efficiency. Overall, almost 70% of the gait speed variability and 46% of the variability in gait efficiency were explained (Table 1). CONCLUSIONS: The results demonstrate that frontal plane motor function, especially RTD at the hip and ankle, explain a large proportion of gait speed and gait efficiency. Ankle proprioceptive function does not appear to influence gait speed or efficiency after frontal plane motor function and confidence are taken into account. We conclude that strength training regimens should particularly focus on improving the capacity to rapidly develop strength in muscles influencing frontal plane control. It is likely that the training response would be superior at the hip than at the ankle in presence of PN.

Table 1: Results of Regression Analysis

Sensorimotor functions predicting gait speed on an irregular surface

Parameters	R	Adj. R^2	SE Estimate	F Change	Sig. F Change
RTD Hip Add	0.610	0.416	0.129	20.907	0.000
RTD Ankle Inv	0.735	0.504	0.119	5.826	0.023
Confidence	0.792	0.583	0.109	5.915	0.023
MVC Hip Abd	0.833	0.643	0.101	5.220	0.031

Sensorimotor functions predicting an efficient gait (low SW/SL ratio)

	R	Adj. R^2	SE Estimate	F Change	Sig. F Change
RTD Hip Add	0.678	0.440	0.061	22.96	0.000

RTD Hip Add = Rate of torque development of Hip Adductors; RTD Ankle Inv = Rate of torque development of Ankle inversion; Confidence (measured with the ABC scale); MVC Hip Abd = Maximum voluntary contraction of Hip Abduction

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P1-E-78 When is visual information used to control adaptive locomotion involving stepping down to a new level or over an obstacle?

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BACKGROUND: Stepping down to a new level or crossing obstacles during locomotion involves the regulation of appropriate foot placement before the step-edge/obstacle and foot clearance over it [1-4]. Stepping down also involves the modulation of gait output to ensure the centre-of-mass is safely and smoothly lowered to the new level [4]. Previous research has shown that vision is used in feedforward manner to adapt gait in such tasks [1,4], with vision from the lower visual field (lvf) used for online updating [2-3]. We conducted two separate studies; the aim of each was to determine precisely when lvf information is used online to update foot clearance over the surface edge (study 1) or obstacle (study 2). Study 1 also determined if lvf information is used online to update landing-control when stepping down to a new level. METHODS: Two groups (n=12) of young adults took part. Groups either stepped down a level or over an obstacle during ongoing gait. Force sensitive resistors (attached to participants' feet) interfaced with an PDLC sheet, allowed the lvf to be unexpectedly occluded at either heel-contact of the penultimate or final step before the surface edge/obstacle. Analysis focussed on determining changes in foot placement before the surface edge/obstacle and clearance over it. Study 1 also determined changes in pre-landing kinematic and landing mechanic measures for the step onto the lower floor level. RESULTS: Lvf occlusion from the instant of final step heel-contact had no significant effect on any dependant variable. Occlusion of the lvf from the instant of penultimate heel-contact led to an increase in final foot placement distance (only significant for obstacle crossing) and foot clearance (both studies), and in study 1, had a significant effect on several pre-landing kinematic and landing mechanic measures. CONCLUSIONS: These findings suggest that lvf (exproprioceptive) input is typically used in an online manner to control/update final foot-placement, and that without such control/updating uncertainty regarding relative foot placement causes foot-clearance over the surface-edge/obstacle to be increased. In study 1, the uncertainty also caused imprecision regarding exactly when contact with the lower level would occur, which led to pre-landing kinematic and landing mechanic changes. Findings also suggest that lvf input is not normally exploited in an online manner to control/update lead-limb swing trajectory (foot-clearance) when descending a surface level change or crossing an obstacle during ongoing gait: which is contrary to what previous research has suggested [1,3]. Instead such is controlled/updated using lvf information acquired during the preceding step, with information regarding final foot placement being the most salient.

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P1-E-79 What visual source is more important for toe clearances and stability regulation during obstacle crossing?

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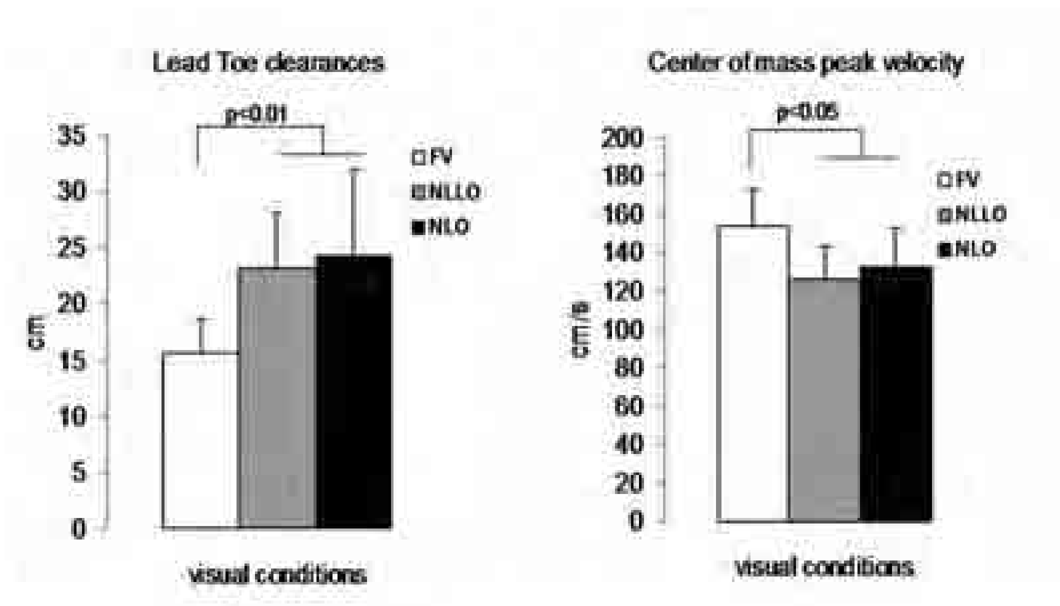
INTRODUCTION: Previous studies have inferred that vision of both the lower limbs and obstacle position during obstacle crossing are important for fine tuning during clearance1. Since it is assumed that most stepping behaviours are pre-planned, the need for vision of other aspects of the environment (other than limbs and obstacle) have largely been dismissed. It is not known how isolating different sources of visual information (from limb and obstacle position and the rest of environment) might influence online control during obstacle crossing.2,3 Additionally, the influence of isolating the source of visual feedback on stability has not been investigated in these previous studies. The aim of this study was to isolate the contribution of visual references of the lower limbs, obstacle and environment surrounding the obstacle during obstacle crossing. METHODS: Nine healthy young participants were walked and stepped over an obstacle set at 15% of their height in complete darkness. Three visual conditions were used in order to selectively constrain visual information: Full vision (FULL); Lower limbs and obstacle cues (LL+O) and only obstacle cue (O). Luminescent stripes were attached to the lower limbs and top edge of the obstacle, in order to highlight the lower limbs and obstacle height and position. RESULTS: Polynomial contrast tests showed that without full vision toe clearances were higher ($F_{1,8}=14.4; p<0.005$) and center of mass peak velocity ($F_{1,8}=22.65; p<0.001$) was slowed during obstacle crossing. Pairwise comparisons confirmed significant differences between FULL and the other conditions (see fig.1). CONCLUSIONS: This study demonstrated that the summation of visual sources from the environment is more important than isolated vision of lower limbs or obstacle for clearance and stability during obstacle crossing. Optic flow provided by environment may be an important reference for adaptive gait adjustments.



P1-E-80 The influence of light touch of the hands on the centre of pressure excursion during functional reach

Darja Rugelj[1], Joze V Trontelj[1], Vojko Strojnik[1]

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BACKGROUND AND AIM: Light touch of fingertips attenuates postural sway in various groups of subjects during quiet standing [1]. The effect of light touch on centre of pressure (CoP) excursions during functional reach has not been studied yet, therefore the purpose of this study was to evaluate whether light touch on hypothenar of dominant hand during the functional reach (FR) allowed subjects to use more of their base of support while standing on one meter elevated surface. METHODS: Nineteen subjects (5 male and 14 female) aged 22 - 2.6 years participated in the study. Subjects stood on a force platform that was positioned on a 1 m high box and were asked to perform FR first without touch followed by FR performed while sliding with hypothenar on the vertical force plate. Subjects were asked to keep the final position of their FR for three seconds and than returned to upright position. CoP movements were measured with the Kistler 9286 AA force platform (Winthertur, Switzerland). To monitor light touch a custom-made force platform with a sensitivity range of 0.1 to 10 N was used. The trajectory of the hand movement was captured with a Sony super 8 video camera and further analysed by the APAS system (Ariel Dynamics, USA). RESULTS: For the analysis the average of four consecutive trials were used. The maximal forward movement of the hand at the height of 1 m, when subjects were allowed to slide with the hand, was significantly larger ($p < 0.01$), in average 8.7 mm, as compared to the no touch condition. The movement of CoP typically began in a backwards direction. The amount of the backward displacement ranged from 15.1 - 9.6 mm without light touch to 13.7 - 11.4 mm with light touch. The difference between the two was not statistically significant ($p = 0.22$). The forward displacement of the CoP associated with FR was significantly larger ($p = 0.002$) with the additional light touch. The difference was on average 6.1 mm (Fig 1). While asked to keep the end position the subjects typically moved their CoP backwards for 12 mm in no touch conditions and for 4.7 mm in light touch condition therefore the average position of CoP was kept significantly more anterior during light touch trials ($p < 0.001$). CONCLUSIONS: The results show that subjects are able to bring their hand and their CoP further anterior and use more of their base of support when allowed to slide their hands on a vertical plate during FR.

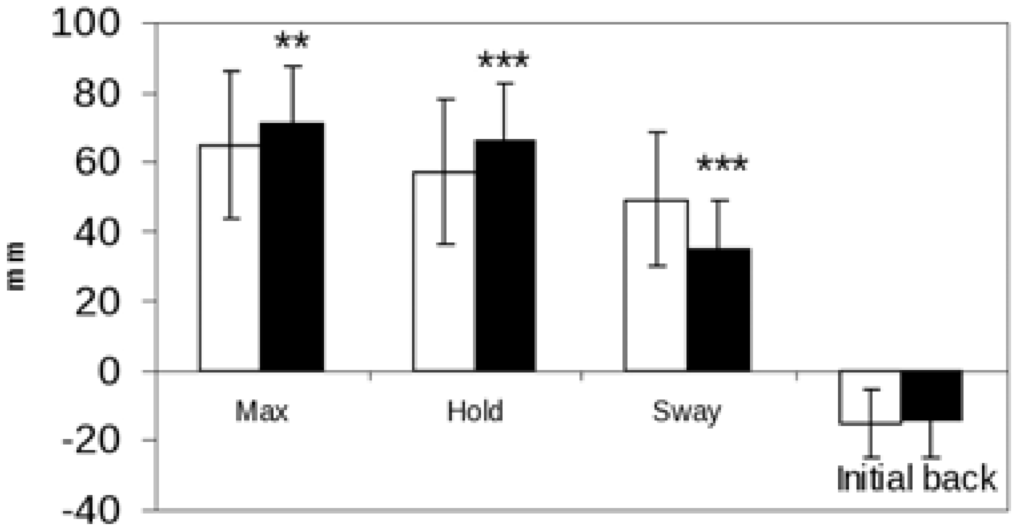

Figure 1. Movements of the CoP during FR without sliding (white) and with sliding (black). (** p < 0,01; *** p < 0,001). (Max - max forward displacement of CoP, Hold - maintained the FR in max. position; Sway - of CoP during 3 seconds hold of FR expressed as path length, back - initial backward displacement of CoP).

ACKNOWLEDGEMENTS: The work was partly supported by grant no. J3 - 3267 of the Slovenian Research Agency.

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P1-E-81 Effects of a spatial pointing task on balancing during tilt perturbed stance in young and elderly adults

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BACKGROUND AND AIM: Previous work indicates that stance control of healthy human adults is essentially performed automatically without drawing much on cognitive resources [1]. (Exceptions are tasks requiring perceptual stabilization of external cues such as visual discrimination of external objects.) These studies typically investigated spontaneous sway in quiet stance. Less is known how balancing of perturbed stance is effected by a second task. Furthermore, we wanted to know whether a difference between pointing in external space coordinates and pointing in body coordinates exists. Finally, we asked whether an effect of age is found in these tasks when comparing young with elderly subjects.
METHODS: Six healthy young subjects (5 males, 1 female, mean age 30 ±3 years) and six healthy elderly subjects (4 males, 2 females, mean age 74 ±5 years) were presented with pseudorandom support surface tilts in the sagittal plane (frequency range, 0.016-2.2 Hz; peak-to-peak amplitude 8°). Motion of trunk in space (TS) and legs in space (LS) were measured opto-electronically (Optotrak® 3020), and

center of mass (COM) was calculated thereof. In addition Center of pressure (COP) shifts were recorded (Kistler®). The spectral characteristics of stimulus and responses (LS, TS, COM, and COP) were analyzed in terms of Bode histograms. Subjects were tested twice with eyes open (EO) and with eyes closed (EC) in each of the following three conditions: (1) Balancing-only task, (2) Balancing plus pointing in space coordinates; upon verbal instruction, subjects pointed with the index finger towards body parts of a human body picture 1 m in front of them (picture was imagined from memory in EC condition), and (3) Balancing plus pointing in body coordinates; pointing at instructed body parts of own body. RESULTS: We found that balancing of the support surface tilt was essentially independent of the three tasks. This applied similarly across the three tasks when balancing was made more difficult in the EC condition as compared to the EO condition. The similarity across tasks was obtained in both the young adults and the elderlies, although the elderlies showed increased tilt-evoked body excursions. This applied similarly to whole-body COM balancing about the ankle joint and upper-body balancing on the hip joint without exceptions across the frequency range tested. CONCLUSIONS: The results demonstrate that human balancing of moderate support surface tilts are automatically compensated for, even when subjects perform spatial pointing tasks in space or body coordinates. This applies to whole-body and upper-body balancing and is not compromised if balancing is impaired by eye closure or by age. We draw the following conclusion for modeling of human balancing (within the above framework such as tilt perturbation): Cognitive commitments need not be considered in the modeling.

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P1-E-82 The influence of different cognitive tasks on postural sway

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BACKGROUND AND AIM: Majority of functional situations require simultaneous postural and cognitive activities. There is still no agreement as to what type of cognitive task interferes most with postural control [1]. In the present work three different types of cognitive tasks were compared in a group of young, healthy subjects. METHODS: 94 young female college students with no known musculoskeletal or neurological deficits participated (age 21.8 ± 2.5 years) in this study. They were randomly assigned into three groups performing a different cognitive task: Stroop task, calculation task and verbal fluency task. In each group subjects first stood bare foot on a force platform with their eyes opened and hands at their side with no additional cognitive task. Than a trial with cognitive task followed. The first group was asked to read the words of colours written in congruent colour (Stroop test 1), the third test was naming the colour in which the word was written (Stroop test 2). The second group performed a calculation task, by subtracting 7 from a given number. The third group performed a verbal fluency task, naming animals. Each trial lasted for 60 seconds. Data were collected using a force platform (Kistler 9286 AA) sampling at 50 Hz. Raw data were uploaded to a server with a Linux operating system and analysed by a specially developed software [2]. The variables of centre of pressure (CoP) movements derived from this experiment were: total path length, mean velocity, medio-lateral and antero-posterior path length and sway area. RESULTS: All the results for the three groups were compared to the unsupported standing

without an additional cognitive task. Performing Stroop test 1, Stroop test 2 and calculation task did not affect the CoP movements. Where as the verbal fluency test as a secondary task significantly increased the amount of postural sway ($p < 0.001$) for total path (from 63.3 ± 17.5 cm to 90.5 ± 44.7 cm), antero-posterior (from 34.6 ± 11.1 cm to 55.8 ± 36.8 cm) and mediol-lateral path (from 45.4 ± 12.6 cm to 58.2 ± 22.5 cm) and mean velocity of the CoP (Fig 1). CONCLUSIONS: Not all cognitive tasks interfere with postural sway. The level of automaticity of the task seems to play a key role in its detrimental effect on posture.

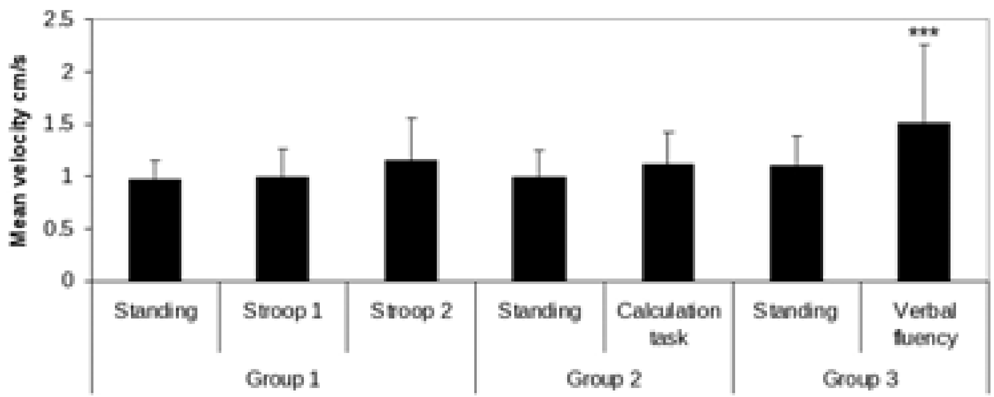

Figure 1. The mean velocity the CoP for the three groups, secondary cognitive tasks compared to the unsupported standing without an additional task. The significnce level is indicated as *** for $p < 0.001$.

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P1-E-83 The immediate beneficial effect of conscious awareness of the body for upright postural stability

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BACKGROUND AND AIM: Numerous studies have shown that somatosensory afferent information plays an important role in the human postural control system. With this in mind, some clinicians in rehabilitation encourage patients to become consciously aware of somatosensory inputs from the body. We have recently reported that the intervention involving awareness of joint movement at the ankle and wrist (a self-awareness intervention; SAI) significantly improved the stability of unipedal posture as measured immediately after the intervention (Yasuda et al., in press, J Bodywork Mov Ther). To extend these findings, the present study addressed whether awareness of "movement" was a necessary condition. We also investigated whether the body parts used for the intervention were critical.

METHODS: Sixteen young adults participated. Each blindfolded participant performed these four interventions: (1) SAI with movement; blindfolded participants reproduced a target joint angle 20 times with as much precision as possible, (2) SAI without movement; they imagined reproducing a target joint angle without actual movement, (3) Movement without awareness; they performed the same reproduction task while continuously performing an arithmetic subtraction task, and (4) Control; participants performed the arithmetic subtraction task only. For all but the control intervention, the target joints were the ankle, wrist, and shoulder. Using a force plate for each intervention, pre-post measurements of postural stability were conducted during both the bipedal and unipedal stances. The mean velocity (MV) of the center of foot pressure during each stance was analyzed with a three-way (self-awareness×2, actual movement×2, and body parts×3) ANOVA and was performed with a 0.05 level of significance. RESULTS: For unipedal standing, the significant main effect of the self-awareness test revealed that participants in the self-awareness condition showed a lower MV than in the no self-awareness condition. There was no significant interaction between self-awareness and actual movement, which indicates that awareness of movement was not a necessary condition for the beneficial effects of the SAI. No significant interaction occurred between self-awareness and body parts, showing that the beneficial effect did not depend on the body parts used for the intervention. Conversely, for bipedal standing, the significant main effect of the self-awareness test showed that participants in the self-monitoring condition exhibited a higher MV than in the control condition. CONCLUSIONS: The SAI significantly improved the stability of unipedal stance as measured immediately after the intervention, but it did not improve in the bipedal stance. Body movement during the intervention was not necessarily important for the beneficial effects of the SAI. It is likely that awareness of any parts of the body that involve maintaining whole-body balance is beneficial in improving the stability of unipedal stance.

P1-E-84 Time to disengage: Holding objects in hand prior to onset of a perturbation has implications for compensatory reach-to-grasp reactions

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BACKGROUND AND AIM: Rapid reach-to-grasp (RTG) reactions are important for recovery from whole body instability. In everyday situations, these reactions may be elicited when individuals are holding an object. Anecdotally, people do not always release the object despite the benefit of having hands free for balance recovery. It is proposed that reluctance to release may be related to CNS processing delays that occur when the initial reaction is to drop the object rather than RTG. This study tested the hypothesis that there would be delays in RTG reactions when evoked with objects in hand compared to hands free. METHODS: 12 young adults sat in a custom-designed chair held in a vertical position by an electromagnet. Magnet release caused the chair to fall rapidly backwards. Participants were asked to regain balance by reaching to a fixed handle equipped with a force-sensing resistor (FSR). Ten RTG movements were performed in four object conditions: 1) no object (CTRL), 2) object fixed to chair (FIXED) which required release prior to RTG, 3) two-inch diameter object (SMALL), and 4) four-inch diameter object (LARGE). SMALL/LARGE objects were free, allowing later or no release. EMG data were

collected from anterior deltoid (AD), middle deltoid (MD), biceps (BB), and extensor digitorum (ED). Onset latencies were determined relative to onset of chair movement to examine response initiation and overall response time. RESULTS: Preliminary analyses (n=6) showed object release for every trial (FIXED and free objects). Muscle recruitment occurred in a proximal to distal sequence across all conditions (82±8ms, 85±7ms, 92±13ms, & 111±32ms for AD, MD, BB, & ED). Onset of AD and MD were delayed by the presence of FIXED and LARGE objects while BB and ED were delayed in all object conditions. The most significant delays occurred in ED for FIXED and LARGE objects (onsets 112% & 132% of CTRL). The greatest difference between onset of AD and ED occurred for the LARGE condition (46±41ms vs. 18±20ms, 25±26ms, & 24±26ms for CTRL, FIXED, & SMALL). Overall response times were only modestly delayed for FIXED and LARGE conditions (onsets 104% & 102% of CTRL) and there were no differences in response success. CONCLUSIONS: Early results indicate that object disengagement delays initiation of perturbation-evoked, RTG reactions, particularly in the focal muscle and when the objects' properties pose greater risk for a failed RTG response (e.g. large object). Delays occurred even when the proximal reach phase could have been initiated without object release. It is possible that increased planning demands accompanying simultaneous object release and RTG cause a shift toward more sequential muscle activation for balance recovery. Despite delays in response initiation, the CNS preserves overall response time leading to the view that a central set for RTG response execution considers the delay implications of pre-perturbation state.

ACKNOWLEDGEMENTS: Funding provided by NSERC.

P1-E-85 An investigation of sensory reweighting in balance recovery among elite athletes

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BACKGROUND AND AIM: Balance recovery depends upon integration of sensory information from visual, vestibular, and somatosensory systems. Application of small electrical current to the mastoid processes, Galvanic Vestibular Stimulation (GVS), causes a temporary error in the vestibular signal and induces a lean towards the anodal ear. GVS allows for studying the contribution of somatosensory information in maintaining postural balance separately from the visual and vestibular; with vision withheld, use of somatosensory information is up-weighted. We hypothesized that athletes would demonstrate superior balance control defined by lower center of mass (COM) excursion during balance recovery than non-athletes, and lower center of pressure (COP) excursion associated with greater weighting toward somatosensory information. METHODS: 20 young healthy males volunteered (10 elite ice hockey players and 10 controls). Participants experienced forward lean-and-release postural perturbations; participants leaned forward, held stationary by a tether with their head turned to the left (sagittal plane GVS bias). Feet-in-place (F) and stepping (S) balance recovery responses were induced via the release of electromagnet that held the tether. 4 conditions were investigated: eyes open (EO), eyes closed (EC), EC with GVS anode left (L; posterior bias), and right (R; anterior bias) ear. Whole-body center of mass (COM) excursions and trunk angular excursions were calculated from marker position data. Center of pressure (COP) excursions were calculated from force plate data. RESULTS: Two-way

repeated measures ANOVA revealed no main effect of group in peak COM excursions with F response. During S, athletes' COM excursions (183.4±19.9mm; mean±SE) were lower (F(1,54)=4.47, p=0.049) than non-athletes' (239.8±21.0mm) (Fig. 1). Trunk angle excursions were smaller (F(1,54)=8.18, p=0.010) among athletes (6.7±1.6°) than non-athletes (14.8±2.5°). Significant group by condition interaction effect for peak COP excursion (F(3,54)=3.17, p=0.032) with F response was found, but no main effect of group, nor group by condition interaction effect with S. Athletes' COP excursions in EC (167.1±9.54mm), L (163.7±9.32mm), and R (169.1±9.62mm) were larger than non-athletes' (EC: 147.2±8.48mm, L: 148.3±9.31mm, R: 151.7±9.28mm) with F response. CONCLUSIONS: Athletes demonstrated superior balance recovery during S responses, indicated by lower COM excursions. The ability of athletes to maintain tighter control of COM during stepping might be attributed to more upright trunk position during recovery, possibly due to sport-specific training. That no differences were observed in COM excursions during F responses suggested that F task was not challenging enough to expose differences between groups. Athletes did not appear to up-regulate the use of somatosensory system as they demonstrated larger COP excursions with F response, and no difference with S response in the sensory manipulated conditions.

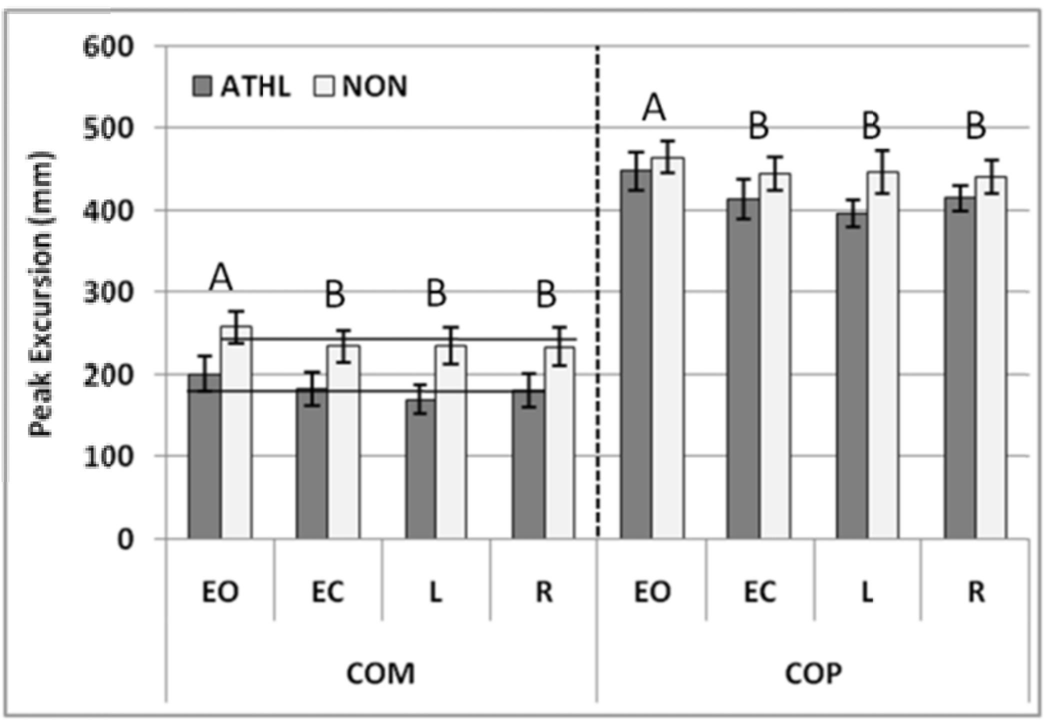

Fig. 1. COM and COP peak excursions during S response (mean±SEM). Different letters – significantly different levels. Horizontal lines – significantly different group means.

P1-E-86 White matter hyperintensities are an independent predictor of physical decline in community dwelling older people

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BACKGROUND AND AIM: Aging is associated with physical disability, but little is known about the influence of white matter hyperintensties (WMHs) on physical function decline in older people. The aim of this study was to investigate the association between white matter hyperintensities (WMHs) as a predictor of decline in physical function in cognitively normal older people. METHODS: Two hundred and eighty seven community-dwelling people aged 70-90 years underwent the Physiological Profile Assessment (PPA) and assessments of total and regional WMH volumes, cognitive function and comorbidities. Participants underwent re-assessments of the PPA 12-months later, and those in the top quartile for increases in PPA scores over the year were regarded as having physically declined. RESULTS: Multivariate logistic regression analyses revealed that people with WMH volumes in the 4th quartile showed greater physical decline (OR [95% CI] = 3.02 [1.02 - 8.95]), while controlling for age, baseline physical function, general health, physical activity and cognitive function. Subsequent univariate analyses indicated WMHs in the deep fronto-parietal and periventricular parieto-occipital regions had the strongest associations with physical decline. CONCLUSIONS: These findings indicate WMHs are an independent predictor of decline in physical function and suggest that interventions that focus on preventing the development or progression of white matter lesions may help preserve physical function in older people.

P1-E-87 Tai Chi practice can improve the balance control of elderly persons with visual impairment: A randomized clinical trial

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BACKGROUND AND AIM OF THE STUDY: Balance control is a major problem for older individuals with poor vision. Regular exercise produces the same positive physiological and psychological benefits for such individuals as for persons without a disability. There are limitations, however, for visually impaired elderly persons wishing to participate in exercise programs. The benefits of Tai Chi for balance control, muscle strength, and preventing falls have been demonstrated with sighted elderly subjects. This study was designed to extend those findings to elderly persons with visual impairment. The aim of the study was to investigate the effects of Tai Chi on the balance control of elderly persons with visual impairment. METHODS: It was a randomized clinical trial. Forty visually impaired persons aged 70 or over and recruited from several residential care homes. The participants were randomly divided into Tai Chi and control groups and assessed pre- and post-intervention using three tests: 1) passive knee joint repositioning to test knee proprioception; 2) concentric isokinetic strength of the knee extensors and flexors; and 3) a sensory organization test to quantify an individual's ability to maintain balance in a variety of complex sensory conditions. RESULTS: After intervention, the Tai Chi participants showed significant improvements in knee proprioception ($p = 0.032$) and in their visual and vestibular ratios compared to the control group ($p = 0.006$ and $p = 0.048$, respectively). CONCLUSIONS: Practicing Tai Chi has been shown to improve the balance control of visually impaired elderly persons. After 16 weeks of Tai Chi training, elderly subjects with visual impairment had better knee proprioception and showed

improvements in balance control under conditions requiring increased reliance on the visual and vestibular systems.

P1-E-88 Virtual reality feedback of a human avatar improves control of trunk position and orientation during locomotion

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BACKGROUND AND AIM: Previous studies in our laboratory using continuous visual feedback during locomotion demonstrated that feedback produces a stabilizing effect by reducing low frequency trunk motion. We have additionally found that the improvements facilitated by feedback are highly task-specific: feedback of approximate center of mass (COM) position reduces trunk position variability, while feedback of trunk orientation reduces variability in trunk angle. We hypothesize that providing simultaneous position and orientation feedback will elicit improvements to both position and orientation control. METHODS: Ten young healthy subjects walked on a motor-driven treadmill at 5 km/hr in front of a 52" TV screen. A triangular arrangement of three markers (one on each side of the chest, one above the navel) was tracked using stereoscopic webcams to calculate trunk position and orientation. The feedback display included a bird's-eye view of a human avatar walking on a treadmill; a bull's-eye target was overlaid on the treadmill surface to indicate the center of the treadmill. The avatar's position and trunk orientation corresponded to the subject's, while its arm and leg swing followed a sinusoidal rhythm. Subjects performed five trials with avatar feedback (AFB) and five trials with no feedback (NFB) in random order. During AFB trials the subject was instructed to maintain the avatar upright and in the center of the bull's-eye. During NFB trials the TV was turned off and the subject was instructed to keep his/her trunk upright and to maintain a stable position on the treadmill. RESULTS: Preliminary results show AFB reduces power for anterior-posterior (AP) and medial-lateral (ML) trunk position and for AP trunk orientation at frequencies below the gait cycle (approximately 1 Hz). CONCLUSION: The data support our hypothesis that AFB improves postural control during locomotion by decreasing variability in trunk position and orientation. We believe this form of feedback has the potential to be used as a tool to rehabilitate balance during locomotion, as this may require improvements to both wayfinding/navigation and control of trunk verticality.

P1-E-89 Changes in cortical activities during gait preparation: Normal gait versus step-to gait

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BACKGRGROUND AND AIM: Movement is preceded by neuronal activities in the motor cortex. Functional near-infrared spectroscopy (fNIRS) studies report increased activities in the supplementary motor area (SMA) and premotor cortex (PMC) before gait. These activities are involved in motor planning and change when adapting to changes in locomotor speeds and during preparation for walking cued by verbal instruction (Suzuki et al. 2004, 2008). Physiotherapists often ask patients to alter their

gait pattern. When such an alteration is attempted, changes in the activities in the SMA and PMC modulate the motor plan that precedes gait. However, few studies have investigated the preparatory activities of the brain for changing gait pattern. The pattern of step-to gait (STG) is different from that of normal gait (NG). Therefore, there is a possibility that preparatory activities for both STG and NG also differ; we investigated these activities using fNIRS. METHODS: Ten healthy subjects (mean age, 22.7 years; men, 8) participated in this study. We investigated cortical activation during preparation for NG and STG by using fNIRS (FOIRE-3000, Shimadzu). The subjects performed 3 NG trials followed by STG trials. The subjects walked at self-selected speeds on a flat ground for both NG and STG, after a 20-s rest period of standing. Thirty optodes were positioned on the skull surface, which were divided into 7 regions of interest, namely the SMA and the left and right hemispheres of the PMC, sensory motor cortex (SMC), and prefrontal cortex (PC). Regional cortical activation was assessed by measuring changes in the oxygenated hemoglobin concentration. Taking into account, a delay of several seconds between the initiation of neural activity and the peak of the corresponding hemodynamic response, we collected the rest period data from the seventh second to the twelfth second (duration 5 s), and data for the preparation period from the last 2 s of the rest period to the first 3s of the gait period (duration, 5 s). We calculated the effect sizes (ESs) at the preparation phases in each channel. To investigate whether the activation patterns between NG and STG differ, we analyzed the regional ESs at the preparation phases in each region by using Wilcoxon signed-rank test. Statistical significance was set at $p < 0.05$. RESULTS: During preparation for STG and NG, the ESs increased significantly only in the PMC ($p < 0.05$). CONCLUSIONS: Our findings show that, in both sides of the PMC, the increase in the ESs was significantly greater during preparation for STG than that during NG. The PMC is involved in motor imagery of gait that requires precise foot placement and increased postural control (Bakker et al. 2008). Therefore, cortical activation in the PMC may be necessary for changing gait pattern. Our results showed that activities in the PMC increase during preparation for gait. Thus, we conclude that these activities may be involved in modulating motor planning.

P1-E-90 Functioning of spinal reflex pathways in infants with Myelomeningocele

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BACKGROUND AND AIM: Myelomeningocele (MMC) is a congenital spinal cord defect which interrupts sensorimotor mechanisms. Understanding their early proprioceptive mono and polysynaptic neural pathways in lower limb muscles is critical to determining possible neural sources of support for the development of sensory and motor functions. Here we assess the function of spinal reflex pathways in MMC infants who had lumbar/sacral level lesions. METHOD: Participants were 15 MMC infants, aged 2-10 months. We assessed the tendon-reflex(T-reflex), vibration-induced inhibition of T-reflex(VI-T-reflex), and tonic vibration-induced reflex(TVR) to determine (a) accessibility of mono and polysynaptic loops and (b) functioning of pre-synaptic inhibition, for three gait muscles: gastrocnemius(GA), tibia is anterior(TA), and quadriceps(QA). By using electromagnetic stimulators equipped with a smooth hammer head, we provided 20 taps(5m pulse) to each muscle tested. Each tap was delivered with a minimum interval of 8s. In VI-T-reflex, 20 taps were administered with concurrent vibratory stimulus.

Both the T-reflex and VI-T-reflex responses were recorded during the 0.5 s immediately following the stimulus application onset. To elicit the TVR responses, 2 periods of 20s vibratory stimuli(80Hz) were provided, preceded and followed by 5s of no vibration, to distinguish voluntary muscle activity from reflex responses. Using a custom designed LabviewTM virtual instrument, all responses were quantified as: ratio of responses to stimulations, latency between stimulus and responses onset, and amplitude of responses. RESULTS: For the T-reflex, 5 infants showed muscle activations to the stimulated or their antagonist muscles or both following tendon taps. Although their ratios were lower than those of TD babies(QA, MMC=33% TD=56%), they demonstrated reflex irradiation to antagonist muscles as seen in TD infants at the same ages. In VI-T-reflex, 5 of those infants who showed the most responses for the T-reflex displayed primarily facilitation of reflex responses. In addition, they demonstrated reciprocal excitation following vibration. However, 6 other infants produced only the T- reflex or the TVR responses for each muscle tested and 4 infants failed to show any reflex responses at all. Neither age nor lesion level predicted level of response. Concurrent lower body motor skills were most predictive overall in showing closest association with reflex responses for the gait muscles(GA: p=.028). CONCLUSIONS: Results show that spinal-level reflex responses were varied among MMC infants and compared to TD infants reflex responses were clearly depressed. Further, those reflex response levels were not dependent on the age or lesion level of MMC. Because our current work involving TD infants suggests the critical role of practice in improving stability of gait reflexes, future studies of MMC infants need to determine if early therapeutic intervention can improve reflex activity.

P1-E-91 Biomechanical effects of dropped foot technology during gait among stroke survivors

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BACKGROUND: Limited ankle mobility due to stroke-related impairments can affect important functional tasks, such as walking, sit-to-stand transfers and stair climbing. An ankle-foot orthosis (AFO) is often recommended to minimize gait deviations by assisting with toe clearance in the swing phase and providing medial-lateral stability during the stance phase. A major concern is that long term use of an AFO may lead to learned disuse and dependency. Conversely, functional electrical stimulation (FES) activates ankle muscles to improve toe clearance. There is evidence of improved walking performance with these devices; however a limited number of studies have evaluated the effects on muscle activity. The purpose of this study was to compare the immediate effects of AFO and FES devices on muscle activity, ankle kinematics and temporal parameters during gait among stroke survivors. METHODS: Two randomized testing sessions were conducted on separate days for the AFO (n=2 posterior spring leaf, n=1 solid) and FES (Odstock Dropped Foot Stimulator) devices. The participants walked over a pressure sensitive mat (with and without AFO/FES) under two conditions; 1) preferred pace and 2) fastest pace. Electrical goniometers were placed bilaterally over the ankle joints. Electromyography data was collected bilaterally for the tibialis anterior (TA) and medial gastrocnemius muscles. Analysis of three stroke survivors is presented; a larger dataset will be presented at the conference (n=10). RESULTS: For preferred pace, the AFO reduced stance times for both limbs, while stance phase percentage of gait cycle did not change (paretic: 67.6% vs. 66.2% - AFO, and non-paretic: 81.5% vs. 79.1% - AFO). Walking

with the FES slightly increased stance times for both limbs, while stance phase percentage remained unchanged (paretic: 68.3% vs. 68.5% - FES, non-paretic: 80.9% vs. 77.8% - FES). Swing phase ankle dorsiflexion improved for all participants with both AFO and FES devices on the paretic limb; however Participant 1 responded better to the FES (9.5° increase vs. 3.2 - AFO), Participant 2 had a similar response between devices (1.1° - FES and 3.7° - AFO), Participant 3 improved more with the AFO (15.6° vs. 2.9° - FES). Participant 1 & 3 initiated paretic limb TA activity between 0.0% - 1.6% of the gait cycle with no device, AFO and FES. Participant 2 displayed delayed TA onset during the AFO testing session (41.5% no device and 49.3% - AFO) compared to the FES session (12.7% no device and 15.7% - FES). DISCUSSION: Initial findings demonstrate improved ankle kinematics in the swing phase with dropped foot technology and varying patterns of muscle onset for the ankle dorsiflexors. FES may improve timing of muscle activation for individuals with a delayed response. Ongoing work will continue to examine the magnitude of lower limb muscle activation and focus on variation across stroke survivors with different functional needs from dropped foot technology.

P1-E-92 Processing vestibular, proprioceptive and visual information for balance control in pure cerebellar disease (SCA6)

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BACKGROUND AND AIM: Balance impairment is a feature of cerebellar disease [1-2], but causal mechanisms are largely unknown. SCA6 is a prevalent type of inherited cerebellar disease, rarely accompanied by any extra-cerebellar signs or symptoms [3]. This study evaluates the processing of individual sensory channels for the control of standing balance in subjects with SCA6 using single-channel balance perturbations. METHODS: Whole body balance responses to sensory perturbations while standing were evoked in 16 subjects with SCA6 and compared with those from 16 age-, sex- and height-matched healthy controls. Galvanic vestibular stimulation (GVS), muscle vibration (VIB) and moving visual scenery (MVS) were used to perturb vestibular, proprioceptive and visual sensory channels respectively. Twenty trials of each stimulus were randomised and intermixed with additional no-stimulation trials to produce unpredictable perturbations. 3D whole-body motion (Coda) and ground reaction forces (Kistler) were recorded throughout each eight-second trial period. Ten trial repeats per direction, per modality were used to assess response habituation and to generate mean traces of response activity over time in two cardinal directions (pitch and roll). From the mean traces, trunk sway responses (0.2-1.0s) and shear-force responses (0.2-0.4s) were measured and groups compared using t-tests. ANOVAs evaluated habituation of responses (group x trial repeat) measured from single trials. RESULTS: All subjects generated clearly identifiable responses to all stimuli. Response directions were normal in the SCA6 group for all perturbation modalities. Response magnitude to GVS did not differ significantly between groups (force, $p=0.964$; trunk sway, $p=0.142$). Response magnitude to VIB was larger in SCA6 for trunk sway but not force (force, $p=0.169$; trunk sway, $p=0.020$). Response magnitude to MVS was highly significantly greater in SCA6 for both measures (force, $p=0.002$; trunk sway, $p<0.001$). Only the visual perturbation revealed a significant positive correlation between SCA6 response magnitude and disease severity, rated using the SARA score (MVS: $r=0.536$, $p=0.018$; GVS: $r=0.021$,

p=0.940; VIB: r=0.378, p=0.149). Habituation to the stimuli was not found for any sensory modality in either group. CONCLUSION: In SCA6 the balance responses to visual perturbations were abnormally large, scaled with disease severity, and were not caused by habituation problems. The increased response magnitude could indicate an increased reliance on vision as compensation for a deficit elsewhere. Alternatively, it could point to a problem in visual processing for balance control. One possibility is that it reflects impairment in distinguishing self-motion from environmental motion which could lead to instability, particularly in busy environments.

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P1-E-93 Inter-hemispheric treatment of visual cues: Effects on postural control for hemiparetic patients

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Postural strategies are the result of a fine interaction between sensory and motor systems under central nervous system control. When the inter-hemispheric relation is perturbed, sensorimotor control is not that efficient anymore. In this framework, we have considered hemiparesis model through an auto-stabilization paradigm, with the aim of improving knowledge about a probably right hemispheric specificity for postural control [1]. Like visual information playing a predominant role in the postural organization, our main purpose is to examine if visual cues treatment has postural consequences depending of the injured cerebral hemisphere. Three groups were recruited: healthy subjects, hemiparetic patients with a right (RCH lesion) or a left (LCH lesion) cerebral hemisphere lesion. They were asked to maintain sitting position as stable as possible on a seesaw instable in sagittal (SgP) or frontal plan (FrP). Four visual conditions were tested: vision, free right visual field (RVF), free left visual field (LVF) and darkness. Standard posturographic parameters, mean antero-posterior (Ym) and medio-lateral (Xm) position and range around mean positions (Y & X range) were computed. Statistic analyze was realized through a repeated measures ANOVA. Surfaces covered by the center of pressure (CoP) and velocity of CoP displacement were always higher for hemiparetic patients than healthy subjects. In FrP instability condition, CoP surfaces for only "RCH lesion" group in vision condition was significantly lower than in darkness condition. In SgP condition, CoP surfaces were 3 to 5 times lower than in FrP condition, for all groups. "LCH lesion" and "RCH lesion" groups showed CoP surfaces significantly lower in vision than in darkness condition. LVF and RVF conditions had an effect on hemiparetic patients, with similar CoP surfaces between vision condition and the condition with opposite visual field of the hemiparetic side. Moreover, LVF and RVF had an effect on Xm position and X range for "RCH lesion" group and on Y range for "LCH lesion" group. Auto-stabilizations in FrP confirm a visual reliance for "RCH lesion" patients. "LCH lesion" patients seem to adopt a non-visual strategy. It leads us to consider a sensory hemispheric more than a postural hemispheric specificity, with some plan-dependent strategies [2]. Auto-stabilizations in SgP show a specific hemispheric selectivity of visual cues for the two

hemiparetic groups, as spatial neglect strategy. This selectivity seems organize more accurately the postural control. A hemispheric control of postural directions appears with a medio-lateral sensitivity for "RCH lesion" patients and antero-posterior for "LCH lesion" patients. These hemispheric specificities bring major elements for adaptability and efficiency of rehabilitation programs for hemiparetic patients.

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P1-E-94 Evidence that eye movement deficits contribute to the turning problems of stroke survivors

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INTRODUCTION: Recent evidence indicates that the Basal Ganglia (BG) is involved in the selection/optimization of initiation, speed, amplitude and timing of automatic motor sequences [1]. We previously hypothesized that the coordination of axial body segments during turning while walking represents a robust pre-programmed postural "synergy" that is dependent on, and triggered by, eye and head rotation in a new travel direction [2]. Other results from our lab showed that stroke patients with BG lesion involvement were slower to initiate pre-planned turns than those whose lesions did not involve the BG and that slowed initiation was improved by visual cues to turn [3]. The current study aims to investigate differences in eye movement control between stroke patients with and without BG involvement while they perform turns to visual targets and to assess to what extent these differences might contribute towards the aforementioned turning deficits in this group of patients. METHODS: 16 participants (8 with lesions involving BG and 8 with lesions not involving BG) who had suffered a stroke at least 6 months prior to participation and who were able to walk 10m without assistance were recruited. Participants were asked to change walking direction by 90°, either left or right, at the midpoint of a 6m path. Visual cues to turn were given as one of three lights which illuminated one stride before the turn point. Full body kinematic data were measured using a Vicon MX motion analysis system and Horizontal eye rotation was recorded using a Bluegain EOG system (CRS Ltd) RESULTS: Preliminary analysis has identified clear abnormalities in the horizontal eye kinematics of BG participants during large turns to visual targets (Fig. 1). Eye movement abnormalities were accompanied by changes to axial segment coordination and turning speed and efficiency. Further analyses are currently underway to assess the extent to which the differences in eye movement characteristics can statistically explain differences in axial segment coordination. CONCLUSIONS: We conclude that a) the basal ganglia contributes towards the optimization of the automatic motor sequences responsible for turning and b) eye movements to align with the new travel direction are an integral part of initiating and controlling the turning "synergy" .

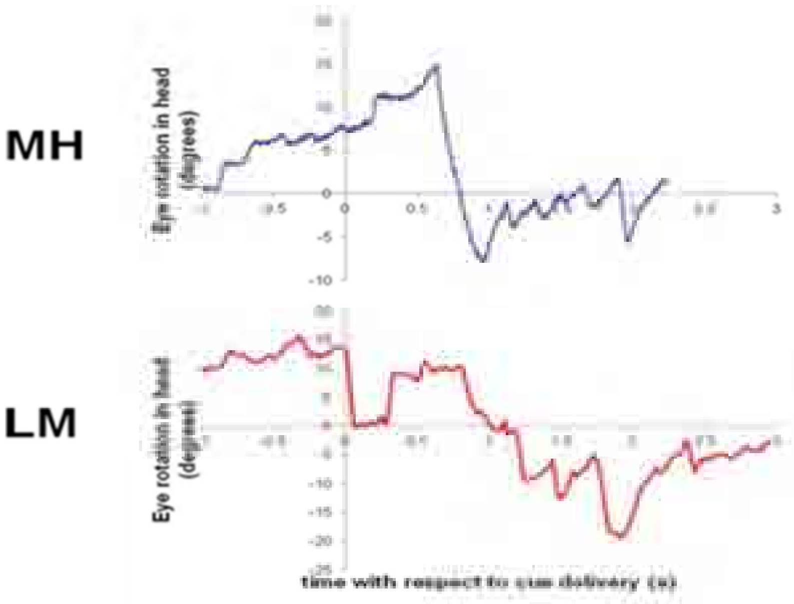

Fig.1 Representative raw eye data from one participant with (MH) and without (LM) BG lesion performing a 90° visually cued turn.

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P1-E-95 Gait abnormalities in different peripheral neuropathies

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BACKGROUND AND AIM: patients with Charcot-Marie-Tooth disease type 1A (CMT1A), mainly affecting large-diameter fibres, do not show abnormal body sway during stance. On the contrary, patients with diabetic neuropathy (DN) or with CMT type 2 (CMT2), in whom both large- and small-diameter sensory fibers are affected, sway is larger compared with normal subjects (NS) and CMT1A patients. These findings suggest that large afferents are less important than smaller afferents in balance control during stance. The somatosensory input modulates gait pattern. However, it is not known if different afferent fibres play different roles in this modulation. Therefore, we studied patients affected by peripheral neuropathies involving either large fibres or both large and small fibres in order to study the modulatory effects of different afferents on gait pattern. METHODS: we recruited 52 NS, 14 DN, 11 CMT1A and 5 CMT2 patients. They were administered the Neurological Impairment Scale (NIS). Participants were required to stand upright on a force platform with eyes open or closed to record body sway. They walked four times with eyes open on a sensorized mattress (GAITRite) to record the spatial-temporal variables of gait. Analysis of covariance with age as a covariate was performed. RESULTS: NIS score showed that the impairment of muscle strength was similar among the three patient groups. Body sway while standing was larger in DN and CMT2 compared with NS and CMT1A patients. Gait velocity, cadence and step length were decreased in patients with respect to NS, but to a lesser extent in CMT1A.

Step width was increased in all patient groups with respect to NS. The duration of single support was increased in all patient groups whilst the duration of double support was increased in DN and CMT2 but not in CMT1A. Gait velocity negatively correlated with body sway during quiet stance, whilst duration of double support showed a positive correlation with sway. CONCLUSIONS: The results show the important role of somatosensory input in the modulation of spatial-temporal variables of gait. Changes in gait variables were present in all patient groups, but impairment was more evident in DN and CMT2 than CMT1A. This is possibly due to the DN and CMT2 affecting small afferents in addition to large Ia fibres. In keeping with results previously obtained in NS, the input from large Ia afferent fibres seems to be scarcely relevant to modulate gait pattern, likely because of the known gating of these fibres during walking. Finally, these findings emphasize the strong correlation between balance and gait variables.

P1-E-96 Perception of aperture size at the end of a corridor is impaired in Parkinson's disease patients with freezing of gait (PD-FOG)

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BACKGROUND AND AIM: Although PD-FOG patients do not differ from those without FOG [1] when judging if their body would fit through an aperture, PD FOG have been found to be profoundly impacted when walking toward a narrow doorway [2]. The aim of this study was to examine how narrowness of the corridor might influence judgment of the size of the opening at the end of the corridor, and how walking through the corridors would affect the judgment. METHODS: 45 participants (14 PD-FOG; 15 PD; 15 controls) estimated distal aperture size in two conditions (parallel and narrowing walls). Participants used an unmarked tape measure to estimate the width of the distal opening of the corridor. The variables of interest were constant error (CE), absolute error (AE) and variability of constant (VCE) and absolute errors (VAE), relative to the true width of the distal opening. RESULTS: A main effect of corridor was found for all variables, showing that the aperture at the end of the parallel (relative to the narrowing corridor) was underestimated (CE and AE $p<0.01$), but variability was greater for the narrowing corridor (VCE and VAE $p<0.01$). A group by corridor interaction ($p<0.05$) for CE revealed that the PD-FOG judged the aperture to be smaller than the other groups, but only in the parallel configuration. In addition, VAE ($p<0.05$) was larger in the PD-FOG than in the other groups. Aperture size judgments were not affected by the experience of walking through the corridor. CONCLUSIONS: When performing a visuo-spatial judgment, PD-FOG are more influenced (greater error and variability) by corridor configuration than PD non-FOG and controls, although they are unable to improve judgment with the experience of walking through the corridor. Perceptuo-motor deficits may be a critical factor contributing to FOG.

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P1-E-97 Vertical perception and standing stability in adeolecents with scoliosis

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BACKGROUND AND AIM: Postural balance is a key reference for vertical perception. The individuals with normal vestibular function align the subjective visual vertical (SVV) within 2 degrees of true vertical (0 degree). It has been proved that SVV is influenced by the body tilt for small inclination in young adults, though the consequence did not show the systemic correlated. Adolescents with idiopathic scoliosis are characterized by apparent body misalignment. The asymmetrical weight-bearing may leads to abnormal postural control strategies and balance, which may subsequently compromised vertical perception. Visual vertical perception is also influenced by body position. It improves when postural control is more demanding. The present study is aimed to 1) compare SVV between adolescents scoliosis and age-matched controls, 2) to realize the relationship between stance stability and attention demanding during dual task context among adolescents scoliosis.METHODS: Five adolescent with sclerosis and five age matched health control was recruited. They were asked to standing still under either single or dual-task condition. In single condition the subjects either stand along or participated in SVV task. In dual-task condition, the subjects have to standing along and at the same time perform the SVV task. The SVV task required the subjects to decide if the line they saw on the monitor is true earth vertical or not. As shown in Figure 1, the line could be tilting from 0° to ±20° in randomized sequence within 4 different tilting frames (0°, 18°, -18° in a square and another in a circle). RESULTS: The results showed that the SVV and standing stability was not different between groups but the standing stability was influenced by concomittent SVV tasks that demanded extra attention for both tasks. CONCLUSIONS: Cognitive tasks which compete attentional resources with postural tasks could deteriorate standing stability, especilly when the individual has impairments in postural control systems and stabilty deteration could be in positive correlation with severity of the sclerosis.

P1-E-98 Motor performance characteristics in fibromyalgia

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BACKGROUND/AIM: Motor problems such as poor balance, tendency of falling, clumsiness, slowness in movements and tremors are reported by patients with fibromyalgia (FM). These problems could be related to the altered processing of sensory feedback associated with FM. The aim of the present study was therefore to look into characteristics of motor performance in FM patients by investigating proprioception and position control in the shoulder joint. METHODS: Twenty-one female FM-patients and 21 healthy age- and sex-matched controls (HCs) participated in the study. In task 1, the participants were blinded and asked to reproduce a shoulder joint abduction angle. In task 2, the participants were asked to keep a constant shoulder joint abduction angle while receiving real-time visual feedback of their joint angle. Both tasks were performed unloaded and while supporting initial loads (0.5, 1 and 2 kg). Vertical acceleration of the upper limb was measured using accelerometers. The data was analyzed in time domain by variance and in frequency domain by power spectrum analysis. Normalized power of the acceleration signal was extracted for three frequency bands: 1-3 Hz, 4-7 Hz and 8-12 Hz. RESULTS:

There was no difference in the accuracy of the proprioceptive tasks or the position tasks. However, the FM patients had a higher percentage of the total energy located in the low frequency band, and a lower percentage of total energy in the high frequency band compared with HCs (P<0.05). The results were consistent for all weight trials. CONCLUSION: FM patients do not show altered performance in position and proprioceptive tasks compared to HCs. However, they seem to have a different motor control strategy in producing the performance compared with HCs. Further research may investigate whether the motor control strategy used by FM patients are less robust to external perturbations and may be an underlying factor for the reported motor problems.

P1-E-99 Lumbar muscle activity during sustained sitting

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BACKGROUND AND AIM: Changed muscle activity and fatigue have been regarded as possible causes to the development and maintenance of low back pain (LBP). LBP patients have reduced tolerance for static postures as quiet standing or sitting. The muscle activity in postural muscles in standing and sitting is usually low, and LBP sufferers may have problems with low level isometric muscle activation. It has been shown that reduced temporal variability in muscle activity enhances muscle fatigue development. The aim of the present study was to investigate if electromyographic manifestations of fatigue occur in lumbar muscles during sustained sitting in healthy pain free adults, and whether these are associated to the spatiotemporal variability of activation. METHODS: 32 healthy adults (age 30 to 50 years) without back pain were included. A high density surface electromyography (HDsEMG) grid with 14x9 electrodes was attached on each side of the lumbar spine. The subjects were asked to sit for 30 min with a trunk inclination of 5 degrees. For all bipolar and monopolar electrode (pair)s, the root mean square (RMS) and the median frequency of the power density spectrum (MDF) were calculated in 1 s non-overlapping time-windows. Overall changes over time in RMS and MDF were investigated by linear regression. For each time epoch, the average of the correlations between the RMS distribution of that epoch with the RMS distribution of the other epochs was calculated. The median (CCT) and coefficient of variation (CV) of the correlations were computed. Lower CCT and increased CV indicate more spatiotemporal variation. Partial correlation was used to explore the relationship between changes in RMS and MDF over time and CV and CCT. RESULTS: Mono- and bipolar RMS significantly increased during 30 min sitting ($p < .001$). Bipolar MDF ($p < .022$) significantly increased while monopolar MDF remained unchanged ($p < .797$). There were significant positive correlations between the monopolar CV and change in RMS ($r = .457$, $p = .025$) and MDF ($r = .494$, $p = .014$) and a significant negative correlation between bipolar CCT and change in MDF ($r = -.487$, $p = .016$). CONCLUSIONS: The increase in EMG amplitude (RMS) and MDF during sustained sitting indicate recruitment of additional motor units, without the typical decline in action potential conduction velocity during muscle fatigue. Increased spatiotemporal variation (low CCT, high CV) was associated with increased RMS and MDF and therefore did not support the hypothesis that increased variation decreases muscle fatigue, but support that recruitment of additional motor units is responsible for changes observed in RMS amplitude. As monopolar EMG signals represent activity from

deeper and bipolar from more superficial regions, the results from our study suggest that additional recruitment appeared in both deeper and superficial parts of lumbar muscles.

P1-E-100 A method for analysis of dynamic posturographic data

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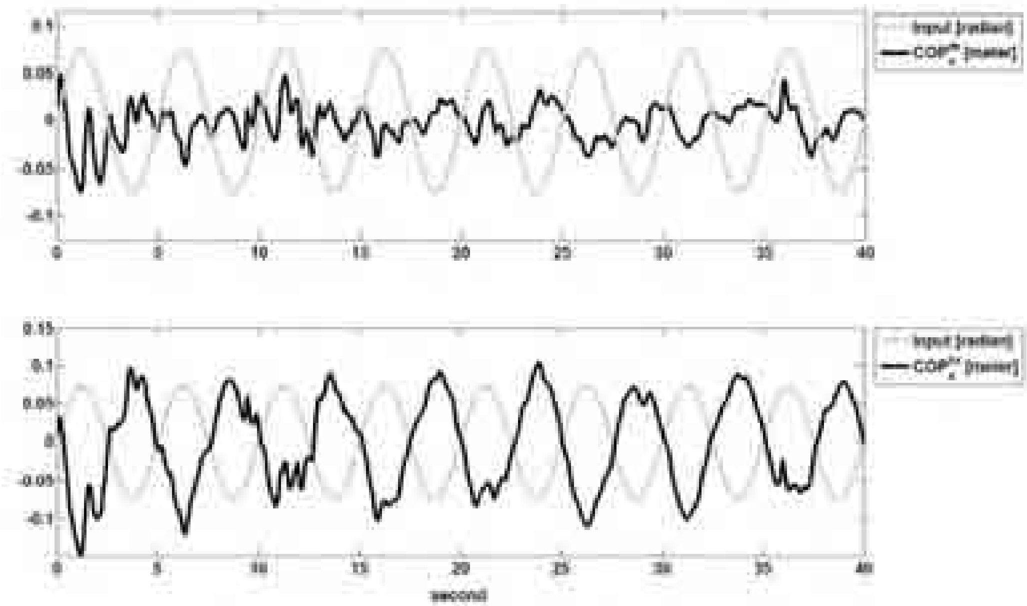
BACKGROUND AND AIM: Quiet stance data have been received during biped stance from which center of pressure (COP) signal was derived in order to understand the dynamics and control principles of erected posture. However, it has been recognized that postural control problem is to be studied in a dynamical sensory environment as the solution of the problem depends on the self perception of the subject as well. COP signal analysis at quiet stance presented further difficulties such that deterministic characteristics of the signal couldn't easily be separated from its stochastic dynamics. Contrary to the quiet stance data, perturbed stance experiments help us to identify postural control system parameters for the given task. METHODS: A two degree of freedom tilt platform (at sagital and frontal planes) has been developed with a performance of 1-10 degrees of peak amplitude at 0.01-1 Hz. COPx^m data collected at antero-posterior tilt has been decomposed according to following equation. COPx^m=COPx^fp COPx^hi COPx^hos COPx^hr where, COPx^fp and COPx^hi are the virtual displacements of the center of mass (COM) of force plate and the static dummy model of the subject respectively. COPx^hos is the initial position of the projection of COM of the subject (eccentricity) with respect to the origin of the force plate. COPx^hr is the projection of the displacement of the COM of the subject to the plane of the force plate caused by the subject's active muscle contraction (self perturbation) during the experiment. The first two terms in the equation are caused by the couple moment vector of the weights of the force plate and the static dummy model as a result of the tilt angle. In contrast, the last term is caused by the active movement of the COM of the subject with respect to the force plate. RESULTS: Figure 1a shows the input given to the standing subject, which is the tilt angle of the platform versus the response of the subject measured by COPx^m. On the other hand, figure 1b shows the decomposed COP signal (COPx^hr), which expresses relative motion of the subject with respect to the force plate. COPx^hr signal presented an out-off-phase relation compared to the input, which means that subject on the tilt platform tried to align himself due to the gravity vertical. However, we couldn't observe this behavior clearly by looking at COPx^m signal. This is because of the fact that COPx^m signal is infected by inertial effects of the force plate and the subject's masses. CONCLUSIONS: We propose a behavioral vestibular model being the subject trying to align himself with respect to the gravity vertical during the experiment. Alternatively, a behavioral somotasensory model can be defined when the subject allows himself to get tilted by the platform. The signal decomposition method suggests a way to differentiate between these two behavioral models as it compensates for dynamical effects of the stationary masses of the force plate and subjects.



P1-E-101 Visual and somatosensory interaction at two different sensory environments tested by tendon vibration technique

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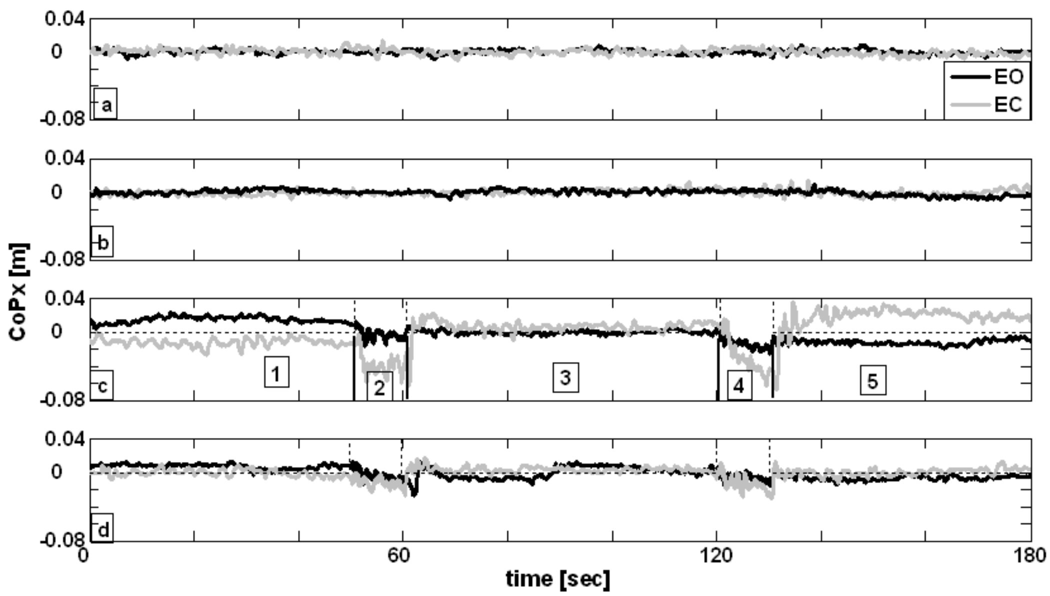
BACKGROUND AND AIM: It has been reported that multisensory fusion enables re-weighting of vision and touch in different sensory conditions for maintaining balance in upright stance. Standing upright depends on the perception of verticality, where proprioception is essential in supplying information about the "self". On the other hand, tendon vibration technique is known to cause corruptions in the proprioceptive information recruited in a given postural task. We created two different sensory environments; biped quiet stance (SE1) and standing while 1-2% of the subject's weight being suspended by a harness fixed to the ceiling (SE2). We hypothesized that visual and somatosensory interaction will differ in the two sensory environments depending on the self-perception (relative position of the self with respect to the gravity vertical), which can be revealed by vibrating Achilles tendon. METHODS: Four healthy male swimmers (21±3.7 years old) stood on a force platform for 180 seconds at eight successive trials. First four trials were eyes open (EO) and eyes closed (EC) repeated at SE1 (Fig 1a) and SE2 (1b) while later trials were the repetition of the first four trials at SE1 and SE2 with vibration (Fig 1c and 1d) respectively. Subjects received 80 Hz vibration to Achilles tendon for 10 seconds twice in a trial (between 50th-60th and 120th-130th seconds, dotted line in c and d). Each of the last four trials was divided into five time segments (1c). Center of pressure antero-posterior coordinate was computed (CoPx) and demeaned. Magnitude of the backward fall (ÄCoPx) experienced at the second and fourth periods of the last four trials were computed and defined as the difference

between the averages of period 1 and 2 (Ä1) as well as the difference between the averages of period 3 and 4 (Ä2) respectively. Then the difference between Ä1 at EO and Ä1 at EC (ÄE1) was computed in SE1 and SE2 respectively. Similarly ÄE2 was computed as the difference between Ä2 at EO and Ä2 at EC in SE1 and SE2 respectively. RESULTS: 2-ANOVA performed on CoPx variance of the last four trials' first periods showed that variability in EC was significantly larger compared to EO ($p<0.03$). Magnitude of backward fall (Ä1) was significantly larger at EC condition compared to EO ($p<0.006$). 1-ANOVA performed on ÄE1 at SE1 and SE2 showed that SE2 significantly reduced the difference in the magnitude of the backward fall observed at EO versus EC conditions ($p<0.015$). However ÄE2 was found to be similar at SE1 and SE2. CONCLUSIONS: Subjects' behavior at EO versus EC conditions were similar in the first four trials but differed significantly at the first periods of the last four trials. Differences in the anticipatory postural adjustments might have caused this result. SE2 reduced the difference in the magnitude of the backward fall observed between EO and EC conditions. This result can be interpreted behalf of somatosensory compensation in the absence of vision.



P1-E-102 Speed and gait patterns during mental imagery of locomotion in fMRI

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BACKROUND AND AIM: To address the question if velocity (fast vs. slow) or gait pattern (running vs. walking) determines locomotor control, we investigated brain activation patterns in a factorial design during mental imagery of locomotion in fMRI. METHODS: 27 healthy subjects (mean age 30.3 years; 15 females) had to imagine five conditions inside the scanner: walking slowly, walking fast, running slowly, running fast, standing still. Conditions were practices before in a corridor. Image processing and data analysis were performed using the SPM5. General linear model was used for statistical analysis. We defined anatomical regions of interest based on the results of our studies using mental imagery of locomotion. RESULTS: BOLD signal increases were found in the condition 'walking slowly' in the precentral gyrus, left putamen and left SMA. In 'walking fast', activation was seen in SMA and the precentral gyrus. With 'running slowly', a cluster of activation in the right precentral gyrus appeared. 'Running fast' had a prominent BOLD signal increase in the right cerebellum. With 'running', the largest area of activity was found in the frontal lobe, the basal ganglia, and in the anterior lobe of the cerebellum. With 'walking', the largest cluster of activity was seen in the left SMA. Analysing 'slow' (slow walking and slow running) large BOLD signals were found in the right hippocampus and the left putamen. CONCLUSION: Slow walking involves most cortical control (motor and premotor cortices). Fast running was associated to midline cerebellar activation. Only slow walking shows thalamic activation, which can be explained by integration of sensory control. Fast walking and both running conditions reflect more automated modes of locomotion involving the cerebellum but not the motor cortex.

P1-E-103 Perceptual motor and locomotor strategies for safe obstacle circumvention in a virtual environment

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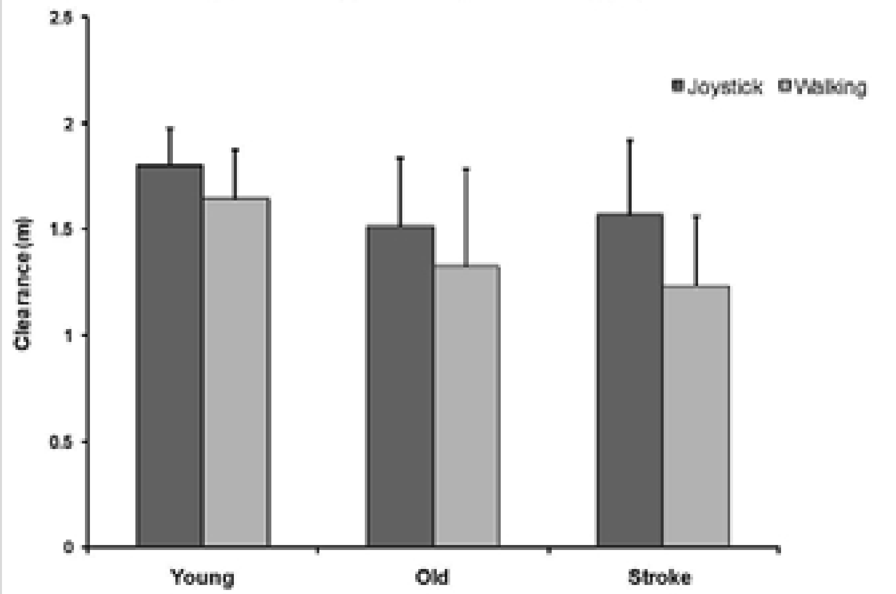
BACKGROUND AND AIM: Successful community ambulation in complex environments encountered in daily life involves navigating around static and moving obstacles. This requires adequate sensory and motor capacities as well as intact executive-cognitive functioning. Individuals with stroke often have deficits in one or all of the above functions that could lead to inappropriate planning and/or execution of avoidance strategies, thus increasing the risk of collisions with obstacles. This study aims at quantifying the clearance maintained by subjects with stroke, as compared to healthy young and old individuals, as they circumvent moving obstacles in a virtual environment (VE) in a perceptuo-motor (PM) and perceptuo-locomotor (PL) task. METHODS: Participants included eight healthy young (18.25 ± 0.46 years), one old (68 years) and one post-stroke (43 years) subject. They were instructed to navigate with a joystick during sitting (PM task) or to walk (PL task) in a VE representing a 7mx5m room with a central target and three cylindrical obstacles distributed (left, centre and right) along a 60-deg radius, viewed through a helmet-mounted display. After advancing 0.5m in the VE, one of the three obstacles moved randomly at the same speed as the subject's comfortable gait speed towards a pre-determined point of intersection in the midline. In both the PM and PL tasks, subjects were instructed to navigate to the target while avoiding collision with the moving obstacles. In the PM task, the VE advanced at the pre-set speed (matching subject's gait speed) in absence of joystick movement. The advancement speed can be increased or decreased by forward or backward motion of the joystick, respectively; while steering motions to the left or right can be controlled by medio-lateral motion. Clearance from the obstacle during the avoidance strategy was calculated using the modified Shephard's method of Inverse Distance Weighting (IDW). This outcome indicates the distance maintained from the obstacle throughout the avoidance strategy that represents the minimum clearance for safe obstacle avoidance. RESULTS: In the PL task, young subjects maintained larger clearance (1.65 ± 0.23 m) as compared to the old (1.33 ± 0.46m) and the stroke (1.23 ± 0.33m) subject (Figure 1). Moreover, a further reduction in clearance was observed in the stroke subject in a collision trial (0.63m). In the PM task, clearances in general were greater than the PL task amongst all subjects. Also, as in the PL task, younger subjects showed larger clearance (1.8 ± 0.17m) as compared to the old (1.52 ± 0.32m) and stroke (1.57 ± 0.35m) individual. CONCLUSIONS: Modified Shephard's method of IDW can be used to measure clearance during obstacle circumvention. The older subject and the post-stroke individual maintained smaller clearance distances from obstacles during walking as well as in a perceptuo-motor task. This might signify a higher risk of collisions with moving obstacles among these groups.

Figure 1. Clearance from the obstacle (m) in the joystick navigation (PM) and walking (PL) task



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P1-E-104 Visual perturbation causes alterations in the gait variability during different locomotion speeds

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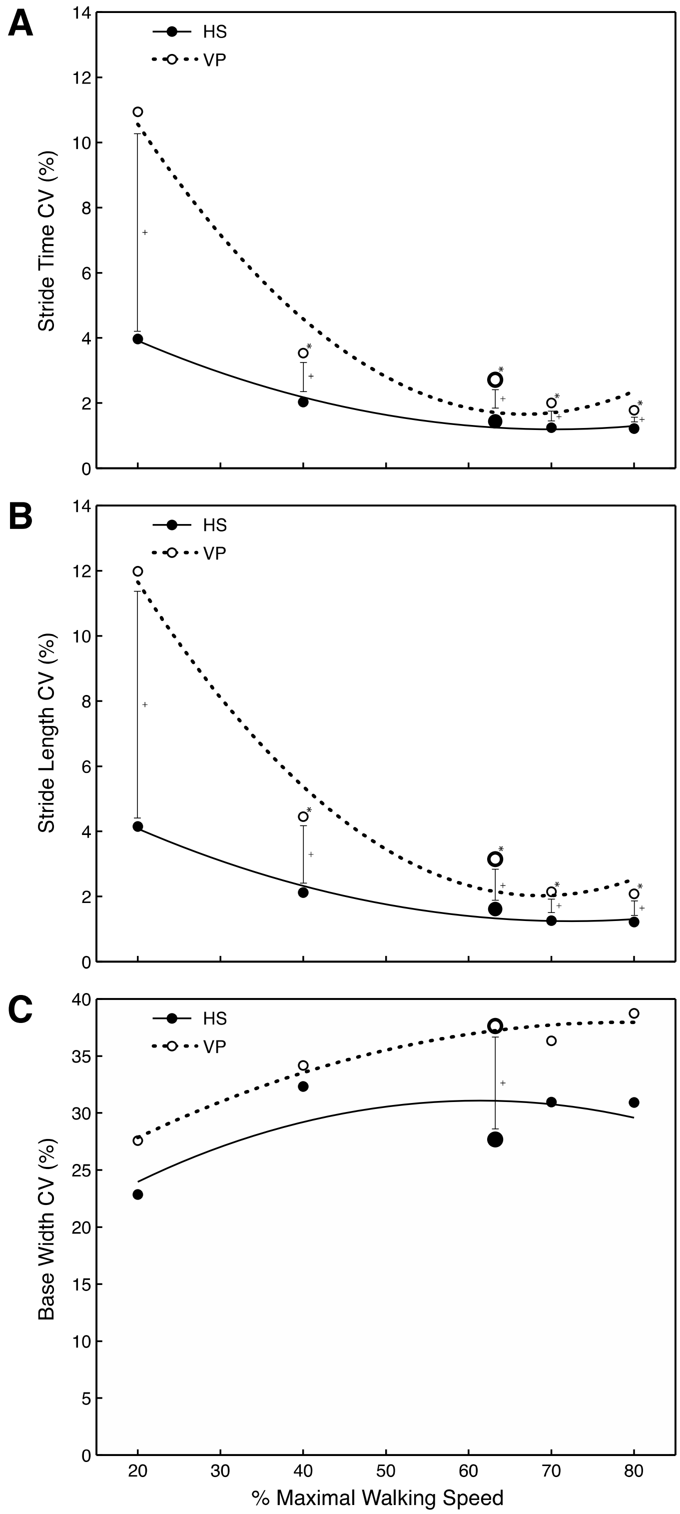
BACKGROUND AND AIM: Temporal and spatial gait variability is relatively small in the healthy walking pattern. Patients with a sensory loss show a pathological increase of gait variability. The purpose of this study was to investigate the influence of artificially disturbed visual locomotion control on the gait variability during different locomotion speeds. METHODS: Nine healthy subjects (31.0 ± 8.4 years, 2 females) participated in the study. For each subject the walking pattern was recorded while walking under normal conditions and while walking under visual perturbation (VP). Therefor, subjects were artificially blinded with light-impenetrable eyeglasses. For each condition, subjects had to walk in five different locomotion speeds on a pressure-sensitive treadmill system (Zebris®). The magnitude of the fluctuations of stride time (ST), stride length (SL) and base width (BW) was analyzed by calculating the coefficient of variation (CV). RESULTS: For normal walking mode the gait variability in the longitudinal plane (i.e. ST and SL) and the lateral plane (i.e. BW) was in the normal range and did not show any significant speed effects. Under VP, longitudinal gait parameters showed significant speed effects and were significantly increased ($p<0.001$) most pronounced for slow locomotion speeds. Lateral gait variability did not show significant speed effects but was significantly increased ($p<0.05$). CONCLUSIONS: VP has a direct effect on the magnitude of stride-to-stride fluctuations in the walking pattern. This impact is differentially pronounced for different walking speeds as well as the variability in the longitudinal and lateral walking plane. These results are highly comparable to the effects of a vestibular loss on the gait variability in patients with a bilateral vestibular failure. Taken together, the speed dependent impacts of sensory perturbation on the gait variability support the hypothesis of a speed dependent sensory locomotion control.



Speed dependency of variability magnitude: *Dependency of the coefficient of variation (CV) of stride time (A), stride length (B) and base width (C) on the walking speed. Black dots represent: mean CV values of the healthy person group (HS) at 20%, 40%, 70%, 80% of maximal walking speed and preferred walking speed (major black dot). White dots represent: mean CV values of the healthy person group* *walking under visual perturbation (VP) at 20%, 40%, 70%, 80% of maximal walking speed and preferred walking speed (major white dot). For each gait cycle parameter a polynomial function was calculated (black line for the HS group, dotted line for the VP group). Within-group analysis: star (*) indicates a significant difference within a group to the CV value of 20% of maximal walking speed. Between-group analysis: cross ($^{+}$) indicates a significant difference of the mean CV value between the groups at the same walking speed.*

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P1-E-105 Evaluation of visual and proprioceptive-vestibular feedback for humanoid robot posture control

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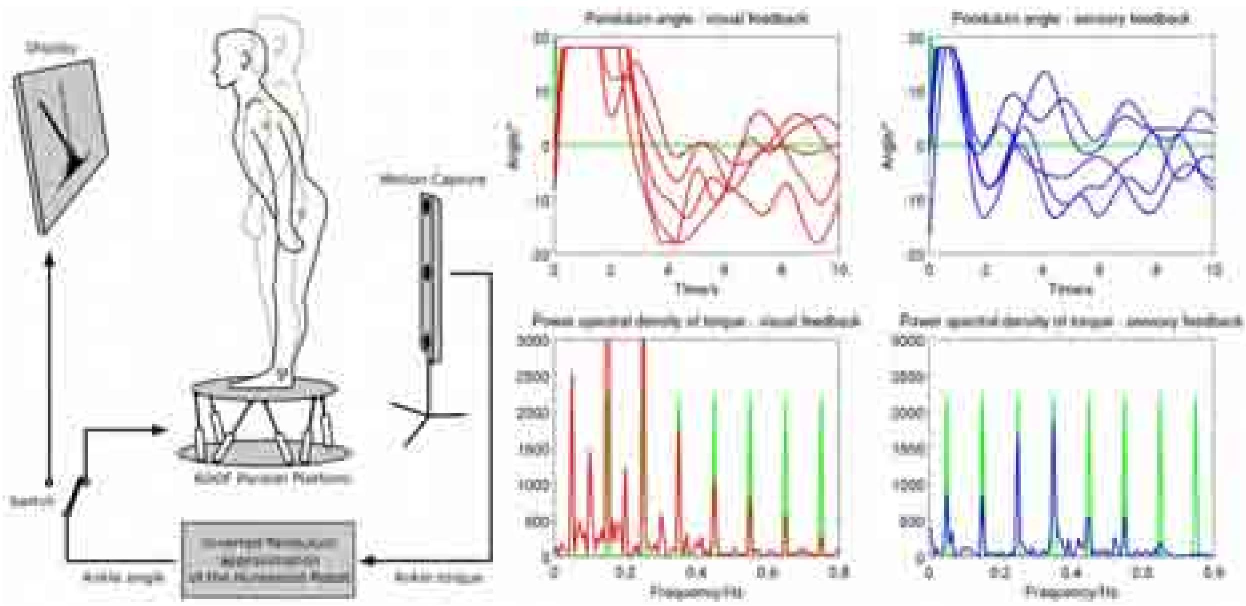
BACKGROUND AND AIM: We address the question whether the human can learn to generate the appropriate motor commands of the humanoid robot to maintain its posture using the human-in-the-loop paradigm [1]. Moreover we evaluated and compared the suitability of the visual and vestibular feedbacks for the control of posture with induced perturbations [2]. METHODS: The motion of the human standing on the parallel platform was recorded in real time. The hip angle was used as the input torque of the inverted pendulum approximation of the full size humanoid robot. The task of the human was to preserve the upright pose of the inverted pendulum by moving the body. This consecutively generated the torque which caused the motion of the inverted pendulum. The motion of the pendulum was then fed back to the human by means of either displaying the animated humanoid robot on a display (visual feedback) or by rotating the parallel platform on which the human was standing (vestibular feedback). The experimental setup is shown on the left side of the Figure. The humanoid robot posture control was performed by four subjects. The task of the subjects was to learn to keep the upright pose of the pendulum with randomly induced external perturbations of the pendulum pose. First the visual feedback was enabled, then, after the break, the vestibular feedback was enabled. RESULTS: The top two diagrams on the right side of the Figure show the trajectories of the pendulum angle after the perturbations. The time needed for the pendulum to return to the upright position was shorter when the vestibular feedback was enabled (mean=1.66s, std=0.47s) than when the visual feedback was enabled (mean=2.73s, std=0.59s). There was a significant difference in the scores for visual-feedback and the vestibular-feedback conditions; p=1.04E-5. The bottom two diagrams show the power spectral density of the torque, generated by the human during the experiment. They suggest that

the response of the human was not as closely synchronized with the perturbation signal in the case of the visual feedback as in the case of the vestibular feedback. The energy expenditure of the human was approximated by the integral of the absolute value of the pendulum angle during the ten seconds after the perturbation. There was a significant difference in the scores for visual-feedback (mean=1.65s, std=0.42s) and the vestibular-feedback (mean=1.35s, mean=0.34s) conditions; p=0.036. CONCLUSIONS: The results suggest that the type of the feedback provided to the person really affects the reaction time and the energy expenditure of controlling the posture of the humanoid robot. By use of the vestibular feedback, both the reaction time and the energy expenditure decrease significantly.



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F - Coordination of Posture and Gait I

P1-F-106 Effects of exercise with a horse on gait and balance in elderly

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BACKGROUND AND AIM: Gait speed has been recognized as good predictor of health and even survival in elderly [1]. Evidence supports exercise intervention as effective means to maintain and even reduce the effects of aging, and consequently delay the functional dependence in elderly. Furthermore, inclusion of animals in exercise interventions may enhance these positive effects. The purpose of this study was to examine the effect of two different exercise programs on gait speed, muscular strength and balance performance of an elderly population. METHODS: 38 volunteers were randomly assigned to a control (C: n=11, 71.8 ± 5.4 yr) or two experimental groups (E1: n=17, 70.5 ± 7.1 yr, E2: n=10, 72.2 ± 7.7 yr). The experimental groups participated in a training program (3 sessions/wk for 12 wks). E1 received a traditional exercise program and E2 participated in an exercise program with horses called "centaur method". Maximal gait speed, normalized handgrip, maximal knee extensors strength at 60° and 90° (NK60, NK90) and balance in three conditions (quiet standing with eyes open (EO), with eyes closed (EC) and with an additional cognitive task (CT)) were collected at baseline, post-intervention, and follow-up after 1-month. The balance variables were: maximal distance, peak velocity, and trajectory of the centre of pressure in the anterior-posterior and medial-lateral directions. 3(group)×3(pre-post-follow-up) ANOVAs with repeated-measures on the time factor were used of all variables. RESULTS: At the onset of training, there were not significant group differences for any variable. A significant gait speed group by time interaction effect ($F(4,68)=2.74$, $p=.03$) and a large effect size ($\eta p2= 0.14$) were found. Only E2 improved significantly gait speed during the intervention while E1 improved but not significantly and C remained the same. The three strength variables also yielded large effect sizes with significant or close to significant group by time interactions ($\eta p2= 0.13, 0.18, 0.13$ for NK60, NK90, HandGrip respectively). Both E groups improved significantly NK90 with the intervention while C remained the same. For handgrip, only E1 yielded a significant improvement for handgrip. Regarding balance, CT revealed the most significant effects for the group by time interaction (moderate effect sizes for 5 of the 6 variables). CONCLUSIONS: E2 presented the largest improvement in maximal gait speed compared to the other groups. However, both E groups showed similar knee extensors strength as an effect of the interventions. In contrast, handgrip increased in E1 only. It seems that an exercise program with horses can improve gait and strength in elderly while a traditional exercise program may impact strength only. These results could be explained by further mobility exploration with the horse. Since observed positive effects seem to disappear when the intervention is terminated, exercise programs should be an integral part of the life style in the elderly.

P1-F-107 Relationship between cerebellar grey matter volumes, processing speed and gait speed

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BACKGROUND AND AIM: Cerebellar damage has been historically linked to gait disorders and the relationship between the cerebellum and executive function is emerging. While cerebral white matter hyperintensities (WMH) and grey matter volumes (GMV) are associated with gait and cognitive functions, the relationship between cerebellar GMV, gait speed and cognitive processing speed in older adults independent of cerebral WMH and GMV is not known. This study sought to address this gap in knowledge. METHODS: Three hundred and thirteen participants of the Health, Aging and Body Composition Study cohort underwent brain MRI for volumetric assessment concurrent with their gait parameters assessment on the GaitMat II. Processing speed was assessed on the Digit Symbol Substitution test (DSST). Bilateral cerebellar and cerebral GMV and cerebral white matter

hyperintensities (WMH) volumes were obtained by an automated process that involved segmentation, registration and classification of brain tissues on MRI. Partial correlation and regression analyses were performed using SPSS 19 and SAS 9.3 statistical packages. RESULTS: The sample included 57 % female with mean age of 79 years, 53 % having completed at least high school education and 58% were Caucasian. Larger cerebellar GMV were significantly correlated with faster gait speed (right: â= 0.25, left: â=0.22; both p<0.001) and higher DSST scores (right: â=0.23, p= 0.002; left: â=0.27, p<0.001) and these associations retained their statistical significance even after controlling for demographics variables (age, gender, race, education), cerebral measures (total WMH volume and GMV) and comorbidities (systolic blood pressure, depression scores, diabetes, stroke and cardiovascular disease). After adjusting for DSST, the association between larger cerebellar volume and faster gait speed remained significant (right: â=0.19, p=0.007; left: â=0.15, p=0.03) but the strength of relationship was attenuated. The association between higher cerebral WMH and slower gait speed (p<0.01) was independent of right and left cerebellar GMV. CONCLUSION: Smaller right and left cerebellar GMV are associated with slower gait speed and slower processing speed independent of WMH burden in older adults. The relationship between smaller cerebellar GMV and slower gait appears to be explained in part by slower processing speed. Research on specific regional cerebellar associations with gait and cognition may better explain underlying mechanisms involved in the interaction between motoric and non-motoric functions of the cerebellum.

P1-F-108 Walking forward while counting backward: Increased variability in temporal but not spatial gait variables for elderly slow walkers

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BACKGROUND AND AIM: The literature typically reports that elderly persons decrease walking speed and increase gait variability during dual task as compared to single task walking [1,2]. However, changes in gait variability might be different for slow as compared to fast walkers. Furthermore, a change in walking speed during dual tasking is a potential confounder when evaluating gait variability measures that are related to walking speed [3]. The aim of this study was to investigate how gait variability changes from single to dual task gait in elderly slow versus fast walkers, while controlling for differences in gait speed. METHODS: 162 healthy elderly persons, mean age 78.6 ± 4.7 years, walked over an electronic gait mat (GaiRite) at 3 instructed speeds (slow, preferred, fast) and at preferred speed while counting backward from 50. Dependent measures were walking speed and variability in Step Length (SD), Step Width (SD), Step Time (CV), and Single Support Time (CV). RESULTS: Consistent with earlier studies, elderly persons walked slower when counting backward (mean gait speeds: 0.97 m/s versus 0.81 m/s) and showed increased variability in both spatial and temporal measures compared to single task walking at preferred speed (p's<.05). When controlling for differences in walking speed, measures of variability were still larger during Dual task walking (p's<.05). Splitting the elderly into three groups based on their preferred walking speed during single task walking (<0.59 m/s; 0.6-1.09 m/s; >1.1 m/s) the slowest group demonstrated larger temporal variability (CV Step Time and CV Single Support Time) compared to the faster walkers during dual task walking. This was not the case for the spatial measures

SD Step Length and SD Step Width. CONCLUSIONS: Gait speed has been suggested to have predictive value and is considered by some as the 6th vital sign. Together with temporal and spatial gait variables, gait speed can provide valuable information of gait in older persons. Our results confirm previous studies finding that dual task challenges gait control in older persons. The finding that increased variability shown by slow walkers in temporal but not spatial variables may draw attention to congruent factors that challenge elderly while walking. We speculate that temporal variables are sacrificed at the expense of control of spatial variables for slow walkers at challenging gait conditions. Thus, temporal gait variability measures can capture other aspects than spatial variability measures.

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P1-F-109 Older persons decrease gait speed at fast and dual task walking but do not increase gait variability over a one year period

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BACKGROUND AND AIM: Both gait speed and variability of gait measures are associated with falls [1, 2]. It has been shown that increased stride-to-stride variability in speed, step length and double support is independently associated with falls in a prospective study of older adults [3]. The aim of this study was to assess changes in gait speed and gait variability in older persons over a 1-year period. METHODS: One hundred and sixty two healthy persons >70 years of age drawn from the National registry, mean age 78.6 ± 4.7 years, walked over an electronic gait mat (GaitRite) at two sessions one year apart. Subjects were instructed to walk at 3 different speeds (slow, preferred, fast) and at preferred speed while counting backwards from 50. One hundred and thirty three subjects completed both sessions. Dependent measures were walking speed and variability in Step Length (SD), Step Width (SD), Step Time (CV), and Single Support Time (CV). Paired t-tests were used to assess change from baseline to 1 year follow-up. Change in variability was assessed at a common gait reference speed for all participants. RESULTS: After one year, fast walking speed was significantly reduced ($p < .001$) while slow ($p<.05$) walking speed had increased (Fig 1A). The participants were split into 3 groups based on preferred walking speed at baseline (<0.59 m/s; 0.6-1.09 m/s; >1.1 m/s). In the slow walking group, no significant changes in gait speed occurred in any of the walking conditions. The medium walkers increased slow walking speed while fast walkers decreased preferred, fast, and dual task walking speed. Variability measures for the entire group did not change from baseline to follow-up (Fig 1 B & C) while for sub groups, fast walkers only increased CV Single Support Time. There were no changes for other measures of variability for any of the groups. CONCLUSIONS: The increased slow walking speed but decreased fast walking speed suggest differential effects between simpler and more complex walking tasks. The larger change in gait speed for the fastest walker suggests start of age-related changes in previously fit persons. Lack of changes in variability may be explained by the analysis methods used (normalized speed) or that gait speed changes in demanding gait situations occur before changes in gait variability.

Future analyses should assess whether gait variability at fast speed increases over the 1-year period in this sample of older persons.

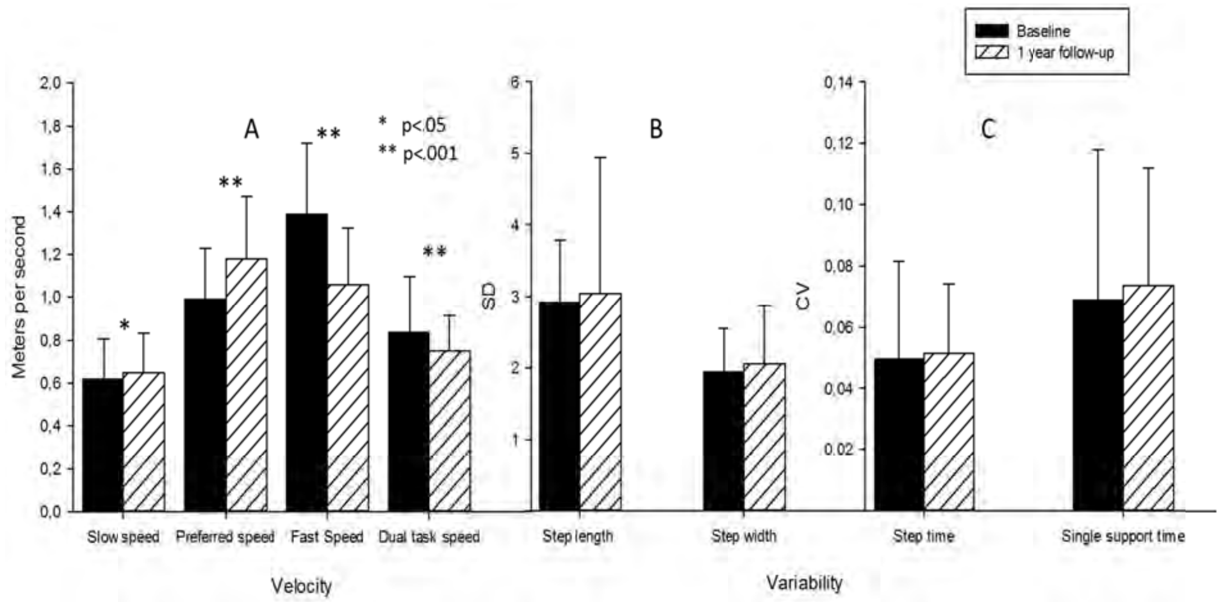

Fig 1. A: Means (SD) of gait speed for each speed condition at baseline and 1 year follow-up. B & C: Means (SD) of variability measures for spatial and temporal gait characteristics at baseline and 1 year follow-up.

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P1-F-110 Contributors to lateral postural control during a cop displacement tracking task in the very old

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BACKGROUND AND AIM: The mechanisms underlying postural control in older adults are complex and may involve both cognitive (e.g. executive function) and non-cognitive (e.g. lower extremity strength and somatosensation, demographic) factors..This study aimed to evaluate contributors to lateral postural control using a center of pressure (COP) displacement tracking test. METHODS: During an annual follow-up visit for the Healthy Brain Study, a subset of participants in the Health ABC Study Pittsburgh field center (n=219, 82.9 yrs old, 40% black, 57% women) performed a postural control task. Participants stood on a force platform with their feet 16 cm apart and viewed a computer monitor displaying an open circle moving along a horizontal line in a sinusoidal fashion and an "X" representing

the subject's medio-lateral COP moving on the same line. Participants were instructed to keep the "X" inside the open circle. Two trials of 60s duration were performed in which the circle moved at 0.125 Hz and 0.75 Hz with a peak-to-peak excursion scaled to 16 cm. Accuracy was computed as the root-mean-square error (RMSE) in cm between the position of the open circle and the "X". Neurological and cognitive function (Digit Symbol Substitution Test, DSST, modified Mini Mental State Examination, 3MS), eyesight, lower extremity joint proprioception, pin-prick sensation, vibratory sensation and knee extensor strength were measured concurrently. RESULTS: Participants were well-functioning, with mean walking speed of 1.0 m/s and a mean 3MS score of 94.7. Persons completing the tests (n=195), were younger, had faster walking speed, higher DSST score and were less likely to have abnormal lower extremity sensation than non-completers (n=24); p<0.04 for all). Among those completing the tests, mean RMSE was higher for the 0.75 Hz trial than the 0.125 Hz trial (6.8 cm and 3.4 cm, respectively). Larger RMSE was univariately associated with older age and lower DSST for each of the two trials and with female sex for the 0.125 Hz trial. Associations with vibratory sensation were borderline significant (p=0.09 and 0.08) and eliminated after adjustment for sex. Muscle strength, gait speed, eyesight were not associated with RMSE (p>0.2). In multivariable regression models (Table 1), female sex was associated with RMSE during the 0.125 Hz test. In contrast, DSST was associated with RMSE during the 0.75 Hz test. CONCLUSIONS: In this group of older adults, lateral control of posture at 0.75 Hz was more difficult (i.e. yielded greater errors) and was associated with a cognitive factor (as measured with DSST). Contributors to postural control may vary depending on external conditions, simulated here as different tracking frequencies.

Table 1. Multivariable linear regression models.

Independent variables:	Outcome: Error during 0.125 Hz Frequency test		Outcome: Error during 0.75 Hz Frequency test	
	Standardized beta	P	Standardized beta	P
DSST	-0.10	0.3	**-0.20**	**0.03**
3MS	-0.06	0.5	-0.05	0.5
RACE (1=W, 2=B)	-0.03	0.7	0.06	0.4
SEX (1=M, 2=F)	**0.18**	**0.02**	0.03	0.7
AGE	0.14	0.06	0.13	0.09

ACKNOWLEDGEMENT:
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P1-F-111 Effects of muscle fatigue on the approaching phase to cross an obstacle

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BACKGROUND AND AIM: Locomotion in complex environments requires adaptive ability from the locomotor system to avoid and cross uneven ground (Krell; Patla, 2002). The approaching phase is important to successful of the task. Fatigue changes the support base and delays motor responses to perturbations of gait in young adults (Parijat; Lockhart, 2008), which may contribute to falls and injuries (Granache et al., 2010). The aim of the study was to analyze the effects of muscle fatigue in the spatial-temporal parameters of the approaching phase to cross an obstacle. METHOD: Twenty young male adults participated in this study (27.72±2.89 years old). The instruction given to the participant was to walk over an 8 m pathway, at his self-selected speeds. They performed three trials for each condition, free and adaptive gait, before and after muscle fatigue. For the adaptive gait trials, the participants were instructed to avoid contact with the obstacle (15 cm high, 80 cm wide and 2 cm thick), which was positioned in the middle of pathway. Spatial and temporal variables were collected through an optoelectronic tridimensional system. The central stride of participants was analyzed in free walking and the stride immediately before (approaching phase) the obstacle crossing was analyzed in adaptive walking. To induce muscle fatigue, the participants performed the sit-to-stand task (Helbostad et al., 2007), at a frequency of 0.5Hz controlled by a metronome. ANOVA two-way (task X fatigue) was performed to evaluate the effects of fatigue in the approaching phase. RESULTS: Statistics analysis showed main effects for task and fatigue, without interaction between the factors (Table 1). For the task, participants demonstrated greater values of stride duration and double support duration, and lower values of stride length, stride velocity and single support duration in the adaptive gait condition than in the free gait condition. For muscle fatigue, independently of gait type, the participants increased step width and stride velocity and decreased single support duration and stride duration after muscle fatigue. CONCLUSION: Despite of modulations in the approaching phase to cross the obstacle, the effects of muscle fatigue were independent of gait type. After the fatigue protocol, the participants appeared to seek more stability during gait.

Table 1. Means and standard deviations of spatial-temporal parameters of the free and adaptive gait before and after fatigue.

	Free Gait	Adaptive Gait	*p*-value
Stride length (cm)	135.91±2.65	131.3±2.36	**0.001**
Stride width (cm)	12.14±0.57	12.58±0.59	0.064
Stride velocity (cm/s)	127.21±3.85	119.22±3.12	**0.001**
Stride duration (s)	1.08±0.019	1.11±0.022	**0.004**
Single support (s)	0.78±0.012	0.76±0.015	**0.023**
Double support (s)	0.30±0.009	0.35±0.011	**0.001**
	Before fatigue	**After fatigue**	***p*-value**
Stride length (cm)	133.25±2.4	133.96±2.5	0.080
Stride width (cm)	11.64±0.56	13.04±0.6	**0.001**
Stride velocity (cm/s)	121.6±3.36	124.83±3.53	**0.005**
Stride duration (s)	1.11±0.022	1.08±0.02	**0.004**
Single support (s)	0.78±0.015	0.76±0.012	0.069
Double support (s)	0.33±0.01	0.32±0.01	**0.023**

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P1-F-112 Dynamic and static margin of stability in sit-to-walk compared to sit-to-stand in older people with and without fear of falling

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BACKGROUND AND AIM: Fear of falling (FoF) increases the risk of falling during locomotion. Furthermore, it has been indicated that sit-to-walk (STW) is more balance-demanding than sit-to-stand (STS) [1]. We compared the execution of STW and STS between older (≥ 70 years) people with FoF and controls (Ctr), in terms of temporal characteristics, and two stability parameters. METHODS: Nine matched subject pairs were investigated in a lab. An 8-camera motion capture system and four force plates (two beneath the buttocks and two beneath the feet) were used. The body was modeled by 13 rigid segments using 38 reflective markers. The vertical projection of the Center of Mass (CoM) as well as extrapolated CoM (XCoM) was calculated. XCoM is obtained by adding to CoM its velocity times a

factor √l/g where l is the height of the inverted pendulum and g - gravitational acceleration [2]. Two stability margin measures were computed: 1) The dynamic spatial margin of stability (D-SMoS) i.e. the minimum distance from the XCoM to the boundaries of the base of support (BoS) [3] and 2) The static spatial margin of stability (S-SMoS) i.e. the minimum distance from the CoM to the boundaries of the BoS [4]. The smallest convex region including the projections onto the floor of the markers on the feet (big toe, lateral 5th toe and lateral heel), defined the border of the BoS. The S-SMoS and D-SMoS were calculated in both posterio-anterior (positive) and anterio-posterior (negative) directions and analyzed only at seat-off. When CoM or XCoM moved outside the BoS, only one of these distances could be computed. The temporal characteristics were calculated from onset to CoM maximum height i.e. the first zero of CoM upward momentum after its 1st peak. Paired comparisons were performed using Wilcoxon matched-pairs signed-rank test. Differences in D-SMoS were defined as main outcome. RESULTS: The FoF-group required significantly ($p<0.05$) more time for both STW and STS. They showed larger anterior and smaller posterior D-SMoS during STW compared to Ctr. There were no differences between FoF and Ctr in either anterior or posterior D-SMoS in STS. The FoF showed smaller anterior but larger posterior S-SMoS in both STW and STS. Moreover, in the Ctr the CoM moved slightly outside the BoS in posterior direction during STS, resulting in negative posterior S-SMoS. The FoF-group showed no differences in S-SMoS between STW and STS in any direction, whereas the Ctr showed smaller both anterior and larger posterior S-SMoS and D-SMoS during STW compared to STS (Fig. 1). CONCLUSIONS: The FoF-group moves slower, which leads to smaller differences between S-SMoS and D-SMoS. Apparently, the fear of forward falls causes a larger anterior but smaller posterior D-SMoS in the FoF-group.

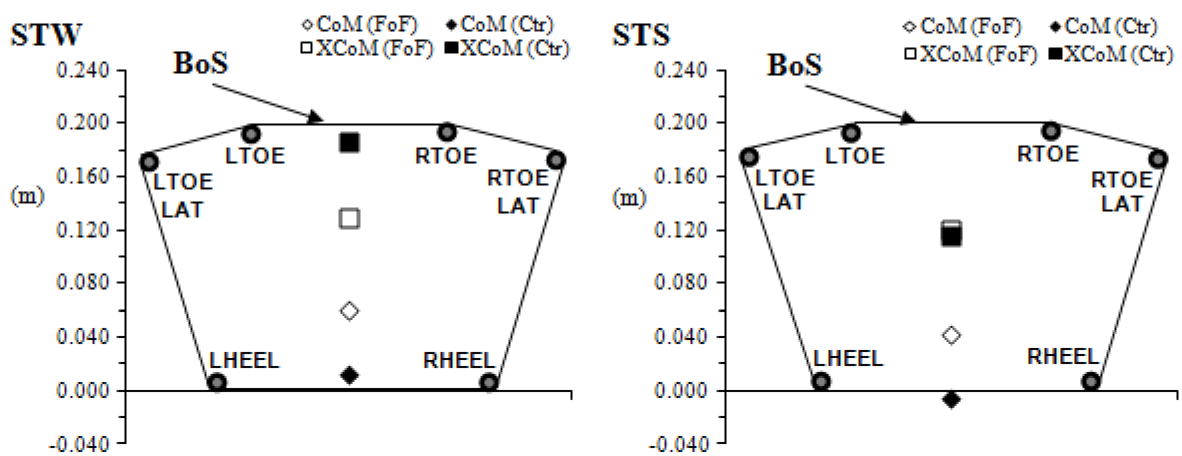

Figure 1. The S-SMoS and D-SMoS in posterio-anterior and anterio-posterior directions at seat-off during STW and STS, respectively, in older people with fear of falling (FoF) and matched controls (Ctr). The BoS was defined using the projection onto the floor of a lateral fifth toe (LTOE LAT and RTOE LAT), big toe (LTOE and RTOE) and lateral heel (LHEEL and RHEEL) markers on the right and left foot.

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P1-F-113 Balance mechanisms in children with and without motor coordination difficulties

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BACKGROUND AND AIM: Children with motor coordination difficulties (MCD) encounter problems in postural control that impact their daily life activities [1]. Two mechanisms for postural control: 'moving the centre of pressure' (M1) and 'accelerating segments' (M2) are used for postural control in unsupported standing [2, 3, 4]. Our aim was to compare percentage utilization of M2 during standing tasks with and without a dual activity (clapping hands to a beat) between children with and without MCD. Furthermore, possible differences in variability of timing (VT) of clapping performance were investigated. METHODS: Based on the Developmental Coordination Disorder Questionnaire (DCDQ) [5], 32 children (aged 8-10 years) were included. Initially, the Movement Assessment Battery for Children [1] was used for the assignment to one MCD group (n = 8) and one control group (n = 24). On a subsequent visit at the laboratory children underwent balance testing. A motion capture system and two force plates were used for the collection of synchronized kinematic and kinetic data during narrow and (right and left) single-leg stance (NS, RS and LS, respectively) with and without clapping to a 2Hz beat. Data from four trials of each task were collected resulting in a total of 28 trials with a duration of 15 s each. The M2 was calculated in anterio-posterior (AP) and medio-lateral (ML) directions. For the dual task trials the VT of clapping performance was calculated. Pair-wise comparisons of the M2 were made by ANOVA. Mann-Whitney U Test was used for VT comparisons. For analyses of associations between DCDQ and both M2 and VT, Spearman's rank correlation was used. Significance level was set at $p < 0.05$. RESULTS: In both right and left single-leg stance, the MCD group showed significantly more use of M2 (irrespective of direction or the dual task) and larger VT than controls, whereas in narrow stance no group differences were found (Fig. 1). A moderate correlation (-0.40 to -0.60) was detected between the DCDQ and M2 in LS except for M2 in ML direction during clapping. A moderate correlation (-0.44 to -0.45) was also found between DCDQ and VT in single-leg stance. CONCLUSIONS: Children with MCD used more M2 (i.e. acceleration of the limbs) in the most balance-challenging tasks, compared to controls. Adding the dual task of clapping hands did not increase these differences in M2 usage between groups, though, in single-leg stance, children with MCD performed the clapping task with larger timing variability than controls. The DCDQ correlations with both M2 and VT indicate that both these measures may be useful in investigations of perceived and measured motor skills in children.

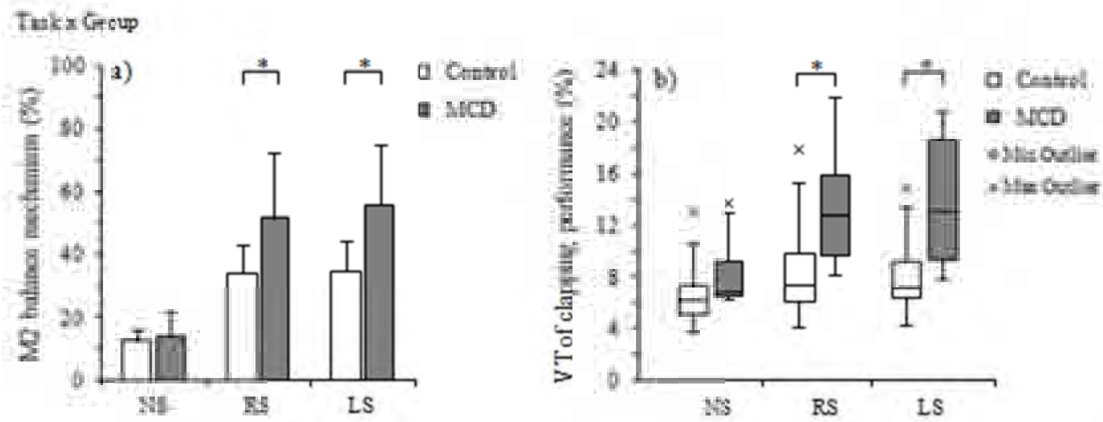

Figure 1. Comparisons between the Control and MCD group in M2 and VT of clapping performance. The bar plot a) represent mean (95%CI) values of M2 in NS, RS and LS, irrespective of direction of the dual task. The box plot b) represent median values (horizontal lines) of VT, the boxes represent quartile ranges and whiskers – values of the 1.5*IQR (interquartile range) above the 75th percentile and below the 25th percentile. Significant ($p < 0.05$) differences are marked with *.

ACKNOWLEDGEMENT: The authors thank BSc Eva Fors and statistician Jan Kowalski for contributing to this study, and Promobilia for financial support.

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P1-F-114 Energy consumption during walking with assistive devices for children with myelomeningocele

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BACKGROUND AND AIM: Myelomeningocele (MMC), the most common and severe form of spina bifida, is a neural tube defect affecting the integrity of sensorimotor nerves in the lower body, typically resulting in gait impairments. If children w/MMC learn to walk, they typically use an assistive device (AD) (walker, crutches) to maintain balance. Nevertheless, ~50% transition to wheelchair use in adolescence and young adulthood [1, 2] due to increasing metabolic demands during walking. Our goal was to determine if walking pole use will increase energy efficiency compared to walkers or crutches. METHODS: We tested 8, 5-12 y/o children w/MMC in 4 conditions: Independent (I), Walker (W), Crutches (C), Walking Poles (P). They performed 1 trial/condition, randomized, wearing a portable oxygen uptake unit (COSMED K4b2). All children were considered community ambulators [3]. 4 used ankle foot orthoses (AFOs) (Community Minus = C-); 4 could walk in the community w/o AFOs (Community Plus = C+). Each trial included 3, 5-minute stages: rest, walk, recovery. Children walked at their self-selected pace for all trials. Net energy consumption (ECSnet) was calculated by subtracting ECSexercise -ECSrest. RESULTS: Our results show C+ ambulators had lower average ECSnet while walking

I =145.85(64.36) than the C- group, 233.15(140.06). However, the C+ group showed higher ECSnet while walking w/any AD than the C- group. While walking w/C, W, and P, the C+ group's M(SD) for ECSnet: 228.12(43.31), 209.9(116.42), and 206.44(46.47), respectively; for the C- group, M(SD) for ECSnet values while walking w/C, W, and P: 192.54(98.44), 199.46(117.30), and 198.27(74.92), respectively. Given the wide range of means, we normalized variability by calculating the coefficient of variation (CV). The C- group demonstrated greater CV across all conditions compared to the C+ group w/highest CV during I ambulation (60.07%) and lowest w/P (37.79%). CONCLUSION: Children w/MMC who use AFOs were more energy efficient while walking w/ADs than independently while those who do not use AFOs showed greater efficiency while walking independently than w/ADs. For children who do not use AFOs, ADs do not appear to provide any energy benefit. However, for those children who do use AFOs, pole use resulted in the lowest variability in energy consumption. Therefore, pole use by children w/MMC who use AFOs for independent ambulation may increase efficiency while decreasing variability in energy consumption, contributing to decreased metabolic demand and perception of fatigue and may be an option for helping these children remain community ambulators beyond adolescence and young adulthood.

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P1-F-115 First use of EMG component analysis on a child with cerebral palsy

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BACKGROUND AND AIM: Cerebral palsy (CP) is a disorder that can affect the natural development of locomotor control. Studies of muscle activation during locomotion in children with CP have revealed increased antagonist coactivation in the leg muscles and low activation of the gastrocnemius muscle [1,2]. These changes are thought to be related to the inability to suppress immature gait patterns during development [3]. Recent studies have focused on the activations of specific muscles in children with CP; however, the focus of the current study is to use a component analysis on EMG signals to determine a basic spatiotemporal structure of the locomotor output and potential underlying neural control mechanisms [4]. METHODS: A seven year old male with cerebral palsy (diplegia, GMFC-S level 1) walked on a treadmill at a speed of 3km/h for 15 strides. Although the child was diagnosed as having diplegia, there was an asymmetry which resulted in affected and less affected sides. Full body 3-dimensional kinematic data were collected using a 9-camera Vicon motion capture system and electromyography (EMG) from 24 lower limb muscles (12 muscles on each side) were collected using a Delsys Trigno System. EMG data for each limb were time-normalized to the stride cycle and averaged over 10 strides in each limb. Components were extracted from the EMG data of each limb separately using non-negative matrix factorization. For each of the components extracted from the analysis, the maximum peak of the trajectory was determined with respect to the stride cycle for that specific limb. RESULTS:

Four components, each with a single peak, explained ~90% the variance of the EMG data in the affected and less affected limbs. Temporal positions of the components tended to be shifted earlier in the stride cycle in the affected limb when compared to the less affected limb. When comparing the timings of these peaks to normally developing humans [4], it appears that the component peaks in the less affected limb resemble that of a normally developing child, while the component peaks in the affected limb occurred at times similar to that of a normally developing toddler. CONCLUSIONS: This study proves feasibility of EMG component analysis methodology in characterizing the spatiotemporal locomotor output for the affected and less affected limbs in a child with cerebral palsy and possibly other developmental pathologies. Furthermore, we also found striking differences between limbs in this single participant which need to be further investigated in a larger group of participants and infer the underlying neural control differences.

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P1-F-116 Comparison of locomotor control mechanisms for segmental coordination between non-paretic and paretic limbs during obstacle clearance following stroke

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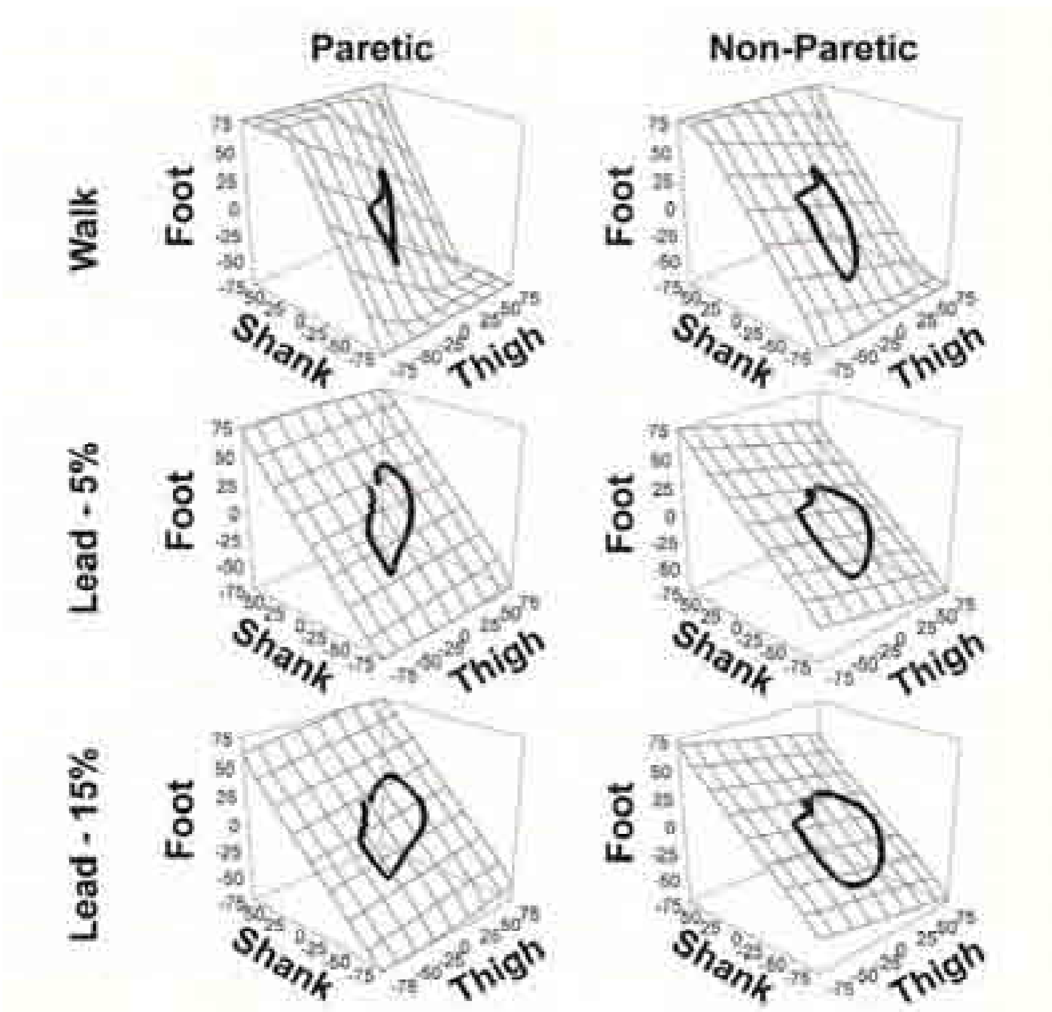
BACKGROUND AND AIM: Participants with a previous stroke have difficulties when stepping over obstacles during locomotion [1], likely due to deficits in coordination. The planar law of intersegmental coordination [2] may be useful in determining changes in segment coordination following a stroke. This study applied the planar law of intersegmental coordination to compare and contrast segment elevation angle trajectories between the paretic and non-paretic leading limbs during obstacle clearance in persons with chronic stroke. METHODS: Six persons stepped over obstacles adjusted for height (level walking, 5%, 15% of leg length) leading with their paretic [P] and non-paretic [NP] limbs. Elevation angles of the thigh, shank, and foot as well as toe clearance and elevation of the lower limb were calculated. Principal component analysis was applied to the three elevation angle trajectories for each stride to determine planarity of the covariance loop formed by the three dimensional plot of these angles. Fourier series were used to represent segment elevation angle trajectories and the difference between fundamental harmonics was further used to quantify the phase difference between adjacent segments. RESULTS: Toe clearance did not differ between P and NP limbs during obstacle clearance, although limb elevation was significantly greater in the NP limb ($p = 0.021$). Both P and NP segment elevation angles followed a planar pattern (Fig 1) and planarity did not differ between limbs ($p > 0.05$). The phase difference between the thigh-shank fundamental harmonics was greater in the NP limb during level walking ($p = 0.002$), and during the 5% ($p = 0.001$) and 15% ($p = 0.004$) obstacle height conditions. Also, the phase difference between the shank-foot fundamental harmonic phase difference

was lower on the P side during the 5% (p = 0.013) and 15% (p = 0.008) obstacle height conditions. CONCLUSIONS: Previous work has suggested that increasing the phase difference between the thigh and shank segments leads to greater toe clearance during obstacle avoidance [3]. Although a difference in toe clearance was not observed between limbs, a greater elevation of the lower limb was found in the NP limb. Therefore, the observed greater phase difference in the NP limb during clearance may highlight a compensation to elevate the NP limb due to insufficient support in the P limb. A planar pattern of segmental elevation angles presents itself in both the paretic and non-paretic limbs suggesting the basic locomotor pattern is preserved in participants with a previous stroke.



ACKNOWLEDGEMENT:
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P1-F-117 Evidence for subtle sway impairment in subjects at high risk for Parkinson's disease

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BACKGROUND AND AIM: Parkinson's disease (PD) is a progressive neurodegenerative disorder with predominance of motor and sway dysfunction. To our knowledge, subtle dysfunction of sway in a "preclinical PD stage", i.e. in high risk subjects for PD (HR, with risk factors such as hyposmia, depression, REM sleep behaviour disorder, and positive family history, in combination with enlarged hyperechogenicity of the substantia nigra [1]) has not yet been investigated. The aim of this study was therefore to evaluate sway in HR subjects compared to PD and control subjects, respectively. METHODS: From 21 HR subjects, 14 PD patients (OFF-medication), and 15 matched controls, sway was assessed in semi-tandem stance for 30s with an inertial sensor (DynaPort Hybrid, McRoberts) at the center-of-mass level, in four different conditions randomly assigned: eyes-open (EO); eyes-closed (EC); eyes-open with foam (EOF); eyes-closed with foam (ECF). The following parameters from the 2-D horizontal acceleration signals (anteroposterior, AP, and mediolateral, ML) were computed: Root-mean-square of sway (RMS) acceleration, mean sway velocity (MV), frequency comprising 95% of the signal (F95), and sway jerkiness (JERK). Statistical analyses were performed with the Linear Mixed Model. RESULTS: In the most difficult condition, the ECF condition, mean RMS was higher in HR compared to both PD and controls subjects ($p<0.05$), and JERK was higher in HR compared to PD subjects ($p<0.05$, Fig.1). Differences were present only in AP, not in ML direction. MV and F95% were comparable between groups. The other conditions (EO, EC, EOF) did not show relevant inter-group differences. CONCLUSIONS: HR Subjects have altered postural sway under the most difficult sway condition tested, compared to both PD patients and controls. These differences may be best explained by an overcompensation of a latent postural deficit.

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P1-F-118 Can we predict freezing of gait in Parkinson’s disease using motor and cognitive variables?

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BACKGROUND AND AIM: FOG is difficult to measure in the gait lab or a neurologist's cabinet as FOG is highly sensitive to environmental constraints and cognitive input. Therefore, we were interested in determining a set of clinical variables that can distinguish freezers (FRs) and non-freezers (NFRs) of equal disease severity. OBJECTIVE: To explore which motor and cognitive characteristics are most predictive of freezing of gait (FOG) in Parkinson's disease, and to determine which predictors determine FOG severity within freezers.METHODS: A group of 27 freezers (FRs) and 24 non-freezers (NFRs), matched for age and

disease severity, were recruited as defined by the freezer-classification item of the FOG-questionnaire. Four groups of variables were analyzed: 1. clinical descriptors; 2. gait and balance function (Timed Up &Go tests (TUG), Berg Balance Scale (BBS), falls and near falls; 3. distal motor function (UPDRS III-repetitive items, and the occurrence of freezing during functional repetitive upper limb movements and speech (non-gait freezing)); and 4. Cognitive function (SCOPA-COG test and Mini Mental State Examination). For the SCOPA-COG test we applied a cut-off score of 28 for cognitive impairment. Statistical procedures included univariate and multivariate stepwise logistic regression analyses with the freezer-classification as the dependent variable. FOG-severity was explored using linear regression analyses. RESULTS: FRs did not differ from NFRs in terms of age, disease severity, rigidity, tremor, and timed gait tests. However, FRs had a significantly longer disease duration (p=0.03), more balance problems (p=0.01) and non-gait freezing (p=0.01). FR's fell significantly more than NFR's (p=0.02) and showed more cognitive deficits as evidenced by both SCOPA-COG (p=0.02) and MMSE scores (p=0.05). Logistic regression analysis determined that only non-gait freezing and the SCOPA-COG were independent predictors of FOG, explaining 20 % of the variance. Within freezers, the occurrence of (near) falls independent of FOG could explain 35% of the variance in FOG severity. The prediction equation derived from the logistic regression analysis indicated that the likelihood of being a FR could be calculated by a score of less than 28 on SCOPA COG and a positive score on at least one of the non-gait freezing items, indicating that patients would have an 87% chance of having FOG. CONCLUSION: The interplay of cognitive, motor and postural components in FOG is a matter of great debate. We found that both non-gait freezing and cognitive factors are independent predictors of whether patients have FOG nor not. In groups with equal disease severity, it is possible to predict FRs with an 87% probability based on these two variables only. FOG severity on the other hand was only predicted by falls, emphasizing the influence of postural load on triggering freezing episodes.

P1-F-119 Effects of walking speed on asymmetry and bilateral coordination of gait

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BACKGROUND AND AIM: The mechanisms regulating the bilateral coordination of gait in humans are not fully known. The objective of the present study was to better understand if bilateral coordination depends on gait speed during over-ground walking. METHODS: 15 healthy young adults (8 women; 26.3 ± 1.9 yrs) wore force sensitive insoles that recorded the timing of the gait cycle events while walking over-ground under three walking conditions (i.e., usual-walking, fast and slow). Ground reaction force impact (GRFI) associated with heel-strikes was also quantified from the force waveform, representing the potential contribution of sensory feedback to the regulation of gait. Gait asymmetry (GA) was quantified based on the differences between right and left swing times and the bilateral coordination of gait was assessed using the phase coordination index (PCI), a metric that quantifies the consistency and accuracy of the anti-phase stepping pattern. RESULTS: GA was preserved in the three different gait speeds (Fig 1A). Mean values (±SE) were 1.26 ± 0.20%, 1.19 ± 0.14% and 1.90 ± 0.40% for the usual, fast and slow conditions, respectively (p>0.208). PCI (Fig 1B) was higher (reduced coordination) in the slow

gait condition, compared to usual-walking (3.51 ± 0.27 % vs. 2.47 ± 0.14%, respectively, p=0.002), but was not significantly affected in the fast condition (2.39 ± 0.14%, p=0.807). GRFI values were lower during slow walking (98±13 Newton) as compared to usual walking (207 ± 19) and higher during the fast (389 ± 20) walking condition (p<0.001). Stepwise regression revealed that slowed gait related changes in PCI were not associated with the slowed gait related changes in GRFI. CONCLUSIONS: The present findings suggest that left-right anti-phase stepping is similar in normal and fast walking, but altered during slowed walking. A priori, one possibility is that this dependence reflects changes in afferent input. However, since the slowed gait related PCI changes were not associated with changes in GRFI, another explanation is needed. We speculate that this behavior might reflect the attention resources required to regulate and maintain a slow gait speed, since this walking condition is less commonplace in daily life. Regardless of the precise explanation, these findings are consistent with the possibility that cortical function and supra-spinal input influences so-called automated spinal gait circuitries.

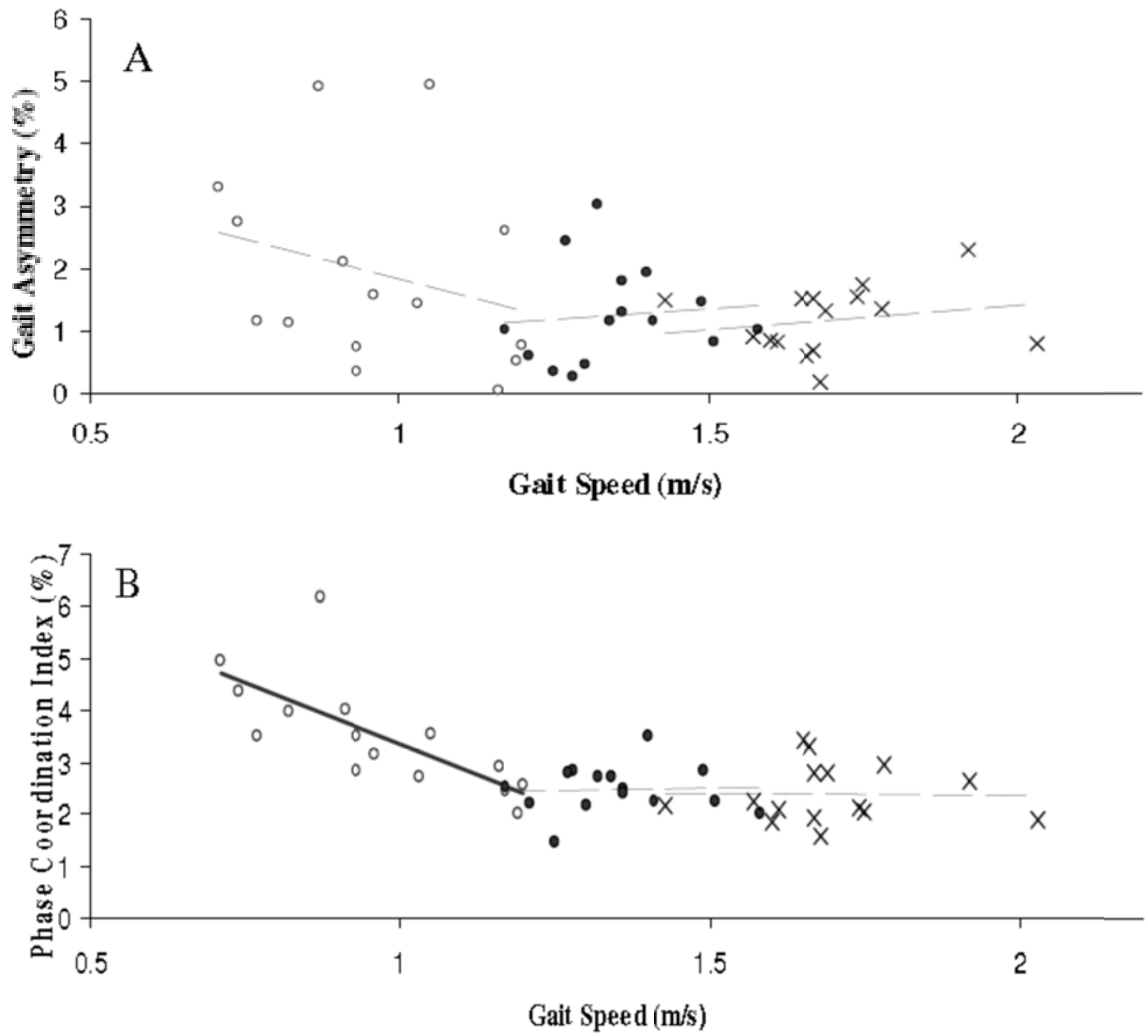

Figure 1: The relation between gait asymmetry, PCI and gait speed. **A.** Gait Asymmetry: For each subject, gait asymmetry values are plotted against gait speed as measured in the slow (○), usual (●) and fast (×) conditions. Regression analyses suggest that in none of these

conditions there is a statistically significantly correlation between GA and gait speed (dashed regression lines, $R^2 \leq 0.09$, $p \geq 0.288$; Pearson's correlation analysis). **B.** For each subject, PCI values are plotted against gait speed as measured in the slow (symbols are same as in panel A). Regression analysis suggests that there is a statistically significant linear relationship between PCI and gait speed only for the slow walking condition ($R^2 = 0.53$, p=0.002; Pearson's correlation analysis). Curve fitting procedure identifies the following relationship between PCI and gait speed: PCI=A*Gait Speed +B, where A=-4.74 ± 1.23 and B=8.08 ± 1.20 (solid regression line). For the other two conditions, the linear relationships between PCI and Gait Speed (dashed lines) were not statistically significant ($R^2 < 0.003$, p>0.892).

P1-F-120 Modulations on the approaching phase of patients with Alzheimer's disease

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BACKGROUND AND AIM: Alzheimer's disease (AD) is characterized as a progressive and neurodegenerative illness, which shows following neurophysiological characteristics: cortex atrophy, excess of beta-amyloid protein and senile plaque (BANHATO AND NASCIMENTO, 2007). In addition to cognitive decline, the AD patients alter ongoing gait, which is marked by decreased stride length and gait velocity, and increased double support phase (MAQUET et al., 2010; SHERIDAN et al.,2003; HAUSDORFF et al., 2001). However, the obstacle avoidance in AD patients still remains unclear, mainly the locomotor behavior during the approach phase to the obstacle. The aim of the study was to investigate the effects of an ongoing obstacle in the locomotor behavior of AD patients. METHOD: Nineteen AD patients (79±6.03 years old; CDR= 1 to 3) participated in this study. The walking task required participants to walk, at preferred speed, along a pathway (8 m long by 1.4 m wide). Patients performed 5 trials in each experimental condition: free and adaptive walking. For adaptive walking condition, patients were asked to walk to an obstacle (half of the knee height; positioned in the middle of the pathway), step over it, and to keep walking until the end of the pathway. Spatial and temporal variables were collected through an optoelectronic tridimensional system. The central stride was analyzed in free walking trials and the stride immediately before the obstacle crossing (approaching phase) was analyzed in adaptive walking. Paired t test was performed to evaluate the modulations in the approaching phase in comparison of free gait. RESULTS: AD patients demonstrated smaller values of stride length and stride velocity in the adaptive walking condition than in the free walking condition. Thus, they increased stride width, double support duration and stride duration. Besides, the patients did not have obstacle contact events. CONCLUSIONS: The adaptive gait requires more attention for locomotion control than the ongoing gait. However, AD patients have attentional deficits and, consequently, need more time to process the obstacle presence. Therefore, the patients decrease the velocity and increase the basis of support to improve the stability and guarantee safety. The strategy employed during the approach phase was efficient to guarantee the successful obstacle crossing.

Table 1. Means and standard deviations of gait variables in free and adaptive walking.

	Free Walking	Adaptive Walking	p-value
Stride length(cm)	102.50±15.43	94.76±24,07	0.015
Stride width (cm)	8.55±3.14	10.06±3,59	0.001
Single support duration (s)	0.94±0.29	0.94 ± 0.15	0.841
Double support duration (s)	0.38±0.08	0.50±0.18	0.001
Stride duration (s)	1.33±0.31	1,44±0.25	0.009
Stride velocity (cm/s)	79.86±16.86	69.20±22,24	0.001

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P1-F-121 Gait rehabilitation with a dual-channel functional electrical stimulation system in a patient affected by hemiparesis: Case report

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BACKGROUND AND AIM: Peroneal nerve functional electrical stimulation (FES) is a common treatment for gait rehabilitation. However, many patients with hemiparesis and dorsiflexors inadequacy also demonstrate insufficient knee control. The aim of this report is to describe the potential advantages of a dual-channel FES system applied daily to the dorsiflexors and hamstrings muscles in a subject with chronic hemiparesis. METHODS: A patient affected by chronic hemiparesis (age: 40; 1.5 years post-diagnosis), presenting with footdrop, reduced knee and hip flexion during the swing phase, and knee hyperextension during mid- to terminal stance, was fitted with a dual-channel FES system (L300Plus). After a conditioning period of 6 weeks (T1), during which the patient increased her daily use of the system up to a whole day, data regarding gait kinematics were collected using the 3D Vicon motion analysis system. Gait was assessed with and without the FES system, as well as with peroneal stimulation alone, while the patient walked on a treadmill at her self-selected walking speed. A second assessment was conducted following 10 months of daily use (T2). The variables assessed included lower limb kinematics and temporal gait measures. In addition, the percentage of gait cycle in which the knee was hyperextended was calculated. RESULTS: Both assessments (T1 and T2) indicated significant benefits when comparing gait with dorsiflexors and hamstrings FES with no stimulation, as well as with the peroneal FES alone. For example, at T1, knee hyperextension during stance improved from -4.2°±0.6° with no stimulation to -3.4°±0.8° and -1.0°±0.4° with the peroneal FES and the L300Plus,

respectively. The percentage of gait cycle in which the knee was in hyperextension decreased from 37.8±2.5% and 35.9±2.6% with the peroneal FES and with no stimulation, respectively, to 18.7±8.3% with the L300Plus. After one year of use, the self-selected comfortable gait speed increased by 35%, from 0.33m/sec to 0.44 m/sec. Knee hyperextension with the L300Plus was reduced by 1.6° and by 3.9° in comparison with peroneal stimulation and with no stimulation, respectively. Peak knee flexion in swing was 57.8°±1.8° with the L300Plus, as compared to 52.5°±3° and 55.7°±2° with the peroneal FES and with no stimulation, respectively. CONCLUSIONS: The present case study demonstrates the feasibility and high acceptance of prolonged daily use with a dual-channel FES system by a patient affected by hemiparesis. The results of this report suggest that dual-channel FES for the dorsiflexors and hamstrings muscles may have important effects on the hemiparetic gait pattern beyond what can be attributed to peroneal stimulation alone. The positive effects observed in this case study on the lower limb kinematics and walking speed point to the potential of dual-channel FES as a means to enhance functional gait in patients with similar impairments. Further studies are necessary to validate these results.

P1-F-122 Strategies to change gait speed of stroke patients with hemiplegia in their different gait patterns

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BACKGROUND AND AIM: Walking velocity is a significant indicator of gait performance and functional impairment after stroke. Stroke patients tend to walk at slow speed, but some are able to change their gait speed slower or faster than their preferred speed. The purpose of this study is to examine how these stroke patients with hemiparesis change their gait speed depending on each gait patterns. METHODS: Eight adult individuals with stroke in the stable phase were asked to walk in three different speed, at their preferred speed, fast speed, and slow speed. As a control group, eight healthy individuals walked at five different levels. Gait was analyzed with motion analysis system and force-plates. Kinematic and kinetic parameters of affected limb were collected to be analyzed and compared. Thereafter, the gait patterns were categorized by the knee joint movements; 'extension thrust pattern', 'stiff knee pattern', and 'normal knee pattern' in this study. To examine the relationship between the gait speed and other parameters, a linear regression analysis was made for normal data and the 95% prediction interval was calculated along the regression line. Each patient's data was categorized in three levels, lower, equal, and higher level compared with the normal data. The number of patients in these levels showed the characteristics of the strategy of patients in each gait pattern. RESULTS: In this study patients were divided into three gait patterns; five patients were identified as 'extension thrust pattern', one as 'stiff knee pattern' and two as 'normal knee pattern'. At 'fast' gait speed, patients in 'extension thrust pattern' showed higher peak hip extension moment during loading response compared with that in 'stiff knee pattern'. Some in 'extension thrust pattern' showed higher peak hip power generation during loading response than normal profile. Patients in 'normal knee pattern' showed smaller peak ankle power generation during pre-swing and higher peak hip power generation during pre-swing than normal profile. CONCLUSIONS: The strategies how stroke patients change their gait speed were different

from those of healthy people and showed variability even among patients. Compensated movement to change the walking speed varied in gait patterns after stroke. It is important to know the difference of strategies to make rehabilitation programs more individualized.

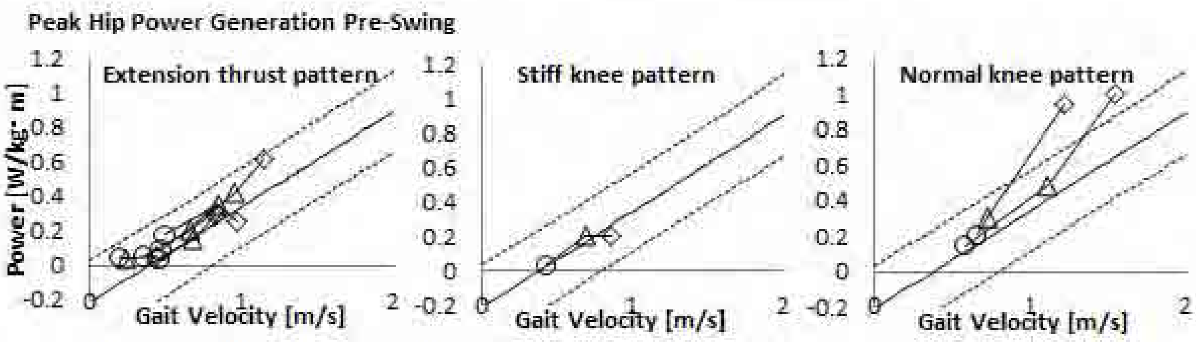

Fig. Plots of Peak Hip Power Generation Pre-Swing; individual patient's values are shown as slow speed (circle), preferred speed (triangle) and fast speed (square). Patients are divided into three gait patterns; 'extension thrust pattern', 'stiff knee pattern', and 'normal knee pattern'. The normal profile's regression line (solid line) and 95% prediction interval (dotted line) are also shown.

P1-F-123 Kinematic gait parameters during stair ascent and descent in people with Parkinson's disease

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BACKGROUND AND AIM: Patients with Parkinson's disease (PD) is marked by slowness, postural instability, small shuffling steps, and difficulty in gait initiation. They may have difficulty performing usual daily activities and problems maintaining independence. Stair walking is a demanding locomotor task frequently performed in daily activities. In special for elderly and people with movement disorders, stairs ascending and descending can be very challenging. Being able to negotiate stairs could dramatically improve the independence and the quality of life of a person with physical impairments, as well as it could facilitate the work load of the caregivers. To our knowledge, none has addressed the locomotor behavior of PD patients while ascending or descending stairs. The aim of this study was to analyze the spatiotemporal gait parameters, in different phases of stair ascending and descending, in people with PD. METHODS: Sixteen idiopathic PD patients (mild and moderate levels in the Hoehn and Yahr Rating Scale) participated in this study. A four steps stair with double handrails was used. Infrared emitters were placed in the lower limbs, in the following anatomical points: 1st and 5th metatarsals and the medial and lateral heel of the right and left feet. Kinematic data were recorded using an optoelectronic tridimensional system. The experimental protocol consisted of 10 trials, 5 trials to walk up and 5 to walk down the stair. The spatiotemporal variables were registered in different moments for each experimental condition: i) for the stair ascending condition: the approach phase, the transition phase and the final phase (from third to fourth step), and ii) for the stair descending condition: the initial

phase (from fourth to third step), the transition phase and finalization phase (after stair descend). RESULTS: The Wilcoxon nonparametric test for repeated measures showed significant differences for some parameters of gait in each phase of the ascent and descent (Table 1). CONCLUSIONS: Different adjustments in the parameters of gait were observed at each moment of stairs ascending and descending. Apparently the biggest changes occur in periods of transition (from the ground to the stair first step and from stair last step to the ground) and the initial and final phases (at the top of the stair). All these moments require attention for the appropriate locomotor adjustments for task success. However, attention can be compromised in PD patients. Despite the typical compromises in PD, patients in early and moderates stages of the disease were able to adapt the parameters of gait to the task demands.

TABLE 1. Means and (standard deviations) of gait spatial-temporal parameters in stairs ascending and descending.

Stair ascend

Spatial-temporal parameters	Approach step	Transition step	Final step
Step length (cm)	43.35(8.89)[b]	47.83(8.41)[c]	32.89(3.18)
Step duration (s)	0.54(0.11)[ab]	0.62(0.13)[c]	0.84(0.32)
Single support (s)	0.38(0.06)[ab]	0.46(0.07)	0.50(0.21)
Double support (s)	0.16(0.07)[b]	0.16(0.07)[c]	0.34(0.13)
Step speed (cm/s)	84.04(21.46)[b]	80.89(21.01)[c]	43.19(12.46)

[a]Indicates significant difference between the approach step and the transition step ($p \leq 0,01$).
[b]Indicates significant difference between the approach step and the final step ($p \leq 0,01$).
[c]Indicates significant difference between the transition step and the final step ($p \leq 0,01$).

Stair descend

Spatial-temporal parameters	Initial step	Transition step	Finalization step
Step length (cm)	37.23(7.96)	45.37(8.34)	31.52(9.94)
Step duration (s)	0.93(0.29)[b]	0.86(0.32)[c]	0.64(0.22)
Single support (s)	0.54(0.10)[ab]	0.46(0.08)	0.46(0.08)
Double support (s)	0.38(0.23)	0.39(0.26)	0.18(0.16)
Step speed (cm/s)	44.12(15.88)[ab]	62.0(28.66)	56.01(26.35)

[a]Indicates significant difference between the initial step and the transition step ($p \leq 0,01$).
[b]Indicates significant difference between the initial step and the finalization step ($p \leq 0,01$).
[c]Indicates significant difference between the transition step and the finalization step ($p \leq 0,01$).

P1-F-124 Delayed recovery of postural stability after voluntary arm movement in people with chronic low back pain

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BACKGROUND AND AIM: It has been suggested that people with chronic low back pain (CLBP) have poor balance. Appropriate trunk and hip motion are essential to maintaining balance in standing, however unlike pain-free controls, people with CLBP less frequently use trunk movement to prepare for postural disturbances resulting from arm movements [1]. As preparatory trunk movement is also thought to be an anticipatory mechanism limiting postural perturbation caused by arm movements [2], we hypothesized that LBP subjects would have compromised control of postural equilibrium following arm flexion. METHODS: Thirteen subjects with CLBP and 13 healthy age and sex-matched controls performed bilateral voluntary rapid arm flexion while standing on support surfaces of different dimensions with eyes opened or eyes closed. The control of the centre-of-pressure during postural recovery, time to recovery and number of postural adjustments during recovery were evaluated. RESULTS: People with CLBP consistently took longer to recover postural equilibrium (679 ± 45 ms) than controls (513 ± 26ms, $p < 0.001$), and more postural adjustments were required in subjects with CLBP than controls during postural recovery (5.4 ± 0.7 in CLBP vs 3.8 ± 0.2 in controls, $p = 0.01$). However, there was no difference in COP excursion between groups during the recovery period. CONCLUSIONS: These data suggest that although COP is tightly controlled during postural recovery, the fine-tuning of the control of postural equilibrium is compromised in people with CLBP following a simple limb movement.

ACKNOWLEDGEMENTS:

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P1-F-125 Lumbar proprioceptive deficits in sitting in patients with non-specific chronic low back pain with a flexion pattern sub-classification

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BACKGROUND AND AIM: There is some evidence that subjects with Non-specific Chronic Low Back Pain (NS-CLBP) have reduced proprioceptive awareness compared with matched controls , although other studies have questioned this. These conflicting results might be related to the heterogeneity of the NS-CLBP population. Sub-classification into more homogeneous subgroups might help to further clarify whether or not proprioceptive deficits exist. Therefore, the aim of the present study was to determine the lumbar reposition sense in sitting in a subgroup of patients with NS-CLBP presenting with a specific Flexion Pattern (FP) motor control impairment in sitting versus healthy controls (HC). METHODS: 15 subjects with NS-CLBP (FP) reporting an increase in LBP symptoms during prolonged sitting were included in the study and matched with 15 HC subjects. To assess lumbar proprioception, subjects had to perform a repositioning task in sitting, whereby they had to reproduce a target position (neutral

lordosis) after five seconds of slouched sitting. This reposition test was repeated three times. Lumbo-pelvic position in the sagittal plane was measured with a remote postural monitoring device (BodyGuard). Lumbo-pelvic position was expressed as a percentage of maximal lumbo-pelvic flexion whereby the target position was calibrated as 0%. Constant Error (CE), Absolute Error (AE) and Variable Error (VE) of the repositioning were calculated as outcome measures. Additionally, self-reported pain (VAS), disability (Oswestry disability index) and fear-avoidance behaviour (Tampa scale for Kinesophobia) were evaluated. RESULTS: A significant difference in reposition sense was found between the two groups for Constant Error (NS-CLBP-group=-6,94%, HC=2,61%; p=0.006) as well as for Absolute Error: (NS-CLBP-group=11,53%,HC=5,06; p=0.002). In contrast, VE was not significantly different between the two groups (VE: Z=-1.39, p=0.165). Absolute Error was significantly correlated with disability (ODI) in the NS-CLBP-group (r=0.601). CONCLUSIONS: The findings of this study suggest that lumbar proprioceptive awareness in sitting is decreased in a direction-specific manner in patients with sitting-related NS-CLBP classified as having a Flexion Pattern (FP). They demonstrated an average 'undershooting' pattern, meaning that during repositioning they assumed a relatively flexed lumbar posture. This may explain why these patients experience LBP during sitting. Further studies are needed to clarify whether different subgroup populations (e.g. Extension Pattern) show similar or different lumbar proprioceptive deficits.

P1-F-126 Cognitive load does not interfere with the coordination of cane use during locomotion

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BACKGROUND AND AIMS: The majority of stroke patients will use a cane at some point during rehabilitation [1]. Despite its common use post-stroke, there is little information regarding the assistance a cane provides during gait. We have developed 2 novel measures: 1) variance of the coordination of vertical cane force with the gait cycle and 2) the pattern of 3D forces applied through a cane with respect to the gait cycle. We have demonstrated in a preliminary study [2] that individuals post-stroke are more variable in the coordination of cane force with gait and their pattern of applied 3D forces differs from age-matched healthy adults. The current study investigated how these measures demonstrate adaptation to prolonged walking and increased cognitive demands in a dual task condition. METHODS: Six healthy participants walked on a self-paced treadmill with an instrumented cane[3], immersed in a virtual environment, for 15 minutes. Participants then walked with the cane under single and dual task conditions. In the dual task condition participants listened to a recording of a series of high and low tones and were asked to count only the low tones. They were then prompted to provide a verbal response. Forces applied through the cane were measured using a force transducer and gait kinematics were recorded using a 6-camera Vicon MX system. The variance of cane-gait coordination was calculated in the following steps: 1) covariance of vertical cane force with left and right toe displacement, 2) plot of coordination of left and right covariance measures, 3) principal component analysis to identify orientation of axes of the coordination plot, 4) estimate of variance of diagonal and perpendicular axes. The pattern of 3D forces applied through the cane with respect to the gait cycle was described by the equation of a plane in 3D space (CosX, CosY, CosZ). RESULTS: Fig. 1 shows the intrasubject plots of variance in cane-gait coordination and interval during the 15 minute walking trial. In general, there appears to be a trend for individuals to show decreased variance in the coordination of the cane with gait over the prolonged walking trial. However, this association was significant in only 1 of the 6 participants (closed circles; r= -0.93, p=0.02). Paired t-tests revealed no significant difference in variance of cane-gait coordination or pattern of applied forces between cane walking in single and dual-task conditions. CONCLUSIONS: The locomotor pattern can be adapted and coordinated with cane use over a relatively short period of time in healthy individuals, requiring very little cognitive resources, as demonstrated by the stable variance in coordination over-time and no difference between single and dual task conditions. Ongoing data collection and will include older adults and individuals with stroke walking with a cane under the same conditions.

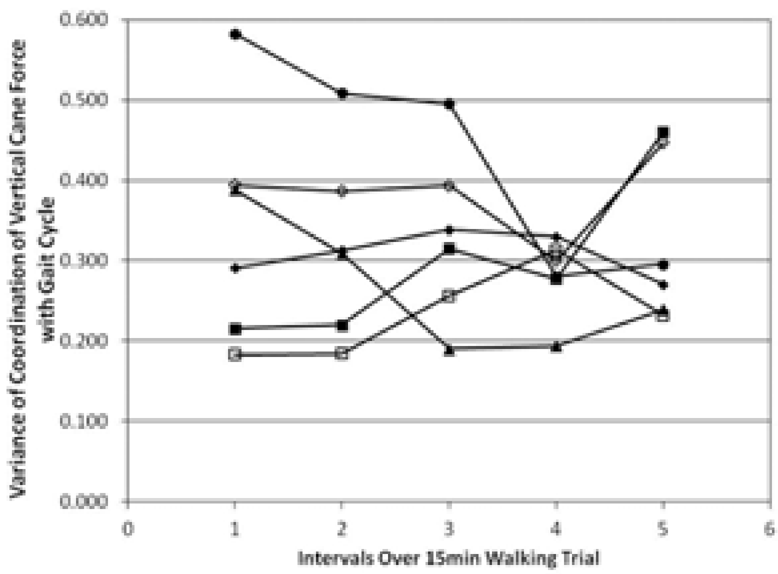

Fig 1. Intrasubject relationship between variance of the gait-cane coordination measure and the duration of the 15 minute walking trial Data was divided and averaged over 2 minute intervals for each of the 6 participants.

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P1-F-127 **Reliability and validity of five gait measures in community-dwelling older persons**

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BACKGROUND AND AIM: Reduced gait speed has been associated with adverse health outcomes in older people e.g. higher mortality, decreased physical function, hospitalization, and institutionalization. Additionally, a large body of research has now shown that dual tasking affects gait performance in healthy older people, in a way that could put them at an increased risk for falls. The size of the impact on gait largely depends on the difficulty of the dual task and the ability of the person to shift or divide their attention between different tasks. The main aim of this study was to assess psychometric qualities (reliability and validity) of a simple gait measure, i.e. speed, under five different conditions in a sample of healthy older adults. METHODS: 50 community dwelling older adults (26 women; age: 77.9 ± 5.7) participated in this study. Gait speed was measured as the time (in seconds) needed to walk 6 meters (hand-stopped) in five different conditions: self-paced (1), fast-paced (2), self-paced with 360° turn at 3 m (3), self-paced with cognitive dual task (answering a question) (4), self-paced with physical dual task (carrying a tray with glass of water) (5). Condition presentation order was randomized. Test-retest reliability was assessed by re-administration 1 week later; inter-rater reliability was assessed for three assessors (two at a time). Validity was assessed by comparing gait measures to accepted measures of physical function in older people, i.e. the short physical performance battery (SPPB) and the timed up-and-go (TUG). RESULTS: Test-retest reliability (N = 39) for all five test conditions was excellent with an intra-class correlation coefficient (ICC) of 0.92 to 0.98. Inter-rater reliability (N=21) was also high with an ICC of 0.96 to 0.99. Criterion validity of the five gait measures was supported by strong correlations with the SPPB and TUG (Pearson's r=.78 - .97; p < .01). When looking at test conditions with an additional cognitive or physical task (conditions number 4 and 5) specifically, correlations range from .79 to .95 (p<.01). Significant gender differences (p<.05) existed for three of the five conditions (conditions 1, 2 and 4) with men walking faster than women. Additionally, performance in all test conditions differed significantly when subjects were grouped by age (median split of 78 years) and self-rated health status on a continuum ranging from 1 (excellent) to 4 (poor). Faster gait speeds were observed in younger and healthier participants. CONCLUSION: Assessing gait under 5 different conditions in older people seems to be a simple reliable and valid assessment. It might help to investigate gait speed linked to daily routine performance in health care settings.

P1-F-128 The influence of advance knowledge of ball speed on postural adjustments in one-handed catching

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BACKGROUND AND AIM: Postural adjustments to an upcoming support-surface perturbation of balance have been shown to be affected by advance knowledge of the amplitude and speed of perturbation [1], which has been contributed to activity of the cerebral cortex [2]. While advance knowledge in one-handed catching has recently been shown to influence the kinematics of the arm when there is certainty about the speed of the ball [3], this study examined how this implicit advance knowledge might also have an effect on postural adjustments. METHODS: 6 skilled ball catchers performed one-handed catches with (blocked-order) and without (random-order) implicit advance knowledge of upcoming ball speed. Measurement of full body kinematics (Qualisys) and kinetics (AMTI force plate) enabled to analyze the postural adjustments while raising the arm for catching. RESULTS: A repeated measures ANOVA analysis showed that providing implicit advance knowledge induced a forward arm raising movement scaled to ball speed in the initial transport phase ($p<0.05$, Fig. 1a, [3]). However, the accompanying backward postural adjustments were unaffected, which is suggestive of a passive control mechanism. In the subsequent grasping phase (Fig. 1b), the scaling of arm raising movement exhibited in the presence of implicit advance knowledge resulted in a reduced need for postural adjustments, particularly at the highest ball speed ($p<0.05$). Fig.1 Mean peaks in momentum of the arm and rest of the body during blocked-order and random-order catching at the four ball speeds. CONCLUSIONS: Advance knowledge of ball speed does not only influence the arm movement kinematics when catching a ball, but seems to have an additional effect on the accompanying postural adjustments to help compensate for the disturbing effect of arm motion.

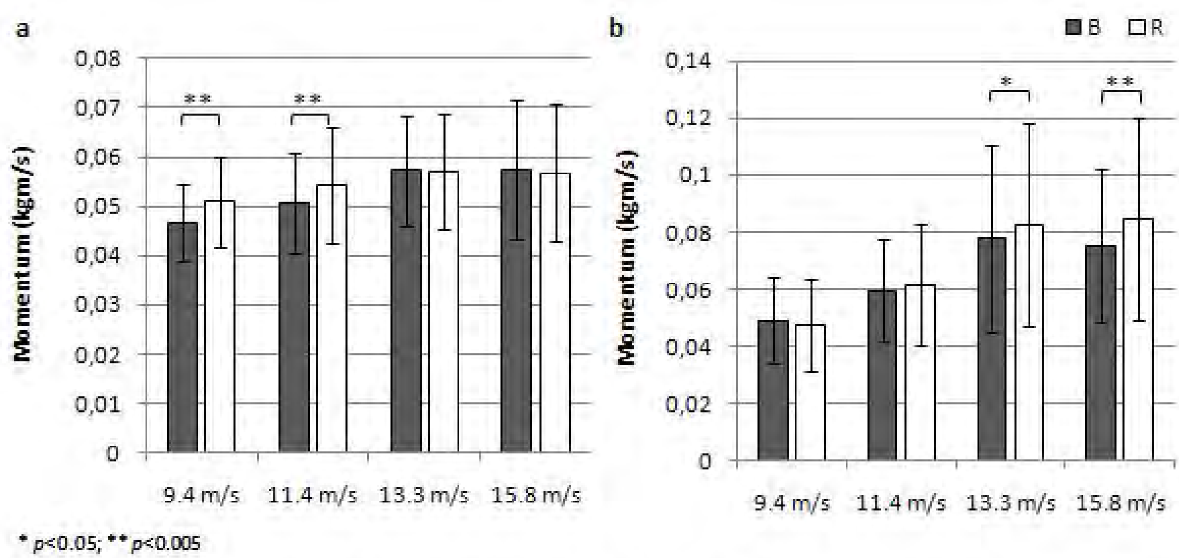

Fig.1 Maximal momentum of **a** arm and **b** rest of body at the four ball speeds for blocked-order condition (B) and random-order condition (R)

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P1-F-129 Are postural adjustments in catching equilibrium control or movement support?

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BACKGROUND AND AIM: The purpose of this study was to investigate postural adjustments that are made in response to raising the arm in one-handed ball catching, given that postural balance might be decisive for successful catching performance [1]. Specifically, it was examined if postural adjustments are a response to overcome the disturbance of balance or merely a consequence of the movement at hand. METHODS: Full body kinematics, kinetics and postural muscle activity while raising the arm when catching a fast-moving ball were compared to a well-studied reaction-time arm raising task. RESULTS: The focal movement of arm raising showed more elbow flexion in catching compared to the reaction-time task (Wilcoxon test, $p<0.05$). Consequently, smaller inertial forces for catching resulted in different postural control mechanisms. In catching, postural adjustments were initiated by co-activation of postural muscles for initial segment stabilization (Fig. 1, left panel), followed by an inverted pendulum mechanism for equilibrium control. Raising the arm in the reaction-time task resulted in early reciprocal muscle activity (Fig. 1, right panel) and segmental counter-rotating at hip-level in addition to the inverted pendulum mechanism to maintain balance. CONCLUSIONS: During arm raising for a reaction-time task or for unconstrained catching, anticipatory postural adjustments seem to be a consequence of the inertia of the movement itself (movement support), rather than a mechanism to overcome possible future disequilibrium [2,3]. Afterwards, compensatory postural mechanisms involving inverted pendulum control with additional segmental counter-rotation to maintain balance are suggested for raising the arm in a reaction-time task, while mainly an inverted pendulum mechanism accommodates equilibrium control when raising the arm for catching [4].

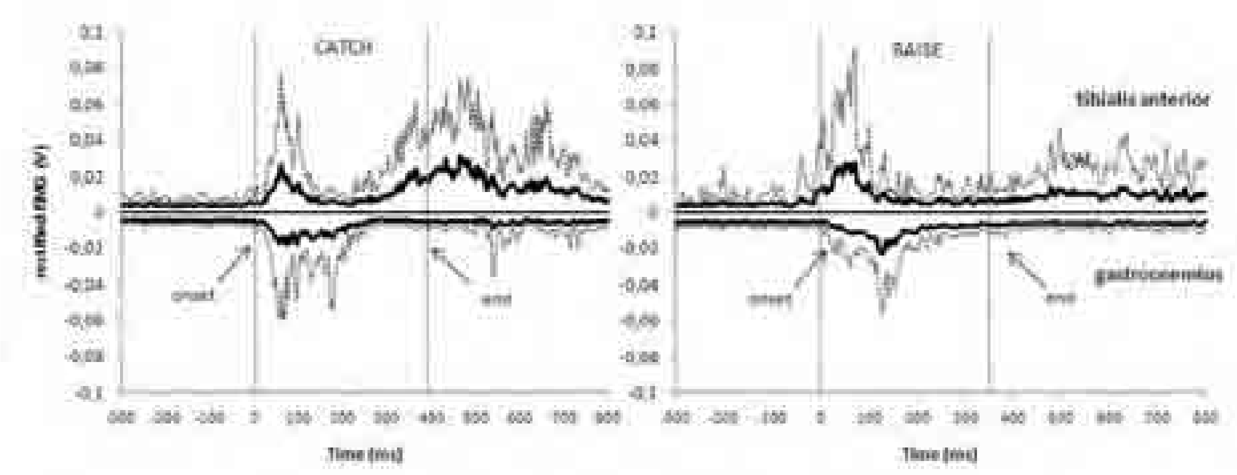

Fig 1 rectified EMG of tibialis anterior and gastrocnemius for the catching (left panel) and reaction time task (right panel)

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P1-F-130 Backward walking in children is organized as the reverse of forward walking both for leg and for arm movements

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BACKGROUND AND AIM: In adults there are indications that the leg movements in backward walking (BW) are organized as the reverse of forward walking [1,2]. Since it is now recognized that arm movements during gait move according to a "quadrupedal" pattern, the question arises whether arm motions in backward walking are also simply the inverse of forward walking (FW). If so, one would like to know at what age such inverse pattern appears. To study these questions it is customary to compare the kinematics of FW with the time-inverted traces of BW. In case there is a complete reversal one then expects strong correlations between these traces. METHODS: 24 healthy children (5-12yr) were included. Total body kinematics were recorded using an 8 camera Vicon system with the Plug-in-Gait model. Three trials were assessed for each condition (FW & BW). The angular displacement of the upper arm (UA), lower arm (LA), upper leg (UL), and lower leg (LL) was measured with respect to the vertical (elevation angle) in the sagittal plane. The time normalized elevation angle traces of BW were reversed in time (revBW) and correlated to the FW traces. RESULTS: In BW the arms moved diagonally with respect to the legs. As expected, for the legs there were very strong correlations between FW and revBW for the traces of the UL and LL (r=0.95 and 0.96 respectively). For the arms (UA and LA) the correlations were somewhat smaller but still very significant (r= 0.81 and 0.73, respectively). This pattern was stable from the youngest age tested (5 yr). CONCLUSIONS: These results support the notion that BW walking is organized as the inverse of FW, both for arm and for leg movements. Similar as for forward and backward arm cycling [3], it is suggested that both gait modes are regulated by equivalent neural systems.This is achieved from an early age on (>5 yr), in agreement with the work on very young children [4].

ACKNOWLEDGEMENTS:
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P1-F-131 Analysis of control, coordination and balance through the application of differentiated programs of rehabilitation in post stroke patients

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BACKGROUND AND AIM: Numerous epidemiological evaluations have shown tremendous number of adult and elderly patients with neurological pathology central type, respectively AVC, both degenerative and dysmetabolic but also young people, as a result of repeated ischemic or hemorrhagic stroke. Increasing number of young and adult patients with neurological central type pathology, in full professional activity that develops professional and functional consequences medium and long term, requires a therapeutic strategy that is associated with pharmacological and non-pharmacological therapy. In the rehabilitation program an important place has computer assisted training. This study was intended to identify the advantages, benefits and limitations of distinguished programs of rehabilitation in hemi-paretic patients after acute and chronic phase. METHODS: There has been realized a prospective study, clinical-functional, with a group of patients (47 patients) selected from patients hospitalized with stroke in IIIrd Rehabilitation Clinic of the National Institute of Rehabilitation-Bucharest. Initially we obtained informed consent, and lots of 10 patients were organized by age (between 25-45 years group, 45-65, over 65 group), setting criteria for inclusion and exclusion. The patients were evaluated initially and after two weeks, in terms of clinical and functional, musculoskeletal and occupational, using specific tests and ICF classification. From these groups a part received only rehabilitation program based on specific program and the other group received kinetic program associate and computer assisted training program. For computer assisted training was used ENP-01 platform, taken from the gym equipment and increased motor performance of athletes. The equipment is based on the concept of Human Performance in a holistic mode and use both with applications in the health and performance in athletes, and allows the study in rehabilitation department .Medical equipment allows the study of position on a horizontal projection of the center of mass of the human subject – pressure center. With this equipment we can be obtained data of the time evolution of the pressure center position, providing visual information in real time to the patient with the possibility of auto-correction, and recovery of motor engrams and psychosocial level. RESULTS AND CONCLUSION: Clinical information and motor acquisition were recorded and analyzed biostatistics, performing the standard calculations on the data on the evolution of pressure center position. Study comparing the benefits and limits of the two types of rehabilitation programs on the studied groups highlighting of features and therapeutic potential of platform balance used for research. For statistical processing of data were taken into account the following parameters: the area on which patient moved, in trying to fulfill the task given (to overlap the projection center of mass over a target within 5 seconds, the target moved right and left side a distance of 50mm for 180s) and average travel speed, the system automatically recorded data; travel time for 10 m round trip measured 2 times by the physiotherapist and marked the best performance. These data were recorded for all patients on admission and discharge. The results show growth of final area, decrease of medium speed and decrease of travel time for each group. For inclusion in the study group, were taken into account the following aspects: the patient suffered a previous stroke ischemic or hemorrhagic, to be stable from cardiovascular point of view, to be able to maintain orthostatic position without support and to be able to travel alone or without auxiliary means (crutch / cane) the time distance (10 m round trip) with minimum risk fall. The patients had to understand what they are required to make, and to handle with the significant visual and intellectual demands during exercise. Recorded data included patient's age, education level, area of origin (urban / rural), type of stroke (ischemic or hemorrhagic), location of motor deficit (Left / Right) and any related disease and other significant observations.

P1-F-132 Gait acceleration mostly occurs during a single support phase of human walking

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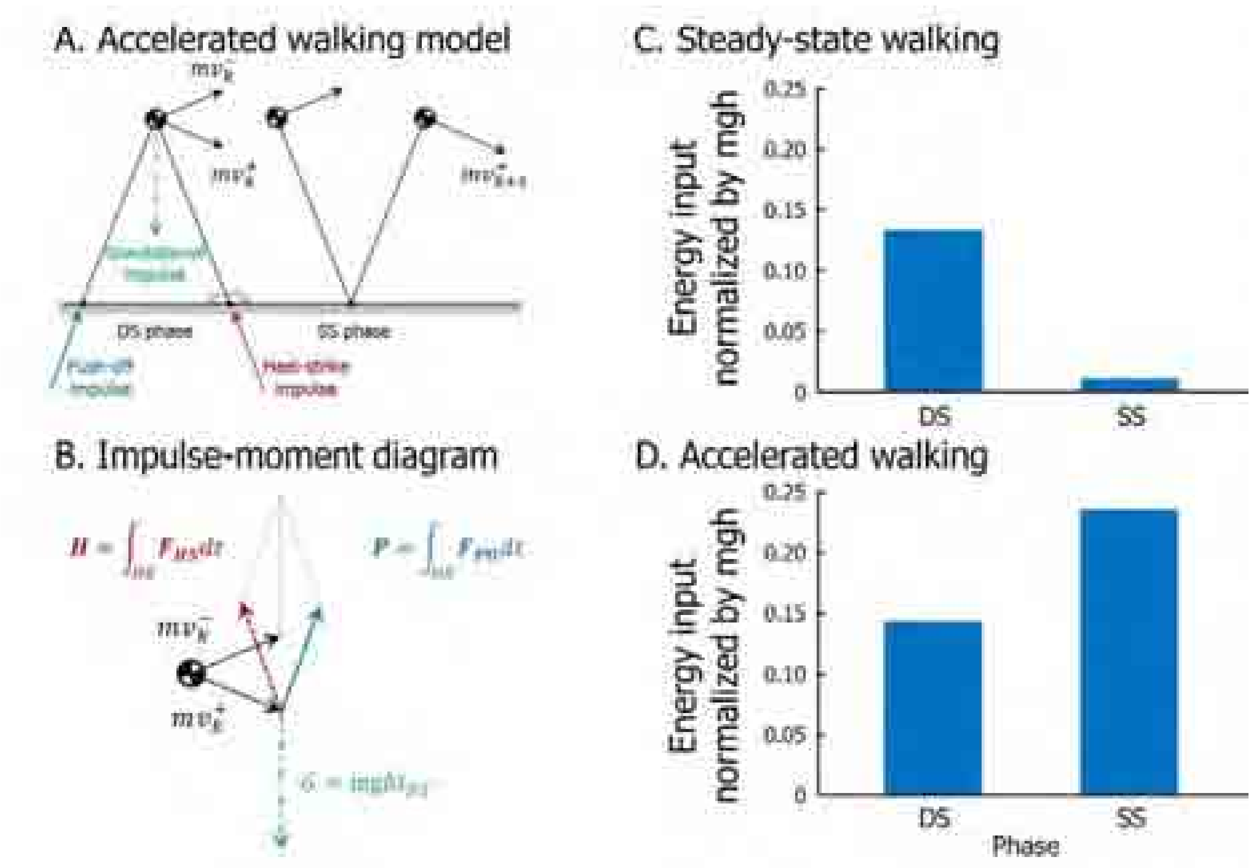
BACKGROUND AND AIM: Energy efficient human gait attributes to the energy balance between the push-off and heel strike during a double support phase. Model simulation of gravitational impulse model of human gait demonstrates that the pre-compensation of the heel strike loss by push-off propulsion during minimizes the mechanical work done though out a gait cycle [1, 2]. However, the magnitude of push-off propulsion required for complete pre-compensation increases with the rate of gait speed increase, which may lead to the physiological limitation of the increase of plantar flexor torques. To examine whether the energy minimization strategy would still hold for accelerated human gait, we predicted the optimal push-off propulsion that minimizes the mechanical work done on the center of mass during a gait cycle and empirically measured the mechanical work done during single and double support phase. METHODS: Eight healthy young subjects (29.28±2.14 yrs) who reported no history of balance disorders participated to this study. The subjects were instructed to initiate their gait and accelerated up to their maximum walking speed with self-selected acceleration on walkway. The ground reaction force (GRF) of three consecutive steps were measured by force plates and joint kinematics were collected by 6-motion capture cameras. The velocity and the trajectory of the COM were calculated by integrating the accelerations obtained from the GRF data [2, 3]. To calculate the mechanical work and required push-off force for accelerated gait, we used the gravitational impulse model which predicts the collision impulse and mechanical work [2, 4]. Then, the optimal push-off that minimizes the COM work throughout the gait cycle is computed. RESULTS: Model simulation predicted acceleration proportional increase of push-off propulsion (about doubled plantar flexor torque for about 20% increased gait speed per step) to minimize the total mechanical work done during a gait cycle. As opposed to the energetically optimal point of view, data showed that the push-off propulsion during the double support phase was almost balanced with the heel strike loss, and the energy increase required for gait acceleration mostly occurred during the single support phase. The result implies that the biomechanical constraint on feasible ankle torque induced less efficient gait energetics in view of mechanical work done during the gait cycle. CONCLUSIONS: As opposed to the steady state gait, the energy minimization strategy did not hold for accelerated human gait due to the constraint on the feasible push-off propulsion.



ACKNOWLEDGEMENTS:
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P1-F-133 Contribution of vision, proprioception, and efference copy in storing a neural representation of an obstacle to guide the trail leg

Daniel Marigold[1], Kim Lajoie[1], Leigh W Bloomfield[1], Fraser J Nelson[1], Jaewon J Suh[1]

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BACKGROUND AND AIM: Stepping over an obstacle requires precise knowledge of its physical characteristics (e.g. height) as well as its location with respect to the body. Vision can provide necessary information to guide the lead leg over the obstacle, but continual visual guidance is not available for the trail leg. Our aims for this study were twofold. First, to determine whether human subjects could retain obstacle characteristics in memory for extended periods of time, as shown in animals. Second, to determine the contribution of three possible sources of information involved in the formation of

obstacle representations: vision, proprioceptive feedback from the lead leg stepping over an obstacle, and a copy of the motor command sent to the lead leg (i.e., efference copy). METHODS: To test our first aim (Delay Experiment), eight subjects were instructed to step over an obstacle of three possible heights with their right (lead) leg and to straddle the obstacle for one of three delay periods (20s, 1 min, 2 min) before stepping over with the left (trail) leg. Toe elevation and clearance measures were collected for each leg using motion capture. To investigate the contribution of sensorimotor signals in forming an obstacle representation, which can subsequently be used to guide the trail leg over an obstacle, eight new subjects performed the same task in three different conditions and with a delay period of 30s (Passive Experiment). In the control condition, subjects actively moved their lead leg over the obstacle. In the remaining two conditions, the lead leg was passively moved over the obstacle using a system of ropes and pulleys with vision (Passive) or without vision (NV Passive). Trail leg toe elevation and clearance were recorded along with EMG activity from flexor muscles of the lead leg. RESULTS: In the Delay Experiment, our results demonstrated that trail leg toe elevation was scaled to obstacle height ($p<0.0001$). Importantly, we found that there was no effect of delay interval on this measure ($p=0.995$). Toe clearance showed a similar trend. In the Passive Experiment, passive movement successfully eliminated active muscle contraction and thus, altered the efference copy as well as proprioception from the lead leg. Interestingly, subjects were no longer able to accurately scale trail leg toe elevation to obstacle height in the NV passive condition. However, when vision was available during the passive movement, trail leg toe elevation was similar to the control condition. CONCLUSIONS: Our results suggest that humans are able to maintain a detailed representation of obstacle characteristics in memory for extended periods of time of up to at least 2 minutes. In addition, visual information obtained prior to the step over the obstacle and during lead leg stepping appears to be particularly important in the formation of obstacle representations that could then be used by the central nervous system to guide trail leg trajectory.

P1-F-134 Reduction of nociceptive plantar irritating stimulus induces amplification of head rotation

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BACKGROUND AND AIM: The foot is considered as an entrance to the postural system [1]. It advises the central nervous system and participates in the regulation of the posturo kinectic activity [2]. It is through this support driving and organizing synergies that motor actions develop [3]. This study focuses on plantar pressure variation by 3 mm stimulation (AI) [2] to neutralized Nociceptive Capacity of Plantar Irritating Stimulus (NCPIS) affecting somesthesia and affects postural control system [3-5]. METHODS: To observe the effect of NCPIS neutralization on muscular tone, we performed right and left head rotations without and with AI. Head amplitudes of 26 subjects with NCPIS located on the first metatarsal sesamoid region were recordings. RESULTS: Results showed improvements of total rotation ($p<0.0001$, 23° ± 31.32°). Effects were greater on right ($p<0.001$; 24.52° ± 38.56°) than left ($p<0.003$; 19.38° ± 24.48°). CONCLUSION: In conclusion, our study expose that NCPIS affect head amplitude. Neutralization of nociceptive plantar cues by AI modifies total head rotation. Reduction of NCPIS by AI induce biofeedback witch improve postural control [4-6]. In response, neck muscular distribution was greater but not symmetrical in spite of seam bilateral plantar stimulus. This indicates that AI stimulation could induce modifications of reflex loops and involved postural control regulation observes by better head rotation.

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P1-F-135 Facilitation of somatosensory potentials depends on the balance constraints during motor preparation of a step: A microgravity and normogravity study

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BACKGROUND AND AIM: It has been recently proposed that the transmission of afferent inputs from the periphery to the somatosensory cortex is attenuated during the preparation phase of voluntary movements. However, it appears counterintuitive and dysfunctional to suppress sensory inputs conveying critical somatosensory information to perform a task such as in gait initiation task. Indeed, gait initiation requires information about the standing condition relative to the equilibrium constraints prior to initiating a step (i.e., during movement preparation). Our hypothesis was that sensory attenuation should be selectively alleviated only if sensory cues are relevant to the task. METHODS: Here we directly tested this hypothesis by recording cortical somatosensory potentials (SEPs) evoked by lower limb vibration (i.e., proprioceptive inputs) during the preparation phase of a voluntary step movement (i.e., stepping condition). In a control condition the subjects were standing still during the vibration (i.e., static condition). RESULTS: In normal gravity, SEPs were larger in the stepping condition than in the static condition. To determine whether this facilitation of proprioceptive inputs was related to step movement preparation per se or to equilibrium constraints, we performed the same experiment in the microgravity environment of parabolic flights in order to remove equilibrium constraints. In microgravity, no difference was observed between the SEPs in stepping condition as compared to the static condition. CONCLUSION: These observations suggest that the brain exerts a dynamic control over the transmission of the afferent signal (i.e. facilitation) according to their current relevance during movement preparation.

P1-F-136 Decreased skin temperature of the foot increases gait variability in healthy young adults.

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[1]Kobe university, [2]National Center for Geriatrics and Gerontology

BACKGROUND AND AIM: It has been recently proposed that the transmission of afferent inputs from the periphery to the somatosensory cortex is attenuated during the preparation phase of voluntary movements. However, it appears counterintuitive and dysfunctional to suppress sensory inputs conveying critical somatosensory information to perform a task such as in gait initiation task. Indeed, gait initiation requires information about the standing condition relative to the equilibrium constraints prior to initiating a step (i.e., during movement preparation). Our hypothesis was that sensory attenuation should be selectively alleviated only if sensory cues are relevant to the task. METHODS: Here we directly tested this hypothesis by recording cortical somatosensory potentials (SEPs) evoked by lower limb vibration (i.e., proprioceptive inputs) during the preparation phase of a voluntary step movement (i.e., stepping condition). In a control condition the subjects were standing still during the vibration (i.e., static condition). RESULTS: In normal gravity, SEPs were larger in the stepping condition than in the static condition. To determine whether this facilitation of proprioceptive inputs was related to step movement preparation per se or to equilibrium constraints, we performed the same experiment in the microgravity environment of parabolic flights in order to remove equilibrium constraints. In microgravity, no difference was observed between the SEPs in stepping condition as compared to the static condition. CONCLUSION: These observations suggest that the brain exerts a dynamic control over the transmission of the afferent signal (i.e. facilitation) according to their current relevance during movement preparation.

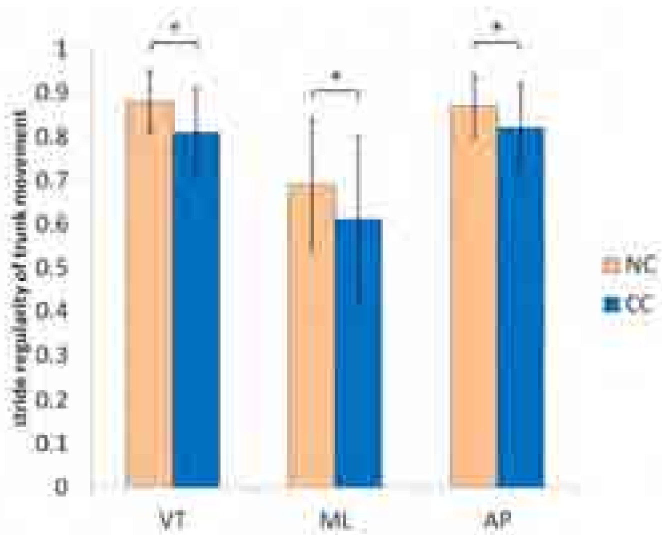

Fig. 1. Differences on stride regularity of trunk movement in three directions. VT: vertical, ML: mediolateral, AP: anteroposterior, NC: normal condition, CC: cold condition. Mean values of stride regularity in three directions are expressed with an error bar representing SD. *Compared between conditions (NC and CC), $p < 0.05$. NC and CC were compared in terms of stride regularity for each conditions using a paired t-test.

P1-F-137 Enhancement of locomotor and postural control by haptic forces: A pilot study

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BACKGROUND AND AIMS: Previous research has shown that when a stroke patient was trained with a rehabilitation dog bearing a steady force on an adapted harness, the patient improved their gait speed while reducing variability throughout the gait cycle. A 'virtual leash' was thus developed with robotics to control the pulling forces delivered to the hand as a subject walks on a self-paced treadmill and interacts with a virtual environment. This pilot study was conducted to determine the feasibility of implementing this innovative approach for posture and gait rehabilitation in stroke patients and older adults. METHODS: Five healthy young adults were tested and their responses in terms of gait velocity and other temporal distance gait parameters were contrasted with those of a chronic stroke patient. Participants walked on a self-paced treadmill while viewing a virtual environment rear-projected onto a large screen. Scene progression was controlled by the CAREN-3 system (Motek BV) synchronized to the walking speed of the subject. A 'constant force' paradigm was used, such that after walking steadily for 10 seconds, a forward pulling force of 0, 5, 10, or 20N was applied to the hand, via a leash controlled by the robotic arm (HapticMaster, Moog BV). This force was active for 20 seconds before being turned off while the subject continued walking for another 10 seconds. An additional 'transient perturbation' paradigm was also tested in the stroke patient, such that walking began with a constant pulling force of 10 N and then a transient perturbation of +/- 5N and 10N lasting 500ms was applied to the hand, before reverting back to the constant pulling force of 10N. RESULTS: Healthy participants significantly increased their stride length ($p<.05$) while systematically reducing their double stance duration when walking with the pulling force in the constant force paradigm. Average walking velocity for the 10N and 20N force conditions also showed marked increases of ~6-17% respectively ($p<.05$) as compared to no pulling force. Mirroring these effects, the chronic stroke patient also showed a ~15% increase in gait velocity when exposed to a constant pulling force of 10N. However, when exposed to a transient force perturbation at the hand, the stroke patient responded by a ~16-25% reduction in walking velocity when the pulling force was increased from 10N to 15N and 20N, respectively. Conversely, the patient increased walking velocity by ~3-6% when the pulling force was decreased from 10N to 5N and 0N, respectively. CONCLUSIONS: As a proof of principle, we have determined that it is feasible to apply different amounts of haptic forces to the hand of a stroke patient while walking in a virtual environment. This pilot study shows that, with the appropriate level of haptic forces, there is a potential in improving the gait profile as evidenced by changes in temporal distance gait parameters, including the walking velocity.

P1-F-138 Differences in the balance control during single leg stance in young adults

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BACKGROUND AND AIM: Adequate balance is important for posture control and motor performance. The control of posture is a complex task depending of the somatosensory, visual and vestibular systems.

There are few studies of single limb balance investigations about differences between genders and ages on this position (LEE et al., 2007 and ZUMBRUNN et al., 2011). The results indicate that a single limb stance protocol may be a useful assessment for determining balance impairments. Control the balance in a single-leg stance is a particular challenging of human locomotion, especially because this process requires keeping the center of body mass within the small area of support and this position is really important for human locomotion and daily activities (RICHARDSON et al., 1996). We did not find any study which compare variables from the balance control between dominant and non-dominant leg in adults. So, the aim of this study was to analyze dominant and non-dominant differences in the balance control during single leg stance between genders in young adults. METHODS: Twenty eight young adults with age between 18-30 years participated in this study voluntarily. They were asked to maintain a stable posture barefoot with their arms alongside the body while fixating a reference point located at eye level (one meter in front) in two situations: Eyes Open Single Leg Dominant and Eyes Open Single Leg Non-Dominant. An AccuSway Plus (AMTI, Inc, MA, USA) force platform was used to measurer the center of pressure (COP) in the anteroposterior (COPap) and mediolateral (COPml) directions, and area (AreaCOP) and velocity (COPvel). Three trials were collected during 30 seconds with an acquisition frequency of 100 Hz and filtered with a cut-off frequency of 10 Hz. T-tests were performed (p<0,05) using SPSS software version 13.0 (SPSS Inc, Chicago, IL, USA). RESULTS:: Men showed that they had significantly better results than women to the dominant leg only in the AreaCOP. In the non-dominant leg, men had better results for COPap and AreaCOP. To women, the dominant side was significantly better than the non-dominant side in all analyzed variables. To men, COPvel was the only variable that showed significant difference with better results to the non-dominant side. One possible explanation for this is that dominant leg is used to do movements that we have to use strength while the non-dominant leg serves as the support of postural balance. In general, men have greater muscle strength than women and that perhaps greater asymmetry in this physical capacity than women (WOLFSON et al., 1994). However, it would be necessary control these variables through a motor test for greater certainly on this statement. CONCLUSIONS: In conclusion, there are differences in postural balance between dominant side and non-dominant in adults. In relation genders, men and women also differ with respect to unipodal postural control.

Table 1 – COP results for the dominant and non-dominant legs

	Intra groups						Inter groups	
	Female			Male			Dom	Non
	Dom	Non-dom	p	Dom	Non-dom	p	p	p
COPml	2.39±0.28	2.39±0.28	0.01	2.38±0.29	2.46±0.30	0.21	0.92	0.49
COPap	3.52±0.64	3.85±0.86	0.02	3.24±0.70	3.18±0.55	0.17	0.28	0.02
COPvel	2.94±0.49	2.78±0.70	0.02	3.40±0.71	3.09±0.59	0.00	0.06	0.23
AreaCO	5.88±1.40	6.47±2.01	0.00	4.74±0.96	5.10±1.27	0.63	0.02	0.04

$p < 0.05$ - significant differences

P1-F-139 **Aftereffects following normal and slow walking on a split-belt treadmill with asymmetrical belt speeds in healthy individuals**

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BACKGROUND and AIM: Post-stroke individuals have locomotor deficits that greatly affect their independence. In comparison to healthy individuals with similar physical characteristics, post-stroke individuals walk at a slower speed and have an asymmetrical gait pattern. Walking on a split-belt treadmill with different lower limb gait speeds has been demonstrated to induce aftereffects, characterized by more symmetrical time-distance parameters in hemiparetic individuals. However, no study has analyzed the effects of walking asymmetrically on a split-belt treadmill on ground reaction force (GRF) components in healthy or hemiparetic individuals. The aim of this study was to examine the effects of gait perturbation on GRF, stance and double-support times in healthy participants using asymmetrical belt speeds while walking on a split-belt treadmill. METHODS: Twelve healthy individuals, 25.4 ± 5.6 years old, were recruited. Participants were first asked to walk on a treadmill at their natural speed with the belts running at the same speed (3 minutes). Then, the perturbation period was introduced with the speed of one belt increased by 50% (ratio of 1:1.5) for 6 minutes. The belts were then stopped and restarted to run at the initial speed (natural condition) for 3 minutes. Stance and double-support times as well as peak values of the vertical (P1 and P3) and anteroposterior (P1 and P2) GRFs were extracted from the force plates of the instrumented split-belt treadmill. The sequence was repeated at a 30% slower speed than normal with a ratio of 1:2. The first 20 gait cycles (immediate aftereffects) were divided into 4 periods (average of 5 cycles), expressed in terms of asymmetry (between side differences/mean of both sides) and then compared to the normal walking condition and over time. Paired Student t-tests and ANOVAs were used to compare peak values of GRF, stance and double-support times between speeds and over time ($p<0.05$). RESULTS: Overall, the perturbation increased asymmetry in all participants at both speeds. However, the aftereffects were greater at a normal speed than at a slow speed for the vertical GRF component. A significant aftereffect was observed for the double-support time, whereas no effect was noted for the stance time parameter. The peak values of the anteroposterior GRF behaved differently: the braking forces (P1) increased under the slower lower limb, whereas the propulsion forces (P2) increased under the faster lower limb. For these parameters, the aftereffects lasted more than 20 cycles ($p<0.05$). CONCLUSIONS: Walking on a split-belt treadmill with different belt speeds induces a reorganization of the inter-limb coordination to maintain a stable gait pattern as revealed by modifications of the GRFs and stance time parameters. Furthermore, healthy and post-stroke individuals are currently being evaluated using a biomechanical approach to better document the aftereffects of walking asymmetrically on a split-belt treadmill.

P1-F-140 Gait analysis of pool-floor walking with additional weight on affected limb for people post-stroke

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BACKGROUND AND AIM: Aquatic therapy settings have become increasingly popular for gait rehabilitation for people post-stroke. Buoyancy helps individuals support their body weight and reduces the impact force while walking in water. However, limbs that are not under complete neuromotor control are inclined to float or show other compensatory movements. In aquatic gait training, cuff weights (CW) are used to reduce the unwanted floatation of the uncontrolled limb. The purpose of this study was to investigate the differences in gait patterns when using a CW on the paretic limb during pool-floor walking for people post-stroke. METHODS: A repeated measures comparative design was used to compare the differences in gait patterns when a CW was applied to the paretic limb. Twenty-one individuals post-stroke (5 females/16 males; age range 48-88 years, time post-stroke 13-64 months) participated in this study. Participants walked across an 8m walkway in chest-depth level water adjusted by a movable-floor pool. Three walking conditions were compared at a comfortable-fast walking paces: a) CW at distal shank, b) CW at proximal shank, and c) no CW. The underwater three-dimensional motion analysis system incorporated six underwater lenses placed in the water to capture all trials. Underwater cameras were connected to and recorded by six digital video cameras. A total of 15 waterproof markers (0.1cm) were placed on bony landmarks of the lower extremities following the Helen Hayes marker set. All markers were digitized and processed using Vicon Motus v. 9.2 for spatiotemporal variables and lower extremity joint kinematic variables. RESULTS: Overall, when participants wore a cuff weight, they demonstrated a faster walking speed compared to the no weight condition (Ps < 0.05). The application of the cuff weight on the paretic limb regardless of position showed a significant increase in stance-phase percentage of the non-paretic limb (Ps < 0.05). The knee weight condition showed a significant decrease (P = 0.015) in knee sagittal range of motion (ROM) of the non-paretic limb compared to the no weight condition. Ankle weight condition showed significant decreases in peak knee flexion (P = 0.047). and sagittal plane ankle ROM (P = 0.038) of the non-paretic limb when compared to the no weight condition. CONCLUSIONS: The use of a cuff weight on the paretic limb can allow people with hemiparesis to walk faster in water with changes in kinematic and spatiotemporal gait variables in the non-paretic limb. It appears such motor adaptations is made primarily using the non-paretic limb even when an additional weight is applied to the paretic limb.

Variable	No Weight		Knee Weight		Ankle Weight	
Speed (m/s)	0.59		0.64*		0.63*	
	(0.19)		(0.22)		(0.20)	
Cadence (steps/min)	54.07		53.06		53.00	
	(14.62)		(13.20)		(14.87)	
	P	NP	P	NP	P	NP
	0.39	0.72	0.41	0.74	0.41	0.72
SL (m)	(0.14)	(0.29)	(0.15)	(0.28)	(0.14)	(0.26)

ST (s)	5.60 (1.43)	2.42 (0.65)	5.60 (1.34)	2.39 (0.51)	5.72 (1.49)	2.40 (0.53)
SW (mm)	224.09 (113.88)	211.13 (93.88)	218.22 (80.57)	215.57 (76.78)	226.32 (85.51)	225.55 (104.75)
FO (%)	56.86 (5.65)	69.27 (7.57)	58.76 (6.96)	71.06* (7.68)	56.97 (6.30)	71.75* (7.52)

P1-F-141 The innovative methods of correction of balance and gait

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BACKGROUND AND AIM: Reactivation of balance and gait is one of the urgent problems of modern neurorehabilitation. Disequilibrium was detected in more than 83% of patients after stroke. 20-25% of patients who underwent stroke are not able to move by themselves mostly due to disorder in mechanisms of the body balance control. So it is necessary to develop the new rebalance techniques. It is still actual to create an effective balance control technique that could be acceptable both for multi-field hospitals and outpatient therapy. METHODS: As a result new methods of correcting balance and gait have been developed: the stabilizing platforms and methodology based on focused dose center of gravity shift in combination with other resources. During the lessons with stabilizing platforms the hip strategy of balance activates. During the training based on focused dose center of gravity shift in combination with other resources the postural static synergies activates. 85 patients were randomized in 3 groups. In the first (n=30) group patients received traditional neurorehabilitation methods and balance training with visual biofeedback. In the second group (n=30) patients had treatment on stabilizing platforms. In the third group (n=25) patients got treatment with the suggested technique of balance correction. Each patient had both before and after the course of treatment physical examination, neurological status assessment, objective evaluation of balance by Computer Stabilometry (CS), balance clinical function - by Berg Balance Scale, walking function - by Dynamic Gait Index. RESULTS: In the first, second and third groups patients had significant improvement by the stabilometry and scales (Wilcoxon nonparametric test: $p<0,05$) after treatment. Significant differences in CS after treatment between the groups were not found. CONCLUSIONS: The suggested methods of correcting of balance and gait decrease the risk of falls during walking with vestibular loads and its efficiency is comparable with high-tech modern methods of balance correction and may be used for outpatient treatment.

P1-F-142 Whole body muscle activation patterns when supporting an unstable load

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BACKGROUND AND AIM: Rehabilitation and exercise training programs frequently use standing on unstable surfaces to challenge balance and improve whole body muscle strength and balance control. Similar benefits may be derived, under safer conditions, by training on a stable surface while supporting an unstable load with the arms. The purpose of this study was to examine the relative contribution of leg, trunk and arm muscles to the support and balance of a stable versus unstable load. METHODS: 10 healthy males (2.6 ± 2.4 years) volunteered to participate in the study. Surface Electromyography (EMG) signals were collect from 10 bilateral muscles: soleus (SOL), tibialis anterior (TA), gluteus medius (GM), adductor longus (ADL), external obliques (EO), rectus abdominis (RA), lumbar division of erector spinae (LES), anterior deltoid (AD), biceps brachii (BB) and triceps brachii (TB). Participants completed a total of eight 30s trials in which they supported 2 different loads in 3 postural conditions. The loads included a solid bar (stable) and a plastic tube (Attitube) of equivalent weight and length (10kg, 1.57m) partially filled with water (unstable). Postural conditions included; 1) standing with feet shoulder width apart, 2) sitting without back support, and 3) sitting with back support. These postural conditions were selected to limit the contribution of different body segments to stabilizing the load supported by the arms. During each of the 8 randomized trials, participants were instructed to balance the bar or Attitube as steady as possible with their elbows flexed at 90 degrees. A 2 X 3 ANOVA (2 loads X 3 postures), with repeated measures, was performed for both a 20s average and 1s peak muscle activation recorded for each muscle. RESULTS: Upper limb and trunk muscle activity significantly increased ($p<.05$) when supporting the unstable vs. the stable load; while lower limb muscles were unaffected by load type. The 1s peak measure revealed an increase for: AD, BB, TB, EO, LES, GM. The 20s average EMG revealed a significant increase for: TB, EO, LES, RA, GM. A change in posture from standing to seated resulted in a significant change in activity for GM and EO only. The GM 1s peak activity decreased when seated with and without back support and for load types. The EO 1s peak activity was reduced only when seated with back support and only when supporting the unstable load. CONCLUSIONS: Supporting an unstable load increases activation of arm and trunk muscles in order to maintain stability of the object and the large mass of the head, arms and trunk. The posture in which the load is supported determines the contribution of trunk muscles. The activation of GM is reduced when seated versus standing and the activation of EO is reduced with trunk support versus without. Supporting an unstable load, with progression from seated to standing, can be a simple and safe training method for improving strength and balance control.

P1-F-143 Control of gait in patients following intensive care unit discharge

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BACKGROUND AND AIM: Critically ill patients lose significant muscle mass and strength within the first 2-3 weeks of their stay in the intensive care unit (ICU) [1]. ICU acquired muscle weakness may result in a persistent reduction in muscle strength, functional outcomes and quality of life for years after discharge from the ICU [2,3]. Deficits in muscular strength have been associated with impaired postural control [4], however, postural dyscontrol has not been examined in patients with ICU-acquired muscle weakness. Understanding how ICU-acquired muscle weakness affects the motor control of gait following critically illness may help to identify potential risk factors, and measurable treatment outcomes in this patient population. METHODS: Seven people (mean age=53.3 y.o.; 5 males), mechanically ventilated for a minimum of one week during their ICU stay volunteered to participate in this study. Gait performance was tested 3 months post ICU-discharge. Study participants were fitted with a wireless accelerometer just proximal to the right lateral maleolus prior to completing a 6 minute walk test (6MWT). Spatial and temporal gait measures were collected during the 6MWT using a GAITrite mat. Measures of interest included: 1) long-term correlations in the stride-to-stride fluctuations (fractal scaling index; FSI) of the stride interval over the 6MWT [5]; 2) spatiotemporal measures of gait (e.g. step length); and 3) symmetry of the spatiotemporal measures between legs (symmetry ratio) [6]. For comparison, previously collected data from eight healthy controls (HC; mean age = 25.6 y.o.; 8 males) was utilized. RESULTS: When compared to HC, ICU Patients (ICUP) demonstrated a 31% reduction in the FSI (ICUP: 0.59±0.06; HC: 0.86±0.05; p=0.0077), a 20% reduction in step length bilaterally (ICUP: 63.12±3.15cm; HC: 79.29±3.28; p=0.0051), and a 20% reduction in gait velocity (ICUP: 1.20±0.1m/s; HC: 1.47±0.1m/s; p=0.0614). Neither group demonstrated inter-limb asymmetry in any spatiotemporal gait measure. CONCLUSIONS: Prolonged ICU stay and associated ICU-acquired muscle weakness may lead to changes in the motor control of gait. In the current study, changes in motor control were evident in reduced long-term correlations observed within stride intervals, a marker of gait dyscontrol. Stride length and walking velocity were also reduced, possibly indicative of diminished lower extremity muscle strength.

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P1-F-144 Coordination among the upper and lower limbs in a lateral body weight-shifting task

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BACKGROUND AND AIM: The lateral body weight-shifting task is often used in therapeutic programs to improve abilities of orthopedic patients in normal standing/gait. In this task, patients are required to stand on the unaffected lower limb and then shift a part of the body weight as a target load toward the affected lower limb, while adjusting the loads between the lower limbs. Patients usually perform this task with the support of both upper limbs placed on a pair of horizontal parallel bars. This may well influence the accuracy of adjustments required in loading the given target load onto the lower limb. This study examined the likely effectiveness/ineffectiveness of the use of the upper limbs in a lateral body weight-shifting task in healthy participants. We measured the features of load transition between the 4 limbs during the body weight-shifting to investigate coordination among the upper and lower limbs. METHODS: Twenty-three right-footed and right-handed healthy adults participated in this study. They

were asked to perform lateral body weight-shifting task in either the left or right direction with a target load of either one- or two-third of the body weight on a given target lower limb, maintaining the load balance for 3 s. The load on each limb was measured using 2 force plates and 2 load cells. Inter-limb correlation coefficients among the respective loads for the limbs were calculated. The accuracy of adjustments for target loads was calculated in terms of constant error (CE/w). The relationships between the inter-limb correlation coefficients (Z-transformed correlation coefficients) and CE/w were then examined. RESULTS: In the one-third target load condition, when the participants performed weight-shifting to the left lower limb, the load on the left upper limb tended to decrease. The Z-transformed correlation coefficients of both the left lower-left upper limbs and the right lower-left upper limbs were significantly correlated with CE/w ($r = -0.44$, and $r = 0.44$, $p < 0.05$, respectively). In the two-third target load condition, when the participants performed weight-shifting to the left lower limb (the load on the right lower limb degreased), the load on the right upper limb tended to decrease. The Z-transformed correlation coefficients of the right lower-right upper limbs were significantly correlated with CE/w ($r = -0.43$, $p < 0.05$). CONCLUSIONS: Our results indicated that the use of the upper limbs may be ineffective in accurately adjusting a given target load on a lower limb. The transition of loads from one to another upper limb may well reflect a slight tilt of the upper part of the body. Our findings suggest that therapists should not instruct patients to use the upper limbs or a slight tilt of the upper body in adjusting a given target load on the lower limb in the lateral body weight-shifting task.

P1-F-145 Foot strike identified by a trunk worn kinematic sensor in persons with severely impaired gait

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BACKGROUND AND AIM: Body worn sensors have expanded the use of gait analysis to clinical environments. Many gait variables can be extracted from data obtained from a single kinematic sensor attached to the lower trunk [1]. Recently calculation of Step time (ST) by trunk accelerometry has been reported for able walkers [2], but impaired walkers present additional challenges due to jerk, trembling, and lack of pronounced foot strikes in cautious and shuffling gait. The aim of this study was to validate an algorithm to identify foot strike and calculate ST from data obtained by a kinematic sensor attached to the lower trunk in persons with severely impaired gait. METHODS: Fourteen persons with severely impaired gait were recruited among nursing home residents or day-care users aged 86.4 ± 5.1 years (range 79 - 94 years). Eleven of the participants used walking aids indoors, but all performed testing without walking aids. The participants walked along a 4.6m walkway (GAITRite®) with simultaneous measurements by a kinematic sensor (Xsens®) fixed over the lower back and a photocell timing system. Data from two trials at preferred speed were averaged before analysis. GAITRite identified left and right heel strikes, and data from the kinematic sensor were analysed by an in-house program (TRASK) utilizing vertical velocity to identify foot strikes, and mediolateral position to separate left and right foot strikes. RESULTS: There were no systematic differences between the GAITRite and TRASK systems. Intrasubject ST mean showed excellent agree¬ment with ICC(1,1) = 1.00, while intrasubject ST standard deviation

(ICC = 0.92) and single ST across all subjects (ICC = 0.94) demonstrated somewhat lower agreement. CONCLUSIONS: GAITRite identifies heel strike and TRASK identifies initial load taking irrespective of foot strike strategy. Therefore the two systems are unlikely to agree unconditionally in persons with severely impaired gait who do not consistently initiate load taking with heel first. The obtained agreement suggests that the TRASK system is well suited for identification of foot strike in persons with severely impaired gait.

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P1-F-146 Assessing asymmetry in post-stroke and prosthetic gait in terms of step-length asymmetry alone is flawed!

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BACKGROUND AND AIM: In pathological gait, step length (SL) typically differs in magnitude between sides. However, the direction of SL asymmetry varies across patients. This study sought to understand directional variations in SL asymmetry in hemiplegic stroke patients and lower-limb amputee patients. Here, paretic/prosthetic (P) SL represents the fore-after distance between non-paretic/non-prosthetic (NP) and subsequent P foot placement positions (vice versa for NP step length). We partitioned SL asymmetry into asymmetries in trunk progression (TP; NP steps are shorter than P steps if the trunk does not displace as far forward of the supporting P than NP foot; Fig. 1A) and forward foot placement relative to the trunk (FFP; a larger NP than P FFP contributes to a longer NP than P step; Fig. 1B). We expected that the identified TP and FFP components account for the observed asymmetry in SL in an additive manner and that their relative contribution is responsible for inconsistencies in the direction of SL asymmetry. METHODS: 28 hemiplegic stroke patients, 10 lower-limb amputee patients and 9 healthy elderly controls walked at a self-selected comfortable speed on an overground walkway and on a treadmill, the latter with and without projection of symmetric stepping stones. Pelvic and heel marker positions were recorded. SL, FFP, and TP of P and NP steps were quantified, as well as asymmetries therein. RESULTS: Asymmetry indices varied within individual patients and occasionally fell within control reference ranges, whereas directional variations across patients were observed for asymmetries in SL and FFP only. Despite heterogeneity in asymmetry across patients, SL asymmetry was determined by the sum of asymmetries in FFP and TP. Asymmetries in FFP and TP were negatively correlated (stroke: r=-0.64; amputee: r=-0.44). The magnitude of SL and FFP asymmetries was significantly smaller for symmetrically cued than uncued treadmill walking for stroke and amputee patients alike. CONCLUSIONS: Variations in SL asymmetry cannot be fully explained by TP and FFP components in isolation. Rather, the magnitude of SL asymmetry was accounted for by the sum of TP and FFP asymmetries whereas their relative contribution accounted for directional variations in SL asymmetry. That is, P and NP steps are of equal length as long as asymmetries in TP and FFP are similar in magnitude but opposite in direction. Likewise, relatively large asymmetries in SL may result from TP and FFP asymmetries that are small in magnitude but similar in direction. Hence, judging the quality of

hemiplegic or prosthetic gait from the magnitude of SL asymmetry alone is flawed. An encompassing gait asymmetry evaluation should therefore include an assessment of foot positioning relative to the trunk. Imposing a symmetric SL by using visual cues during treadmill walking decreases asymmetries in SL and FFP, thereby contributing to an overall more symmetric gait in stroke and amputee patients.

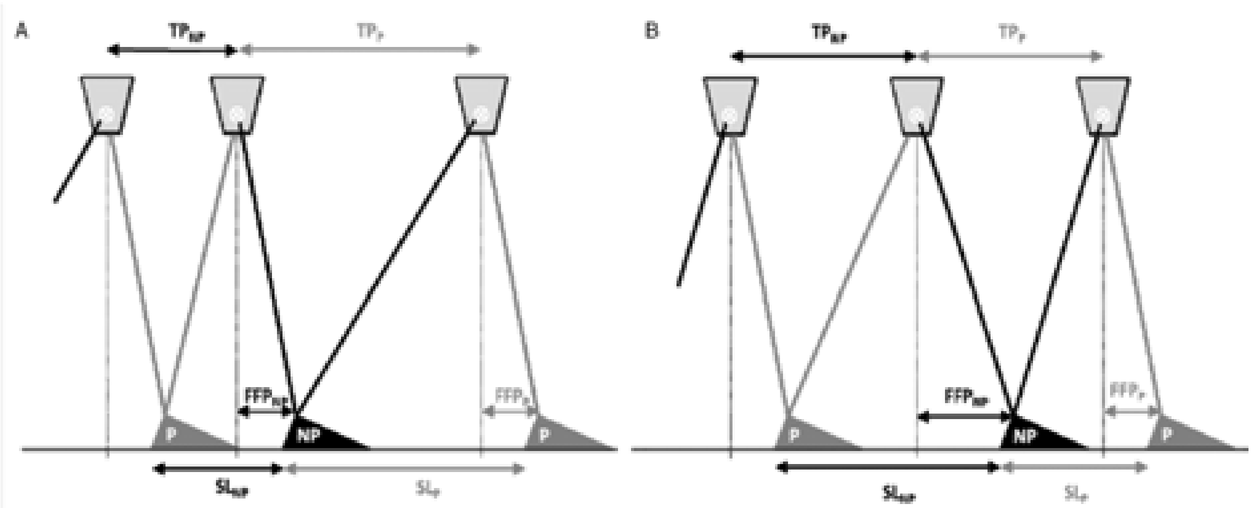

Fig. 1. Schematic of determinants of SL asymmetry. (A) SL asymmetry due to asymmetry in TP and (B) SL asymmetry due to asymmetry in FFP

P1-F-147 The effects of an adopted narrow gait on the external adduction moment at the knee joint during level walking: Evidence of asymmetry

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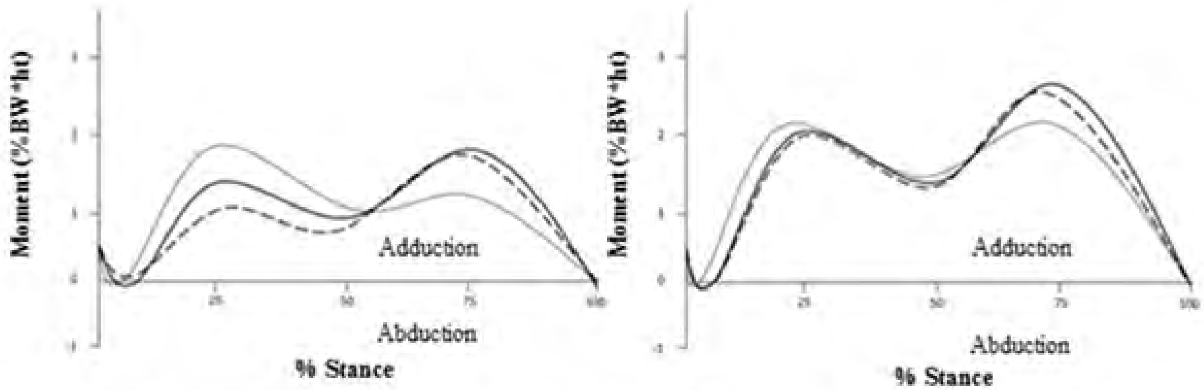
BACKGROUND AND AIM: The external knee adduction moment is an accurate estimation of the load distribution of the knee and is a valid predictor for the presence, severity and progression rate of medial compartment knee osteoarthritis. The use of various gait modification strategies has been shown to be an effective means of reducing the external knee adduction moment. The purpose of the study was to investigate how different gait modification strategies affect the external knee adduction moment bilaterally, and if the pattern is affected by the paradigm of limb-dominance. METHODS: 15 healthy male participants (age: 23.8 (SD 3.1) years, height:1.8 (SD 0.1) m, body mass: 82.9 (SD 16.1) kg) took part in this study. Five walking trials were performed for each of the three different gait conditions: normal gait, toe-out gait and narrow gait. RESULTS: The narrow gait condition significantly reduced the external knee adduction moment at the early stance phase peak, as did the toe-out gait condition at the late stance phase peak, when compared to the other two gait conditions ($P<0.002$). However, it was observed in both the aforementioned reductions that this pattern only occurred in the non-dominant limb. CONCLUSION: Gait modification can reduce the external knee adduction moment. However, asymmetrical patterns between the dominant and non-dominant limb, specifically during gait modification attenuate the bilateral effectiveness of this intervention. The mechanism of limb-

dominance and the specific role of each limb during gait seems to be manifested in an asymmetrical pattern in the frontal plane moment arm and centre of mass displacement during stance.



Ensemble average data for the external knee adduction moment normalized to % stance. External knee adduction moment, at early stance phase peak, was reduced in the non-dominant limb, during the narrow gait condition; external knee adduction moment, at late stance phase peak, was reduced in the toe-out condition. There was little to no effect of gait condition on the external knee adduction moment measure in the dominant limb, and an asymmetry between the limbs was observed in this measure in all gait conditions. The solid line corresponds to the normal gait condition, toe-out and narrow gait conditions are indicated by the dotted and dashed line, respectively.

P1-F-148 A new method to calculate foot clearance during stair gait

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BACKGROUND AND AIM: Falls on stairs, especially during decent, can lead to injury and death. Two important factors for understanding the mechanisms behind falls on stairs are the foot placement and foot clearance. While foot placement on the step is relatively easy to measure, clearance point has not been well standardized in the literature. The purpose of this work was to present a new method to calculate minimal foot clearance during stair gait. METHODS: Sixteen healthy young (25.1± 3.9 years) adults descended a five step staircase over 5 trials at their self-selected speed. One cluster of three non-colinear markers was fixed to the lateral aspect of the each person's shoe. Ninety points on average (depending on shoe type) were digitized using a digitizing probe (Optotrak; NDI inc) on each shoe sole and later related to the movement of the shoe markers. Two points were also digitized for each staircase step to define their edges. A three-dimensional representation of the sole surface was created using Matlab (v.7.0) based on the "meshgrid" function. Foot clearance was calculated as the minimum three-dimensional distance between the edge of each step and: the anterior tip (toes), posterior tip (heel) and sole surface for both feet. Sole distances were separated into fore-foot, mid-foot and hind-foot clearance. Statistical analyses involved paired t-tests and Pearson correlations. RESULTS: The closest point to each step edge was consistently found to be for the sole surface of the foot. Toe clearance was generally highest, except for the first transition step where the heel and toe were similar. The hind-foot was identified as minimum sole distance on 69 % of all trials, with the fore-foot on 14 % and the mid-foot on 17% of trials. CONCLUSIONS: This new method is easy and quick to implement and

it is not dependent on specific chosen points or intra-operator variability. Moreover, the present technique only requires one cluster of markers placed on the foot during experimental trials. It is more representative of the real spatial position of the foot over steps and allows a more global detailed study of clearance strategies used to descend stairs. Our results showed that the hind-foot, and not the heel or toe, is the point generally most at risk of contact, but also that this is dependent on the on subject and position on the staircase . Such measures can be used to help identify possible alterations in gait patterns that can increase the risk of falling during stair gait with age, or even other environments requiring foot clearance (e.g., obstacle avoidance).

P1-F-149 Temporal characteristics of motor-equivalent stabilization of upright standing

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BACKGROUND AND AIM: During human upright standing, motor equivalence is exploited to stabilize whole-body equilibrium and orientation (Hsu, Scholz, Schöner et al. 2007). The goal of the present study was to further investigate temporal characteristics of this stabilization process, in particular to assess potential differences between task-equivalent and task-relevant postural fluctuations. METHODS: Fifteen healthy young adults took part in the experiment during which movement kinematics and force plate data were recorded during one bipedal quiet standing trial of 5-minutes duration. Using the uncontrolled manifold approach (Scholz and Schöner 1999), postural (joint angle) variability in the sagittal plane was decomposed into task-equivalent and task-relevant components with respect to four task variables: (1) center of mass (CoM) position, (2) head position, (3) trunk orientation, and (4) head orientation. This analysis was carried out for sliding time windows of duration ranging from 5 to 300 seconds. RESULTS: Motor-equivalent stabilization (task-equivalent exceeding task-relevant variability) was found for CoM and head positions, and trunk orientation, but not for head orientation. Both task-equivalent and task-relevant variability increased with window size. For CoM and head positions and trunk orientation, this increase was more pronounced for task-equivalent variability than for task-relevant variability (interaction between window size and variability component). Such an interaction effect was not observed for head orientation. CONCLUSIONS: The present findings provide evidence that temporal characteristics of postural fluctuations during quiet standing differ between task-equivalent and task-relevant components. This was the case for three of the four analyzed variables (CoM and head position, trunk orientation), which arguably are functionally more important for whole-body equilibrium than the fourth variable, head orientation. The observed time-scale effects indicate not only selective reduction of variability, but also reduced accumulation of fluctuations over time in task-relevant compared to task-equivalent dimensions.

P1-F-150 Adult age-related differences in voluntary movements of whole-body center of mass

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BACKGROUND AND AIM: Balance abilities decline with advancing age, as shown by increased risk of falling as well as poorer performance in laboratory tasks challenging body equilibrium. Control of whole-body center of mass is a crucial component of maintaining balance. However, to our knowledge, the effect of normal aging on voluntary control of center of mass (CoM) position has not been investigated so far. METHODS: Twelve young (20-30 years) and twelve healthy older (70-80 years) participants performed a visual center-out target acquisition task, with online feedback of whole-body CoM provided by a 3D motion capture system. The task required CoM movements of an amplitude of 2 cm in 8 different horizontal directions. Experimental sessions consisted of five blocks with 16 trials each, allowing to assess learning. Unsupported one-legged standing (OLS) time was assessed as an independent covariate, with eyes open (EC) and eyes closed (EC). RESULTS: Older adults exhibited longer movement duration and CoM path length. Across blocks, both age groups improved in most of the performance measures. Absolute and relative improvements in CoM path length were larger in older adults. Average CoM path length correlated negatively with OLS/EC time in older but not in younger adults. Initial center of pressure (CoP) movement opposite to the target direction showed no age difference in amplitude but was delayed and less direction-specific in older compared to younger adults. CONCLUSIONS: Performance in voluntary CoM movement was reduced in a sample of healthy older adults and correlated with OLS performance, suggesting the present task may be a valid indicator of normal age-related decline in balance. Our findings further indicate that response speed and fine regulation of movement direction may be the main contributors to age-related performance differences in this task. Further functional implications, for instance with respect to gait stability or ability to respond to external perturbations, should be addressed by future studies.

P1-F-151 Postural steadiness during tandem stance: The influence of foot positioning and weight distribution on center of gravity and center of pressure trajectories

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BACKGROUND AND AIM: Tandem stance is often used in clinical assessment to evaluate balance problems and fall risk. Typically, foot positioning and weight distribution are not standardized, although each of these factors may influence postural steadiness. The aims of this study were twofold: (1) to assess what foot positioning and weight bearing asymmetry healthy adults spontaneously adopt during tandem stance, and (2) to investigate the influence of instructed foot positioning and weight distribution on distance travelled, amplitude, and frequency of the center of gravity (CoG) and center of pressure (CoP) traces. METHODS: Sixteen healthy, young adults performed 7 different tandem stances, consisting of preferred tandem stance and 6 conditions with instructed foot positioning (preferred foot front or rear) and weight distribution (most weight on rear foot, on front foot, or weight divided evenly over both feet). Vertical ground reaction forces, recorded by two force platforms, were used to determine the CoP trajectories. CoG trajectories were derived from the horizontal force signals by the zero-point-to-zero-point double integration technique (Zatsiorsky and King, 1998). RESULTS: In preferred tandem stance, participants placed more weight on the rear than on the front foot ($p<0.001$), irrespective of whether the dominant foot was positioned front or rear ($p=0.804$). Foot positioning did not influence

distance travelled, amplitude, or frequency of the CoG and CoP trajectories either (all p's>0.151). Instructed weight distribution had a large influence on distance travelled and amplitude of the CoG and CoP trajectories. When more weight was placed on the front foot, the distance travelled and amplitude increased especially in the anterior-posterior direction, whereas an increase in distance travelled and amplitude was seen in medial-lateral direction when the rear foot was loaded more. CONCLUSIONS: Although preferred tandem stance is an asymmetrical task, stability is not influenced by which foot is positioned in the front or rear. However, body weight distribution has a major influence on postural steadiness during tandem stance. During clinical testing, explicit instructions should thus be given to how body weight should be distributed over both feet. Further research should follow up on the importance of swaying frequency in medial-lateral direction as a possible indicator of postural steadiness in tandem stance.

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P1-F-152 Stability during sit-to-stand using different movement strategies

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BACKGROUND AND AIM: Sit-to-stand (STS) is a precursor for independent mobility and requires moving from a stable sitting position to a more unstable base on two feet. Previous authors have noted different movement strategies for performing STS (momentum transfer, stabilization and dominant vertical rise) based on physical characteristics such as strength, flexibility, coordination and postural stability. Time-to-Boundary (TtB) measures have been used as indicators of postural stability. TtB is the time for the center of pressure (COP) to reach the border of the base of support based on instantaneous COP velocity and acceleration. A lower TtB may indicate reduced postural stability. The focus of this analysis was to explore differences between STS strategies in terms of COP stability measures. METHODS: Twenty-one healthy young adults (9 males/12 females, age 23 ± 2 years, mass 78 ± 20 kg, height 1.71 ± 0.08 m) participated in this study. An 8-camera video system tracked reflective markers for 3-D kinematic analysis. Participants performed 3 trials of each STS strategy (Momentum, Stabilization and Vertical) from a 46 cm wooden bench with and without upper extremity usage, for a total of 18 trials. The lower extremities were placed on two in-ground force platforms and hands were placed on 9 cm supports when using upper extremities. COP excursions, maximum base of support percentages, mean velocities, and minimum TtB measures were calculated in the mediolateral (ML) and anteroposterior (AP) directions from the point of seat-off to STS termination. Differences between STS strategies and upper extremity usage were assessed via ANOVA. RESULTS: Trunk flexion at seat-off differentiated the three strategies across upper extremity conditions, with Stabilization > Momentum > Vertical (p<0.001). There were no differences in COP variables when comparing upper extremity usage to no hand support. AP COP excursion was increased for the Stabilization strategy compared to the Momentum and Vertical strategies (p<0.02). In the Vertical strategy, the AP COP traversed to a larger percentage of the base of support border compared to the other strategies (p<0.03). Mean ML COP

velocity was increased for the Vertical strategy compared to the Stabilization strategy ($p<0.02$). AP TtB was reduced when participants used the Stabilization strategy compared to the Momentum strategy ($p<0.05$). CONCLUSIONS: Trunk flexion was a distinguishing feature of the three strategies. As expected, fewer differences between strategies were noted in the ML direction as STS is a predominantly sagittal plane movement. The increased AP COP excursion with the Stabilization strategy and the increased AP COP utilization toward the base of support border with the Vertical strategy indicate additional stability requirements. The increased TtB measures while using the Momentum strategy suggest greatest stability with the technique most familiar to young adult participants.

P1-F-153 The influence of foot dominance and task on the trajectory of CoP and CoG in planned gait termination

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BACKGROUND AND AIM: Termination of gait is a transient period from a cyclic movement to a full stop. This abrupt change of velocity alters the criteria of balance. We investigated whether the same mechanism was used in planned termination of gait as in taking a voluntary step. Furthermore, we examined the influence of foot sequence to verify the hypothesis of functional asymmetry, i.e., the notion that the preferred limb takes a primary role in the forward progression action, while the non-preferred limb secures stability. METHODS: Fifteen healthy subjects performed two movement tasks (planned termination of walking and voluntary stepping) in two variations of foot sequence (preferred foot and non-preferred foot termination). Three force platforms were used at the end of an 8 m walkway to record ground reaction forces and determine the position of the center of pressure (CoP) and calculate the center of gravity (CoG) using the double integration technique proposed by Zatsiorsky and King (1998). Four maximum peak-to-peak amplitudes of CoP and CoG sway were derived to determine the maximum displacement of the CoP and CoG in the lateral and anterior-posterior directions. RESULTS: In all conditions, vertical and horizontal peak forces of the leading limb were higher than those under the trailing limb. In the anterior-posterior direction, preferred foot termination produced 1) a higher peak force, 2) less CoP displacement, and 3) larger CoG displacement compared to non-preferred foot termination. In the lateral direction, the preferred foot sequence showed 1) a lower peak force, 2) more CoP displacement, and 3) less CoG displacement. Higher anterior-posterior peak force and larger CoP and CoG displacements were found in walking compared to stepping. One exception was the larger lateral displacement of the CoP in stepping, which could be explained by an increased lateral shift of the CoP when initiating a step from a standstill. The contrast between the two foot sequences in the forward direction was significantly higher in walking compared to stepping while placing the leading limb. After final foot placement, no significant differences were detected between tasks or foot sequences. CONCLUSIONS: The first limb to come to a standstill in the final foot position contributes most to the braking force for stopping; the trailing limb plays a minor braking role while securing stability by widening the base of support. Clear differences in produced forces and CoP and CoG displacement support the hypothesis of functional asymmetry. The larger forces and displacements in walking as compared to stepping might be caused by the higher velocity momentum of the body that

needs to be nullified. After both limbs are placed in the final foot position, the same mechanism of maintaining balance seems to be used, independent of task or foot sequence. These findings have implications for standardization in clinical testing.

G - Modeling, Robotics and Biomechanics

P1-G-154 The effectiveness of gait excercise using rehabilitation robotics HAL for the patients with hemiplegia

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BACKGROUND AND AIM: The Hybrid Assistive Limb (HAL) has been developed by Cyberdyne, Japan. This is one of the most popular rehabilitation robotics in Japan which assist the motion of the hip and knee joint by operating the motor unit based on the information of active potential of the muscle, center of pressure (COP), and degree of the range of motion (ROM). We have been applying this device for the patient in our rehabilitation unit. The purpose of this study was to prove the effectiveness of the device applying for the patients with hemiplegia during gait exercise. METHODS: Three patients were recruited in this study. They were the patients with hemiplegia due to cerebral vascular accident. The gait analyses for them were performed by using six force plates (AMTI, USA) and eight cameras of VICON MX (Vicon, England). The task for the patients was gait analysis with their adequate speed before and after the thirty minute gait exercise with HAL. The data were obtained for five times, and their average parameters were calculated, which were the change of the degree of ROM of their hip, knee, ankle, and trunk, and the lateral sway of the center of gravity (COG). RESULTS: The COG was tend to sway to the affected side. As for the ROM of the hip, there were no differences of extension while the increase of flexion. As for the flexion of trunk, there were no differences of ROM between before and after gait exercise. CONCLUSION: We assumed that the gait exercise using HAL stimulated the patients to sway their COG to affected side during the stance period of the gait cycle. Simultaneously, it also facilitated the motion of hip flexion without the compensate motion of posterior tilt of the trunk.

P1-G-155 Mathematical modelling and simulation of the lower limb during gait analysis

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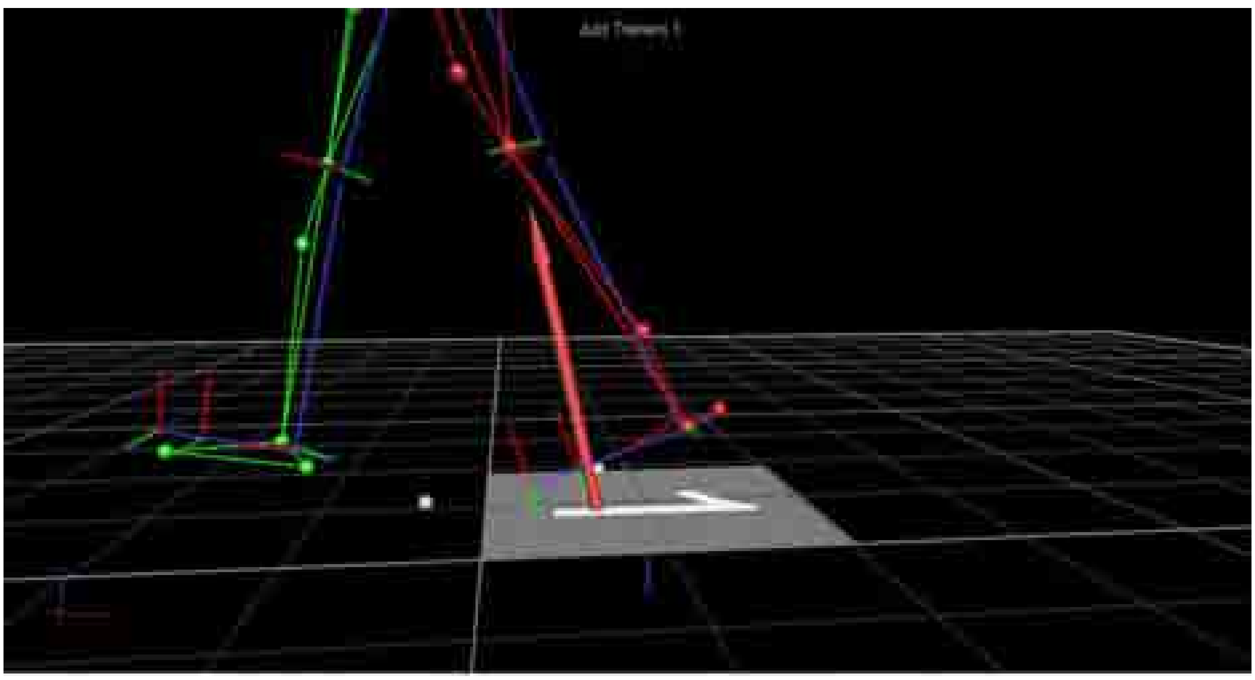
BACKGROUND AND AIM: In this study, the main objective is to look at human motion modelling using experimental motion data recorded and analysed by Vicon camera system in Gait Laboratory, wireless surface electromyography (EMG) electrodes and Matlab® software. Laboratory experiments were conducted between non-sporting and sporting people i.e. gymnasts and athletes etc. Experimental results were expected to be different between athletes and control subjects regarding the impact on joints and muscles of landing. Landing is a common motion in athletes' training and competitions, and it

is also where injuries can arise. This project focuses on the reaction of muscles and joints in landing in a human's lower limb. Furthermore, to prevent athletes from acquiring injuries by using EMG signals would be another objective. Suggesting that by alteration of technique, injury-preventing methods could be applied or suggesting whether uses both limbs equally on landing. METHODS: Mathematical models of skeletal muscle play an important role in the simulation of movement, and the understanding of control mechanisms. Although many phenomenological and biophysiological models have been developed to represent the dynamics of isolated muscles, the phenomenological modelling approach based on Hill [1] dominates in modelling of musculoskeletal systems for simplicity and low computational cost. RESULTS: Simultaneously, the electromyographic activity (EMG) of both legs is in action. In the session, raw EMG data is collected and it must be normalized to be used as a muscle activational signal input for the muscle models. Normalization process includes rectification and filtering. CONCLUSIONS: Experimental results show us that there is a huge difference between athletes and control subjects regarding the impact on joints and muscles of landing. This is because the athletes are doing more exercise than non-sporting people thus they have stronger, more developed and balanced musculature in the lower limbs. The reliable mathematical model of the lower limb that is created in this project will enlarge the previous studies that have been done before by looking at structural identifiability of model parameters as well.



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P1-G-156 Three-dimensional methods for the study of the coxo-femoral joint, a central joint in the bipedal gait and posture

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BACKGROUND AND AIM: Although numerous primates use bipedal locomotion to some degree, humans are characterized by a permanent bipedalism resulting in strong mechanical constraints on the coxo-femoral joint, especially during one-legged stance. Both stability and mobility are required to ensure a functional interface between pelvis and lower limbs. A precise knowledge of this joint has important clinical implications in advancing hip surgery and functional rehabilitation. Moreover, an understanding of this joint has implication for physical anthropology and may improve our biomechanical understanding thereof in an evolutionary context. An appropriate 3D orientation of the coxo-femoral joint, composed of the acetabulum and the proximal femur, is fundamental to ensure an efficient bipedal gait and posture. The structure of this joint was explored in our study by analysing the 3D orientation of the acetabulum and its relation with the orientation of the femoral neck. METHODS: The 3D orientation of the acetabulum is defined in the literature as the perpendicular to the plane that passes along the acetabular rim. However, the acetabular rim is not regular, thus suggesting a methodological problem. An innovative cadaver study of the labrum was developed to shed light on the questions surrounding the proper method to quantify the 3D acetabular orientation. Digitalisations on 20 cadavers using a MicroScribe system were performed and data were analysed using a custom-designed library in R. Moreover, an accurate determination of the 3D orientation of the femoral neck requires a consideration of its complex architecture reflecting the biomechanical constraints induced by bipedal gait and posture. We modelled the femoral neck using successive cross-sectional ellipses rather than a circular cylinder as it is frequently done. Fifty specimens were used to evaluate this method. The surface geometry of the femoral neck was acquired and used to fit the two models successively. RESULTS: On the one hand, our results suggest that the anterior and posterior rims of the acetabulum form an angle of 156.2° on average, rather than being in the same plane. The value and the orientation of this angle allow us to predict ($p < 0.001$) the orientation of the labrum, a fibrocartilage not present on dry material. On the other hand, the model based on successive ellipses provided a significantly smaller standard deviation than the one based on a cylinder ($p < 0.001$) and reduced the observer-induced measurement error. Based on these results, a tool was developed to propose a semi-automatic determination of the 3D orientation of the femoral neck. CONCLUSIONS: The variations of the 3D orientations of the acetabulum and the femoral neck as obtained were described in a large sample of modern human skeletons. Comparisons with great apes were also performed and relationships between shape and weight-bearing behaviour were explored.

P1-G-157 Reproducibility of segment lengths obtained from a low cost markerless camera system

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BACKGROUND AND AIM: The recent availability of low-cost single camera based systems for 3D vision in for instance the gaming world (e.g. Microsoft Kinect), also provides opportunities for low-cost applications in biomechanics and revalidation sciences. The currently available Kinect software, provides a very simple skeleton (a stick figure model composed of 20 points), with sufficient accuracy for tracking movements in games. The question we investigate is whether this simple skeleton with all its limits provides useful biomechanical information. In a first series of experiments, we investigate the accuracy and reliability of specific joint angles and segment lengths. In this abstract, we compare reproducibility of segment lengths as computed from Vicon and from Kinect. METHODS: Subjects (n=20) were equipped with 31 reflective markers and their motion was simultaneously captured with photogrammetry (8 MXT40 Vicon cameras) and a single Kinect camera. It was verified that the reflective markers did not affect to Kinect based skeleton. Subjects were asked to stand still in anatomical position for 5 seconds (static condition) and to perform a sequence of 10 elbow flexion-extension movements (dynamic condition). One week later, the same experiment was repeated; markers were repositioned by the same researcher. Reproducibility of the segment lengths of right arm, right forearm, right upper limb, trunk, right thigh, right leg, right lower limb, left thigh and left lower limb were assessed using correlation. RESULTS: Averaged over the different upper body parts studied, correlations for the Vicon system were 0.87 and 0.85 in the static and dynamic case respectively. For the Kinect, correlations were 0.92 and 0.89 respectively. Averaged over the different lower body parts studied, correlations for the Vicon system were 0.89 and 0.89 in the static and dynamic case respectively. For the Kinect, correlations were 0.81 and 0.88 respectively. Detailed results for each of studied segments are provided in table 1. CONCLUSIONS: Both the Vicon as well as the Kinect based system show reproducibility for segment lengths. The advantages of the latter system are however important: it is low cost, portable, markerless and can be operated by untrained personnel.

	VICON	VICON	KINECT	KINECT
segment lengths	DYNAMIC	STATIC	DYNAMIC	STATIC
right arm	0.89	0.82	0.90	0.92
right forearm	0.80	0.89	0.84	0.98
right upperlimb	0.89	0.93	0.91	0.90
trunk	0.81	0.82	0.90	0.90
average upper body	0.85	0.87	0.89	0.92
right thigh	0.75	0.77	0.97	0.99
right leg	0.94	0.94	0.78	0.65
right lower limb	0.95	0.95	0.95	0.93
left thigh	0.85	0.84	0.97	0.97
left leg	0.87	0.89	0.68	0.43
left lower limb	0.97	0.96	0.94	0.91
average lower body	0.89	0.89	0.88	0.81

Table 1: correlations between test and retest segment length obtained from Vicon and Kinect.

P1-G-158 Comparing human-inspired artificial vestibular sensor with technical analogue

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BACKGROUND AND AIM: Human biped balancing profits considerably from using a gravito-inertial sensor (i.e. the vestibular system). The same holds true for robot biped balancing [1]. The human vestibular sensor comprises two transducer systems, the canal and the otolith organs, the signals of which are fused with each other for better performance. With the help of the canal signals, the fusion decomposes the acceleration signals from the otolith organs into one set of signals coding head-tilt with respect to gravity and another set coding head linear acceleration. Furthermore, with the help of the otolith signals, the fusion extends the high-pass characteristics of the canal signals into broad bandpass characteristics for the earth vertical planes. Essentially the same procedures are used by engineers to fuse the signals of equivalent technical transducers, i.e. gyrometers and accelerometers. In cooperation between neuroscientists and engineers we asked, how the standard engineering fusion compares to the biological fusion. METHODS: The presumed biological fusion was taken from previous own work [1]. Technically, it represents a version of the so-called complementary filter solution. The engineering fusion consisted of an extended Kalman filtering. Both fusions mechanisms were implemented on one processor unit (mbed NXP LPC2368 platform), both receiving inputs from the same gyros and accelerometers (Analog Devices ADIS16364). The performance of both were tested using translation and rotation stimuli and combinations thereof (eccentric rotations; human amplitude and frequency ranges). In addition a commercial sensor (MicroStrain, 3DM-GX3) was included for comparison (fusion algorithm not disclose). The sensor estimations of the stimuli were expressed as Bode-Histogramms, i.e. in terms of gain and phase. RESULTS: The performances of all three sensors were similar across the human range of kinematics tested. A minor flaw in the Kalman filter solution with eccentric rotations was attributed to imperfect parameter adjustments. However, the complementary filtering required clearly less computational effort than the Kalman filtering. For example, calculation time per cycle was smaller by a factor of 10. CONCLUSIONS: Performance of the presumed biological (complementary filter) solution is similar to that of the engineering (Kalman filter) solution. But it achieves this in a more parsimonious way (possibly the result of an evolutionary optimization). Its technical implementation in gravito-inertial sensors for use in the human dynamic motion range appears to be advantageous with respect to sensor size, costs, and energy consumption. This may apply, for example, to extensions of cochlea-implants by an artificial vestibular system.

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P1-G-159 Solutions for marker-based real-time representation of whole-body centre of mass in transverse plane dynamic balance tasks

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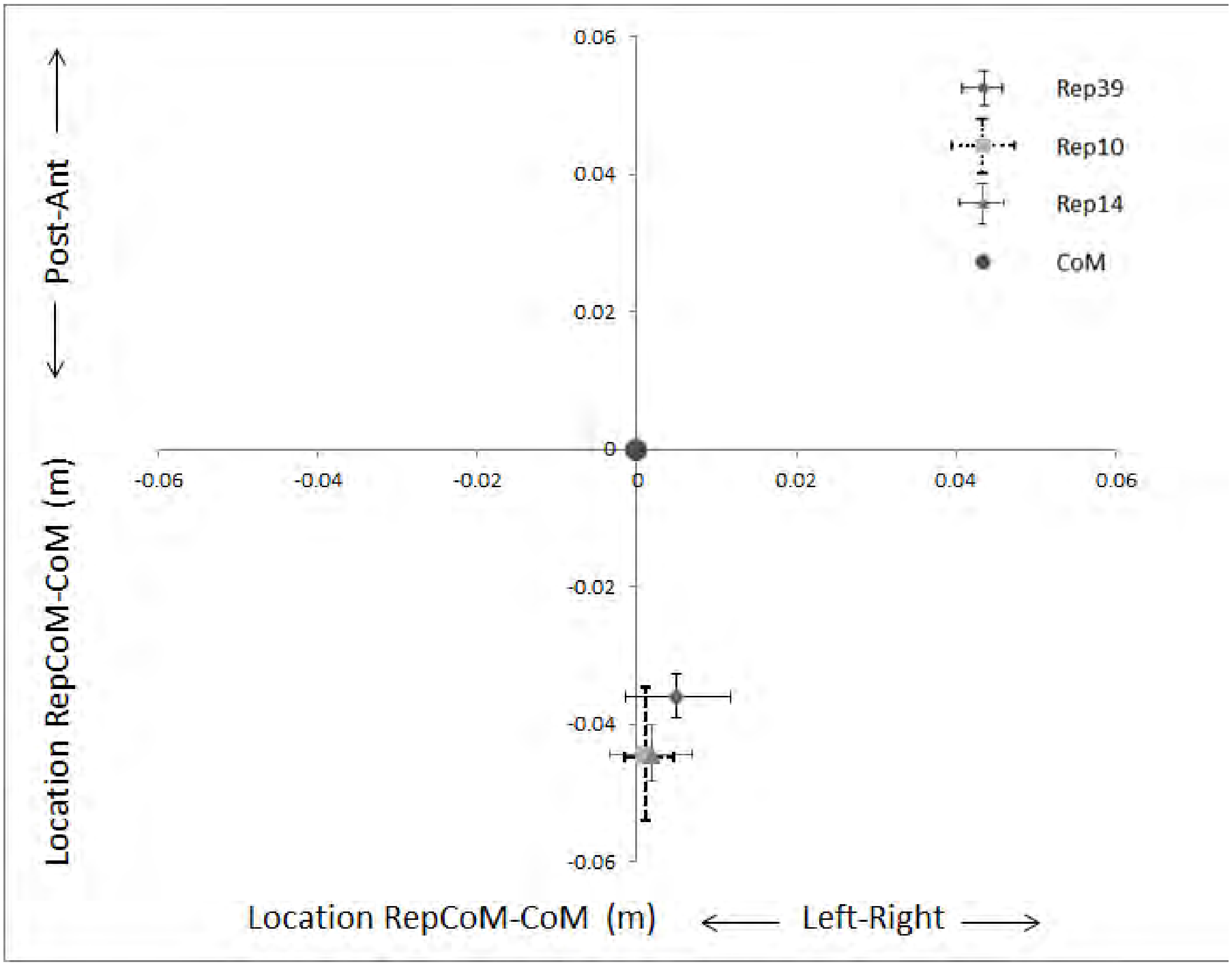
BACKGROUND AND AIM: The behaviour of the projected whole-body centre of mass (CoM) relative to the boundaries of the base of support is a good identifier of the state of equilibrium during human upright standing [1]. This notion offers novel opportunities for assessment and training of dynamic balance in individuals with increased risk of falling due to impairment or ageing, particularly if the CoM can be used for real-time feedback applications [2]. Real-time calculation of the CoM is however not very robust as marker-based kinematic models can be computationally demanding, disappearing markers can prevent calculation of an entire segment, or the time-consuming setup procedure for automatic labelling of markers is not patient-friendly. The aim of this study was to test whether a simple arithmetic mean of (unlabelled) markers can be used to represent the CoM with adequate accuracy. METHODS: 40 healthy older adults (aged 59.3 ± 3.5 yrs) performed a series of dynamic balancing tasks involving tracing a virtual target with CoM for 20 seconds along a widening circle (details in [3]). 39 reflective markers were placed on the body according to the Plug-in Gait kinematic model (Vicon, Oxford). The CoM was calculated in addition to representations of the CoM based on the arithmetic mean of all 39 markers (Rep39). Other CoM representations used 10 trunk markers (Rep10) or 14 trunk and thigh markers (Rep14) as they represent 50% and 70% of body mass respectively. Bias and limits of agreement (LoA) between representations and CoM were analysed using Bland-Altman plots for anterior-posterior (A-P) and medio-lateral (M-L) directions (as in [4]). RESULTS: CoM representations from means were on average located 0.04 m behind the actual CoM, while Rep39 was slightly to the right of the mid-line due to one asymmetry marker on the back (fig.1). LoA's indicated poor performance in A-P for Rep10 against poor performance in M-L for Rep39 and Rep14. Revised Bland-Altman plots demonstrated that the large LoA's represented over- or under-estimations of movement away from the central position (by positive or negative slopes). CONCLUSIONS: CoM representations based on arithmetic mean offer a fair solution for real-time applications. If full-body kinematics is desired and real-time marker labelling is not possible, underestimated deviations from the centre need to be taken into account for Rep39. If real-time labelling of markers is possible, or full-body kinematics is not desired, Rep14 is best in A-P and Rep10 in M-L direction.



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P1-G-160 Analysis of seated postures using orientation sensors

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BACKGROUND AND AIM: In European Union, over 40 % of all employees work at a computer workstation which normally involves sitting. There is no clear epidemiological evidence for a relationship between seated posture and low back pain but an increased risk for pain has been associated with prolonged sitting. The limited evidence may be due to poor evaluation methods. There are no easily applied and direct methods to measure seated postures at workplaces. The aim is to validate the applicability of using orientation sensors to measure seated postures during office work. METHODS: A system using orientation sensors will be validated against a high speed camera system (OQUS) The

orientation sensors consist of 3 directional accelerometers and gyroscopes and the technique has been used in other settings. The system is developed by MT-R&D, University Hospital of Umeå and consists of 5 sensors and 1 wearable collecting device and software. Three different seated postures will be tested in laboratory; 1) Lumbar lordosis, 2) Lumbar kyphosis , 3) Neutral/Habitual sitting. The sensors are applied at the forehead, Th2, Th12, L3 and S2 and attached to the body with elastic Velcro straps and a customized vest. Reflex markers will be attached on the sensors and various landmarks of the body. To also emulate real work conditions two office tasks; 1) regular computer work and 2) handwriting during a self selected seated posture, will be measured and analyzed. RESULTS: The usability of using orientation sensors in field conditions for analyzing seated postures will be presented. CONCLUSIONS: A sensitive system that is easy to use could be valuable in the evaluation for incorrect seated postures during work, for research on exposure but also for individual risk assessments.

H - Tools and Methods for Posture and Gait Analysis

P1-H-161 Refractoriness in a whole-body human balance task

C van de Kamp, P. Gawthrop, H. Gollee, I. Loram

BACKGROUND AND AIMS: For the control of a sustained movement task, such as human balance, continuous peripheral and serial ballistic intermittent mechanisms might be integrated [1]. This implies that for the sustained control of human balance feedback mechanisms not only act continuously “closed loop” but can be intermittently “open”. Intermittent control limits the frequency bandwidth of the human operator and makes it refractory in nature. METHODS: Classic observations by Craik [2] revealed refractoriness in tracking responses to closely spaced pairs of unpredicted, discrete step stimuli. In recent work [3] we employed a new method capable of revealing refractoriness in the control of unstable second-order loads. RESULTS: Applying the method to visuo-manual tracking data we found refractoriness in participants manually controlling and balancing an external load to follow a tracking target. CONCLUSION: Subsequently, it is unclear whether the observation of refractoriness would generalize to other movement tasks. Here we planned to investigate whether evidence exists for refractoriness in the sustained control of human balance.

P1-H-162 From the center of pressure to the center of gravity through a simple calculation

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BACKGROUND AND AIM: The stability and stabilization of a man standing at rest are mechanical properties of the gravity center [CoG], characterized by its position, its speed and its acceleration. However most current studies start from the position of the center of pressure [CoP]. Nevertheless, some methods do exist to evaluate the mechanical properties of the CoG from the position of the CdP, but either they are of no clinical use [1, 2], or they include quite a lot of uncertainties [3-5]. METHODS

AND RESULT: We suggest a simple and rigorous arithmetic method from the mechanical equation of the inverted pendulum [2]: P = G kG'' which is verified for the N sampled CoP positions. Therefore, expressing G'' according to G, one can write a set of N equations with N 2 unknown terms, the numeric solution of which is possible in the case of the stabilometric signal, though subject to an uncertainty of which it is proved that it doesn't spread beyond two seconds of the first and last values of G. CONCLUSION: This method gives an excellent result for the man standing upright at rest, for whom the inverted pendulum model is the first level of approximation; and simulations of more complex models show that this method gives a very good approximation of the CoG, compared to the other methods.

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P1-H-163 Gait deviation during combined vestibular and visual stimulation in the roll plane

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BACKGROUND AND AIM: Human gait involves multimodal processes. Proprioceptive, visual and vestibular inputs modify gait. Galvanic vestibular stimulation (GVS) induces body sway and gait deviation to the anodal side of stimulation[1,2]. Visual motion stimulation (VMS) in roll also induces gait deviation in the direction of pattern motion[3,4]. Functional imaging has shown that vestibular input causes deactivation in the visual system and vice versa. Patients with bilateral vestibular failure (BVP) do not show visual deactivation. This was postulated as a permanent shift to the visual system[5,6].In the present study we examined the interaction of GVS and VMS and its influence on gait performance in healthy subjects. METHODS: 12 healthy subjects (5 females, aged 26-38 years, mean 29,9±4,1, one left hander) were examined in a gym (10x6m). GVS was applied at mastoid processus (direct current, 0.9-2.5mA) with left and right anodal stimulation. VMS was applied by a whole visual field random dot pattern rotated constantly in roll at /-15 degree/s. Gait deviation was measured by a stereo camera system detecting a light-emitting infrared diode fixed at the back of the subject. All subjects did three runs for each of the following conditions: without any stimulus (=baseline), GVS and VMS convergent, GVS and VMS divergent. For analysis angles of deviation were calculated. Eye movements were detected by videooculography (VOG). RESULTS: 1. In the convergent condition, gait deviation differed significantly from baseline ($p<0.0001$; post hoc: right: $p<0.05$; left: $p<0.05$). There was no significant difference between baseline in the divergent condition ($p=0.076$). 2. Gait deviation was larger for convergent compared to divergent stimulation (right: $p=0.019$; left: $p=0.012$). More torsional eye movement was seen in convergent condition. 3. Differences of angles of gait deviation between right and left stimulation were larger for the convergent condition ($p=0.019$). CONCLUSION: Visual and vestibular stimulation during gait influence each other. If inputs are convergent there is a summation of effects in

healthy subjects. If inputs are divergent effects on gait are diminished. This paradigm will be helpful to investigate visual-vestibular interaction in patients with sensory deficits.

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P1-H-164 A dual task paradigm for assessing older adults? stepping down performance - a test-retest reliability study

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BACKGROUND AND AIM: Stepping down and stepping backward are common activities in daily life. The ability to maintain standing balance during these activities is important for older adults, especially when they have to perform concurrent cognitive tasks. Once the deficits in performing dual stepping-cognitive tasks are identified, appropriate rehabilitation protocols could be formulated to improve the standing balance in older adults performing such dual tasks. Therefore, aim of this study is to investigate the reliability of a new method assessing the cognitive response and the standing balance of older adults while they step down or backward with or without performing a concurrent cognitive task. METHODS: Seventeen healthy older adults (mean age, 71.8±6.3 years) were recruited by convenient sampling. Participants could walk independently without obvious lower limb deformity or disabling arthritis. Participants were invited to visit the research laboratory twice with one week apart. They were asked to step down or step backward onto a force plate from a 19 cm high platform with their dominant leg, followed by single-leg standing for 10 seconds. A force plate was used to measure subject's postural sway at a sampling frequency of 240Hz. The concurrent cognitive task involved an auditory Stroop test. In the test, "high" and "low" words in Chinese were presented in high and low pitches. Subjects were asked to press the right hand thumb switch on hearing a high pitch tone and press the left thumb switch on hearing a low pitch tone, regardless the meaning of the words. Baseline cognitive response of the Stroop test was assessed in sitting. A total of 16 trials of the Stoop test alone, 4 trials each of stepping down and backward (alone), and 16 trials of the dual stepping-cognitive task were conducted. The response time of the Stroop test and the number of wrong answers were recorded respectively under single- and dual-task conditions. Total sway path, maximum displacement and velocity of the antero-posterior and medio-lateral direction of center of pressure of the subject, as well as the sway area were calculated under single and dual-task conditions. The test-retest reliability of the above outcome measures was assessed by calculating the intraclass correlation coefficient. RESULTS: ICC values of the response time under single- and dual- tasks were 0.706 and 0.877, respectively; while those of the

number of wrong answers were 0.867 and 0.739, respectively. ICC values of the body sway parameters under single-task ranged from 0.635 to 0.917, while those under dual tasks ranged from 0.659 to 0.877. CONCLUSIONS: The reliability of the novel stepping down and backward outcome measures with and without a concurrent cognitive task were moderate to high. These dual-task outcome measures could be used as a reliable method to assess the stepping down and backward capability in healthy older adults while they perform a concurrent hearing test.

P1-H-165 The reliability and validity of a temporal-spatial sitting balance assessment for wheelchair users with spinal cord injury

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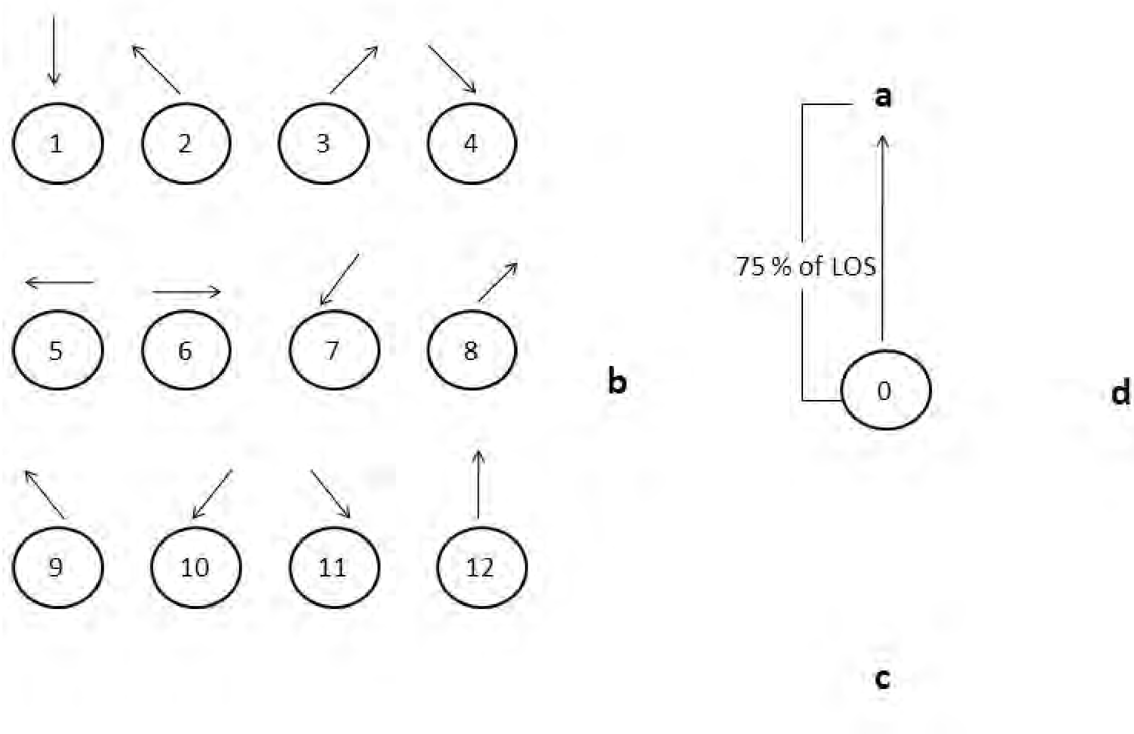
BACKGROUND AND AIM: Sitting balance control is essential for people with spinal cord injury (SCI) because they are often confined to sitting position when performing the activities of daily life. From quiet sitting such as feeding, grooming, bathing to dynamic activities, propelling wheelchair up or down ramp, all level of activities require different degrees of sitting balance control. An objective assessment of dynamic sitting balance control in temporal domain and spatial domain which includes both orthogonal and diagonal movements is badly needed. The aim of this study is to develop a reliable and valid tool to measure the dynamic sitting balance of subjects with SCI. METHODS: Participants were selected (n=11) with SCI between levels C3 and L5 (1 to 40 years post-injury). A temporal-spatial balance task was administered using a centre of pressure (COP) shifting task. The setup consisted of a force platform (90cm×90cm) and an adjustable-height visual display unit (VDU) on which the COP was continuously displayed. Participants performed the balance test, sitting on their own wheelchair (supported sitting) and also on a standardized stool (unsupported sitting) with seven days apart. A target appeared on the VDU which was positioned in front of the participants. Subjects were asked to reach 12 targets appearing sequentially on the VDU by shifting their COP as fast as possible without losing balance. When each target was hit, it disappeared and the next target appeared. A total of 12 targets appeared in four locations (a) top (b) left (c) bottom (d) right from the center and apart from each location (Fig. 1). Amount of the COP shifted to each target was calculated according to 75% of maximal excursion as measured from the subject's limit of stability (LOS). Visual feedback of each subject's COP was provided on the VDU so that subject could adjust their centre of mass position in order to reach the targets. Total time (TT) and directional control (DC) for subjects to sequentially hit the 12 targets was computed. The Spinal Cord Independence Measure III (SCIM III) was administered for correlation with the sequential weight shift test. Nine sub-items of the SCIM III related to mobility were used for the correlation study. RESULTS: The sequential weight shift test was shown to have moderate to excellent test-retest reliability (ICC ranged from 0.688-0.952) with both the wheelchair and the unsupported sitting. Significant correlations were found with the SCIM III mobility scores (TT r=-0.829, p=0.011; DC r=0.849, p=0.033 in support sitting; TT r=-0.823, p=0.044, DC r=0.927, p=0.024 in unsupported sitting). CONCLUSIONS: The sequential weight shift test was found to be a reliable and valid tool for assessing the dynamic balance control of subjects with SCI. Both temporal and spatial outcome measures are

correlated with the SCIM III score. The dynamic sitting balance test can provide an objective balance measurement for subjects with SCI.



P1-H-166 Familiarization period on gait spatio-temporal parameters in Facioscapulohumeral Muscular Dystrophy patients

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BACKGROUND AND AIMS: Gait analysis techniques generally performed in laboratory are expensive, time consuming and require technical expertise. More recently, new evaluation tools like the GaitRite walkway system provide friendly-user use. Yet, laboratory environment gait analysis like treadmill walking (1), might alter gait patterns and require an adaptation time. Besides, some patient groups may experience high rate of fatigue that can deteriorate gait distance. The present study investigated whether spatio-temporal gait parameters measured with a GaitRite walkway system would necessitate a familiarisation time and would be impaired by fatigue in patients with facioscapulohumeral muscular dystrophy (FSHD). METHODS: Six adults with FSHD and four healthy-controls (HC) performed eight trials on a GaitRite electronic walkway, at self-selected speed. Step length, stride length, stance time as a percentage of the gait cycle (GC), double support time (% of GC), speed data, and the functional ambulatory profile (FAP) were obtained and calculated by the GaitRite software. For all subjects together, and for the FSHD group only, the intraclass correlation coefficient (ICC) was calculated to investigate the repeatability between trials. An ANOVA with repeated measures and Bonferroni post-hoc test was used to compare the dependant variables across the trials. RESULTS: All ICCs were above 0.93. The statistical analysis indicates that gait spatio-temporal parameters studied are significantly different between FSHD and HC groups (see Figure 1). There was a significant trial effect but no interaction between trials. Moreover, post-hoc analysis revealed a significant difference between the first and all other trials for both FSHD and HC groups. Finally, there was not any significantly greater gait variability for last trials for each group. CONCLUSION: FSHD and HC participants needed one trial to be familiarised and adjusted. Once the first trial is performed, other trials showed stable gait spatio-temporal parameters. Therefore, FSHD patients do not seem to experience more fatigue than healthy controls.

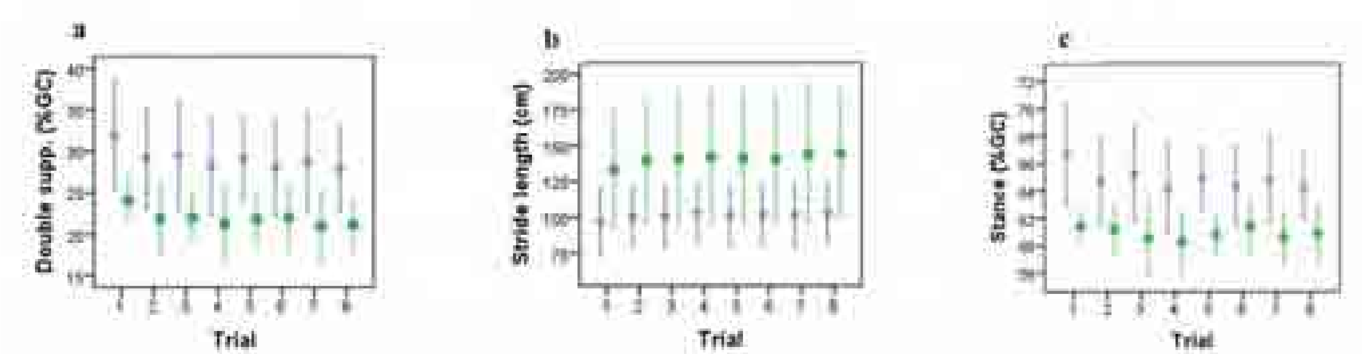

Figure 1. Mean and 95% confidence intervals for (a) the double support time expressed in percentage of GC; (b) the stride length (in cm); (c) the stance time expressed in percentage of GC

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P1-H-167 Concurrent validity of a combined accelerometer and gyroscope system for the measurement of temporal gait parameters in young and older adults

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BACKGROUND AND AIM: Technical progress has made possible using a miniature sensor unit contained accelerometer and angular rate gyroscope. We proposed the original method determining temporal gait parameters by combining the acceleration and the angular velocity data. The aim of this study was to examine the concurrent validity of the combined accelerometer and gyroscope system with the standard system using force sensitive resistors (FSRs) for the measurement of temporal gait parameters in young and older adults. METHODS: Acceleration and angular velocity of heel were measured using the miniature sensor units while walking at preferred speed among 10 young adults and 10 older adults. The gait events (heel-contact (HC) and toe-off (TO)) were identified, and temporal gait parameters (step, stride, swing and stance time) were determined combining the acceleration and angular velocity; "acceleration - angular velocity method (A-V method)". The A-V method identified the maximum of vertically directed acceleration as HC, and the first maximum of heel angular velocity on sagital plane as

TO. Those temporal parameters were also determined using the angular velocity data only; "angular velocity - angular velocity method (V-V method)", and using the FSRs outputs. RESULTS: The levels of agreement between A-V method and FSRs method were excellent for step time, stride time and stance time (intra-class correlations (ICCs) between 0.95 and 1.00, limits of agreement (LOA) between 0.73% and 6.73%) in both age groups. However, swing time had lower levels of agreement when compared with others temporal gait parameters (ICCs of left 0.89 and right 0.91, LOA 8.18 % and 10.63% in young; left 0.83 and right 0.83, LOA 7.22 % and 9.71 % in older). The levels between V-V method and FSRs were equivalent to the levels between A-V method and FSRs for step time, stride time and stance time (ICCs between 0.93 and 1.00, LOA between 0.77% and 6.11%), but the levels for swing time was fair-to-good (ICCs of left 0.83 and right 0.87, LOA of left 7.24 % and right 6.40 % in young; ICCs of left 0.79 and right 0.81, LOA of left 7.30 % and right 6.32 % in older). CONCLUSIONS: Our study suggests the combined accelerometer and gyroscope system could provide a valid measurement of temporal gait parameters, and allow the objective and accurate evaluation of gait in clinical condition. The measurement would become more accurate using the method combining acceleration and angular velocity data than the method using angular velocity only.

P1-H-168 Can metabolic energy expenditure be used as indicator of postural control ability?

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BACKGROUND AND AIM: Quantifying postural control ability is a challenging task. Many outcome measures exist but all have limitations regarding sensitivity and ease of interpretation. We propose that in addition to existing measures metabolic energy expenditure could be used as a measure for postural control ability. This measure directly captures the effort for postural control and therefore is easily interpreted as the difficulty experienced by an individual to perform a given postural control task [1]. We tested this proposition by assessing responses in energy expenditure to balance manipulations during upright standing and walking in healthy people and stroke patients, and by assessing the relation between energy expenditure and existing measures of postural control. METHODS: Two separate experiments were performed in which stroke patients and able-bodied subjects participated. In one experiment subjects performed upright standing tasks on a force plate with different balance perturbations (i.e. eyes closed, foam surface, small base of support). In the second experiment postural control during gait was manipulated by walking on a treadmill with and without handrail support. In both experiments metabolic energy expenditure was assessed using respirometry. In addition, for upright standing postural control was assessed using different parameters from posturography [2], while for walking the magnitude and variability of spatiotemporal gait parameters were used[3]. RESULTS: In the upright standing experiment energy expenditure significantly increased by as much as 50% in response to the balance perturbations. This increase was on average twice as high in patients compared to controls. The correlation between energy expenditure and various posturography measures was moderate. Center of pressure sway path length showed the highest correlation (r=0.60). During walking with handrail support energy expenditure decreased by 15% compared to unsupported walking in the stroke group, while it only marginally decreased in the control group. The decrease in energy cost was

moderately correlated with changes in cadence and stride length (r=0.45), but not correlated with changes in variability of these parameters. CONCLUSIONS: It is shown that metabolic energy expenditure could be used as an indicator for postural control ability. This measure is sensitive to differences in postural control performance between groups and between perturbation conditions, and is easily interpreted as it directly quantifies the physical effort for postural control. The moderate correlations of energy expenditure with other measures of postural control seem to indicate that this measure can provide additional and unique information on postural control ability of healthy persons and patients.

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P1-H-169 Harmonic ratios: A measure of physiological asymmetry

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BACKGROUND AND AIM: Harmonics Ratios (HRs) are derived from proxy center of mass (COM) accelerations and have been used to quantify gait smoothness. HRs represent the complex shape of COM accelerations as a single value for a given stride (ie global measure) such that higher ratios indicate greater smoothness. The HR is derived from the frequency decomposition of the time series using the discrete Fourier transform (DFT) based on the fundamental stride frequency. The HRs for each direction (anteroposterior (AP), mediolateral (ML), and vertical (VT)) are calculated as the ratio of the even and odd magnitude coefficients for the first twenty harmonic components of the DFT for a stride and the HRs are averaged across a trial. While the odd components of the AP and VT harmonics have been described as "out-of-phase" signal components, this terminology does not fully explain the relationship between even and odd harmonics. Our aim was to more fully describe the contribution of the harmonic components to the overall signal, particularly the contribution of odd harmonics to the overall shape of the acceleration signal. METHODS: Five women in good health (mean age 37.8 ± 12.28) completed 3 trials of preferred and experimentally-induced asymmetrical overground walking (unilateral limb loading: 1lb, 3lb, and 5lb). Preferred cadence was recorded prior to the test conditions and then maintained for all conditions using a metronome. The HRs were determined from trunk accelerations using a triaxial accelerometer secured posteriorly at the L3/L4 level, and custom-made footswitches were used to determine heel contacts for stride segmentation. RESULTS: The odd harmonics of preferred walking contributed constructively to one step and destructively to the other step in the biphasic dimensions (AP, VT). The result was asymmetry of time and magnitude of the acceleration signal and a lower harmonic ratio (Figure 1). All subjects demonstrated lower HRs in all dimensions during the progressive limb-loading conditions. Across-subject means for AP HRs: preferred, 3.60 ± 0.58, 1lb load, 3.44 ± 0.61, 3lb load, 2.22 ± 0.65, 5lb load, 1.74 ± 0.49; VT HRs: preferred, 4.33 ± 0.57, 1lb load, 4.26 ± 0.36, 3lb load, 2.87 ± 0.77, 5lb load, 2.09 ± 0.35; ML HRs: preferred, 2.83 ± 0.97, 1lb load, 2.61 ± 0.73, 3lb load, 2.07 ± 0.70, 5lb load, 1.69 ± 0.39. CONCLUSIONS: The even harmonic components

represented the symmetrical biphasic characteristics of the acceleration signal, while the odd components contributed to asymmetry in the shape and magnitude of the signal between steps. We suggest that HRs may be better defined, not as a measure of smoothness, but as "a reflection of step to step (interlimb) asymmetries in timing and magnitude of the force experienced by the body during the gait cycle."

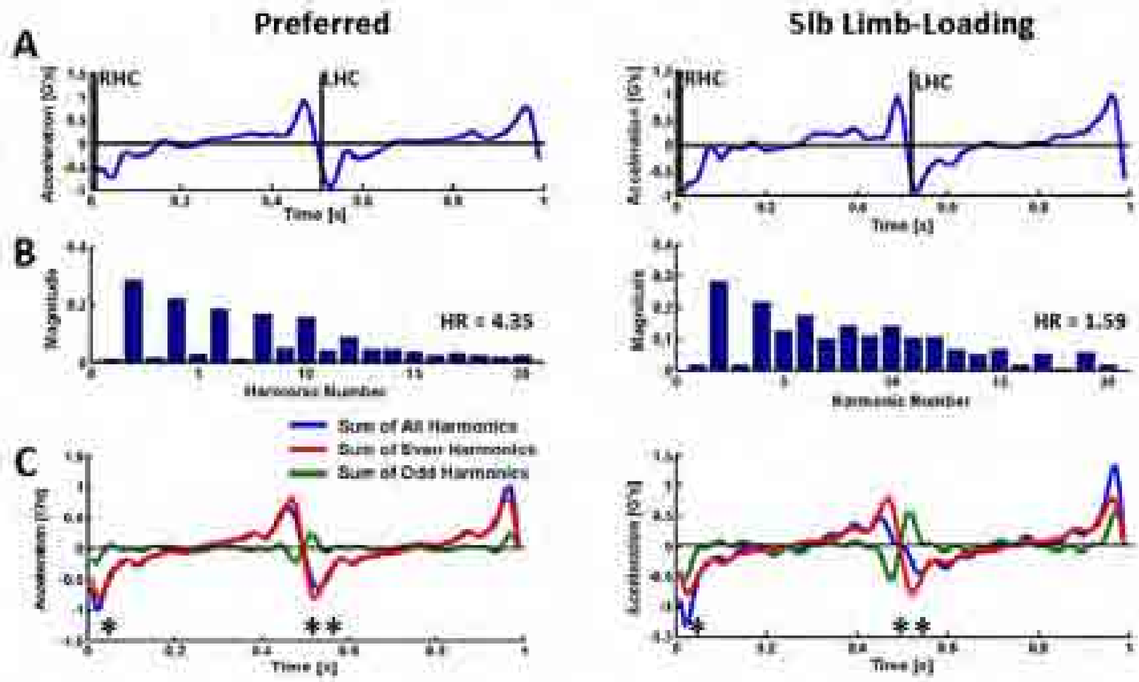

Figure 1: **(A)** A typical AP L3-L4 acceleration over one stride during preferred walking (left) and during 5lb unilateral limb loading (right) for the same subject (RHC – right heel contact; LHC – left heel contact). **(B)** Magnitude coefficients of the harmonic breakdown for the strides in (A). Note the greater magnitude of the even harmonic coefficients and the dominance of the second harmonic in both conditions consistent with the step frequency. Also note the greater magnitudes of the odd coefficients during 5lb limb loading resulting in a lower HR (1.59 versus 4.35). **(C)** Reconstructed signals (blue) from the harmonic breakdown in (B). Note the consistent and symmetrical peak magnitudes in the even harmonic summations (red). The odd harmonics (green) constructively (*) and destructively (**) combine with the even summation (red), resulting in asymmetry in time and magnitude across the steps (blue).

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P1-H-170 Event detection in sit-stand and stand-sit transitions: A hybrid-sensor method versus force-plate based analysis

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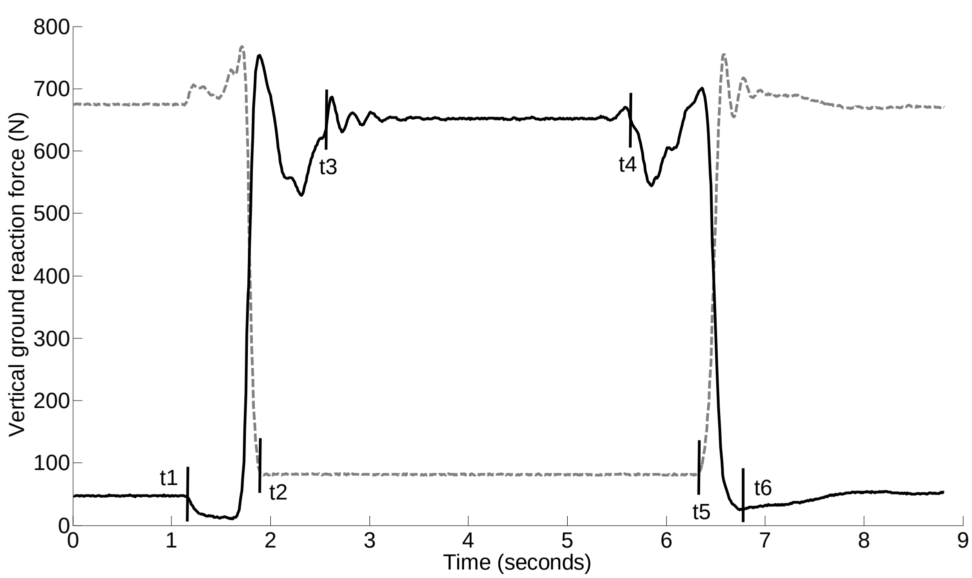
BACKGROUND AND AIM: A single-sensor solution to assess or monitor the performance of standing up (SU) and sitting down (SD) may assist in optimizing interventions for supporting independent mobility in older adults. Insight in the detection of events in the sensor-based data is needed. The aim of the study was to evaluate agreement of event detection and duration estimation in sit-stand-sit transitions based on a novel body-fixed-sensor (BFS) method with a force-plate based analysis. METHODS: Twelve older adults (mean age 70.3, 6 males) and 10 patients with Parkinson's disease (PD) (mean age 70.0, 8 males, Hoehn & Yahr stage 2-3) performed sit-stand-sit movements from a chair. A sensor unit containing accelerometers and gyroscopes (DynaPort Hybrid, McRoberts) was worn with a waist strap at vertebrae L2-L4. The start and end of forward and backward trunk movement was identified from the sine of the trunk angle in the sagittal plane. Positive and negative peaks in the vertical velocity signal were used to discriminate SU from SD. The DynaPort data were sent to the supplier for blinded analysis. The figure illustrates event detection in sit-stand-sit (t1-t6) based on a force plate below the feet (black line) and below the chair (grey line). RESULTS: As determined based on force-plate data, group mean duration of SU with arms crossed for the older subjects and patients was respectively 1.75 and 1.79 s and for SD 1.93 and 1.92 s. Only small time differences existed for the start of forward trunk rotation compared to the onset of SU or SD as detected in the force-plate data. The end of forward trunk rotation had a small and consistent delay compared to seat off, whereas during SD, the end of forward trunk rotation occurred earlier in relation to seat on. Longer SD durations were found for the BFS method because backward trunk rotation ended after movement end as detected in the force-plate data. Between-method ICCs for movement duration were ≥ 0.75, except for SU duration in the patients with PD (ICC=0.61). CONCLUSIONS: High agreement of BFS based event detection of sit-stand and stand-sit transitions with that based on force plates was demonstrated in older adults and patients with mild to moderate PD. Additional evaluations are needed to establish reliability for unstandardized sit-stand-sit performance in different settings and populations.



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P1-H-171 Estimating gait event timing for pathological subjects using a single inertial measurement unit

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BACKGROUND AND AIM: A method based on wavelet transform (CWT) analysis has been previously proposed for estimating gait events using a single inertial measurement unit (IMU) positioned on the lower lumbar spine in young healthy subjects [1]. The aim of this work is to determine if the same method can provide accurate estimates of initial contact (IC) and final contact (FC) timing when used with pathological gait data. METHODS: Seventeen older individuals (14 male, 3 female; age: 77±11 years; stature: 1.65±0.09m; mass: 77±9kg) participated in the study. Seven of them suffered from hemiplegia (HG) and ten from Parkinson's disease (PG). They were asked to walk along a 4m instrumented mat at a self-selected speed to record IC and FC times. One IMU (Freesense, Sensorize, 100 samples/s), positioned over the lower lumbar spine of each participant by a waist belt, was used to acquire linear acceleration components. The vertical acceleration was smoothed by integrating and then differentiating the measured signal using a Gaussian CWT. IC events were identified as the times of the minima of the smoothed signal. FCs were identified as times of the maxima of the signal obtained from a further CWT differentiation. Means, and standard deviations of the absolute differences, and Bland-Altman limits of agreement between measured and estimated events were computed. An independent samples Mann-Whitney U test was used to compare the results for SG and PG groups. RESULTS: All the investigated ICs and FCs were correctly detected by the algorithms, and no differences in the error values were found between the two groups (p= 0.051 and p=0.894, respectively). Absolute errors were 0.07±0.05s for IC and 0.08±0.05s for FC, with lower and upper limits of agreements of -0.04s and 0.18s for IC, and -0.18s and 0.20s for FC, respectively. For about 80% of the analysed events, the algorithms provided an error lower than 10% of the stride duration with a maximum error of 18% for IC and 21% for FC. CONCLUSIONS: The use of a single IMU mounted on a waist belt allowed the proper detection of all the analysed events in both pathological groups, confirming the feasibility of this very simple and low cost approach. The errors obtained with the CWT method had a similar magnitude to those previously obtained using foot switches for hemiplegic patients (3.2 to 12% of stride duration) [1] and using an ankle IMU with Parkinson's sufferers (0.05s at IC and 0.03s at FC) [2]. The accuracy of the CWT method, however, needs to be improved for applications requiring a higher level of detail. Observed inaccuracies could be due to the "foot flat" motion often observed in elderly and pathological subjects, which could have altered the lower trunk motion with respect to what previously observed in healthy subjects.

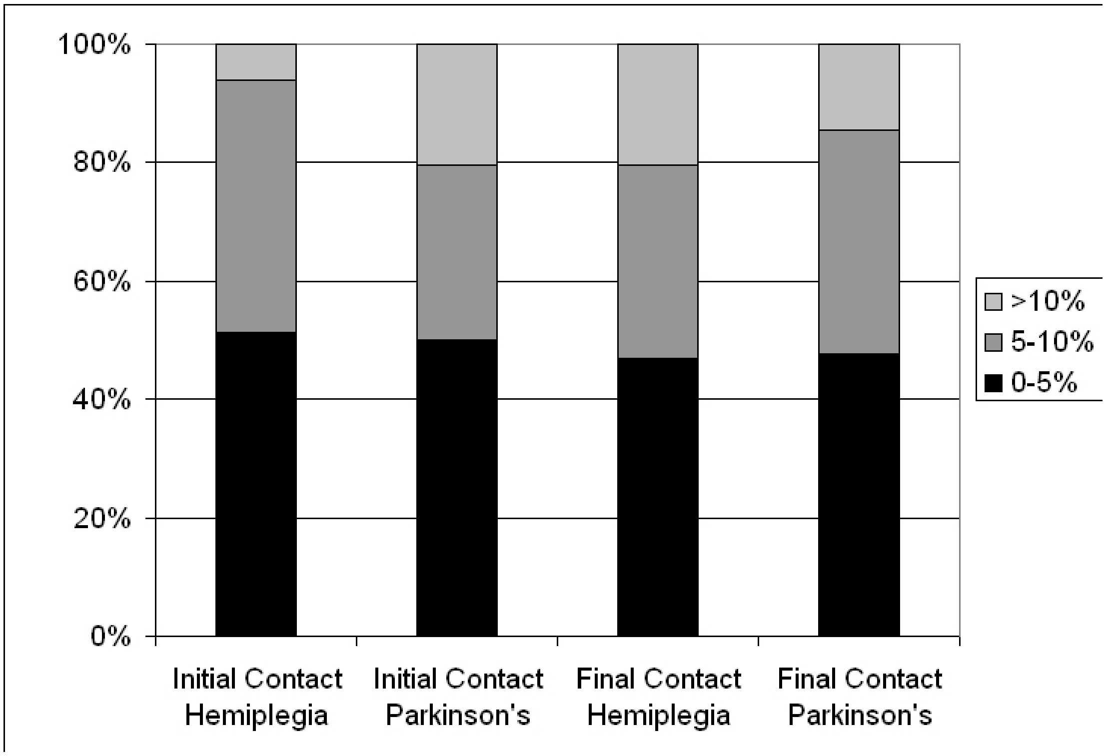

Figure 1: Percentage distribution of event estimation errors expressed as a percentage of the stride duration.

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P1-H-172 Estimate of trunk rotations during walking using gyroscope data

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BACKGROUND AND AIM: This study proposes the use of a Weighted Fourier Linear Combiner (WFLC) algorithm [1] to estimate trunk rotation angles during walking using the three angular velocity components measured by an inertial measurement unit (IMU). The WLFC method enables the determination in real-time of the rotations around three local orthogonal axes defined relatively to their initial orientations (pitch (P), roll (R) and yaw (Y)). Since the method is based on the analytical integration of a Fourier series, it is suitable for the analysis of quasi-periodic movements such as gait [2].
METHODS: In each sampled instant of time i, the algorithm identifies the coefficients of a Fourier series Fi that minimise the squared difference between the measured angular velocity (Ωi) and its estimate (Fi) [3]. Since the algorithm does not rely on a-priori knowledge about the expected angular velocity, all the amplitude coefficients are initially set to zero. The frequency of the fundamental harmonic is set to be close to the expected step frequency. After identification, Fi, (i=1 ... N) is analytically integrated and P, R and Y estimated. Twelve able-bodied individuals volunteered for the study (6 males and 6 females, 24-

64 years). An IMU (Freesense, Sensorize srl) was located on the lower back of the subjects. Three reflective markers were attached to the unit case and their reconstructed position using stereophotogrammetry (Vicon MX) defined a marker-cluster local frame. Volunteers were asked to perform three walking trials (40s each) on a treadmill at their natural speed of progression (NS, measured over the ground), at 80% of NS and at 120% of NS. The angles P, R and Y were then estimated using the IMU data and the proposed algorithm and, also, using the stereophotogrammetric data. The latter values were taken as the true values. Thus, the accuracy of the proposed algorithm could be assessed using the Root Mean Square difference (RMSD) and the correlation coefficient (r) between the above-mentioned two sets of angle values. RESULTS: The algorithm took approximately 10 s to estimate its parameters, after which data could be used for the analysis. Results obtained for all trials are presented in Table 1. CONCLUSIONS: The WFLC method provides estimates of the IMU instantaneous orientation and thus of the trunk lateral and frontal bending and torsion angles during walking on treadmill certainly adequate for most applications. During over-ground walking the method is expected to give the same results. A limit of the method is the time required for the stabilisation of the parameter values. Further studies are needed to determine how well the algorithm performs for other quasi-periodic motor tasks.

walking speed	P		R		Y	
	RMSD	r	RMSD	r	RMSD	r
fast	0.8°±0.4°	0.92±0.01	0.6°±0.2°	0.87±0.01	0.4°±0.2°	0.97±0.01
normal	0.9°±0.5°	0.85±0.30	0.7°±0.4°	0.85±0.23	0.5°±0.4°	0.92±0.13
slow	0.8°±0.4°	0.92±0.07	0.6°±0.1°	0.86±0.04	0.4°±0.1°	0.95±0.03

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P1-H-173 Measurements of pelvic rotation by use of body worn sensors

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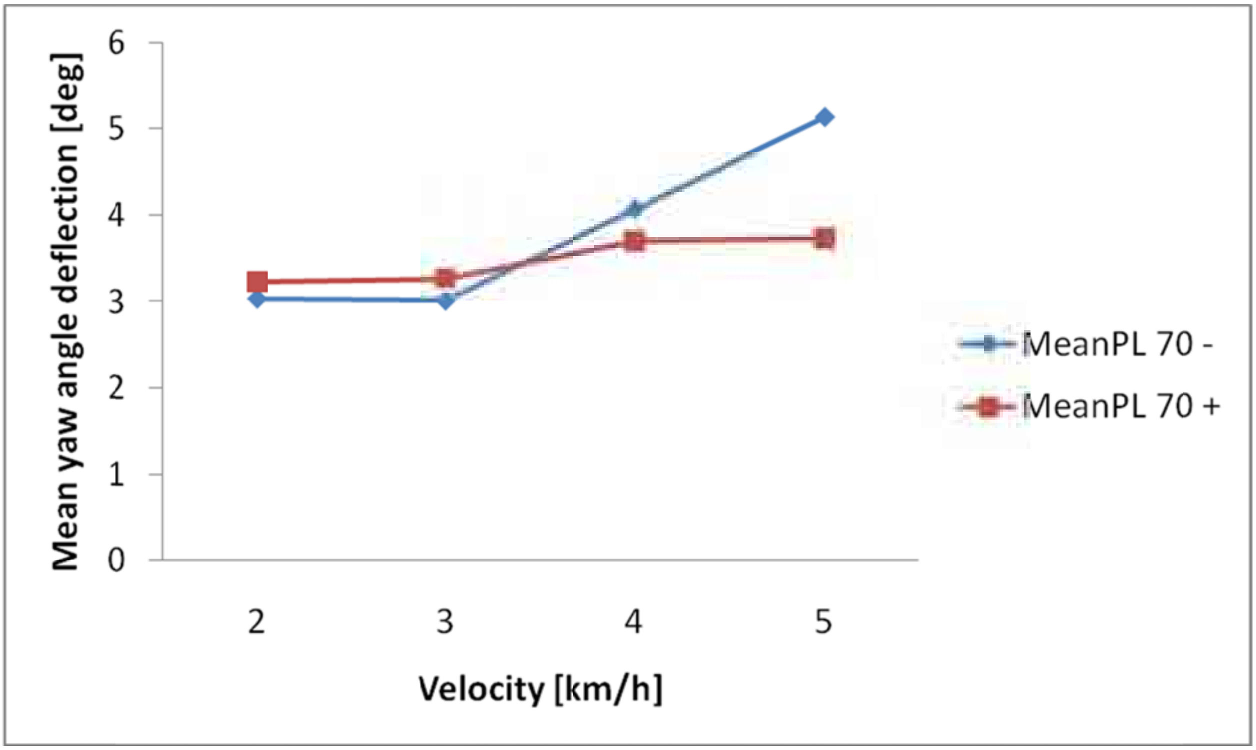
BACKGROUND AND AIM: Body worn sensor systems to quantify human movement patterns have mostly focused on kinematic data and to a limited extent orientation data. Allum et al. used angular velocity data to analyze balance and gait. The aim of this study was to investigate pelvic rotation (yaw angle) by use of an Inertial Motion Trackers (IMU (MTx, XSens)), and assess how yaw angle relates to age and gait velocity. METHODS: Two groups of subjects were included: 11 younger (mean age 41.1 ±14.7 years) and 9 older subjects (mean age 74.8 ± 3.8 years). Each subject performed two test sets. In the first part of the procedure MTx-sensors were attached between the shoulder blades and on the pelvis (between the PSIS), respectively. The measurements were validated by use of a 3D camera system (Vicon). A full body retro-reflective marker model was used in addition to markers on the MTx-sensors. The subjects were asked to walk on a treadmill at 4 different velocities (2, 3, 4 and 5 km/h), 1 minute at each velocity, wearing a ceiling mounted safety harness. In the second part of the experiment, the upper MTx-sensor was placed on the lumbar region, and not between the shoulder blades. Data collection, signal processing and analysis were performed by use of in-house technology and Matlab 7.6. RESULTS: For the younger subjects, the deflection increased notably with velocity, but for the older subjects the deflection was almost the same for the four velocities (see Figure). The standard deviations for the two groups were similar. CONCLUSIONS: This study showed that IMUs can be successfully deployed for measuring the yaw angle of the pelvis in gait analysis and that yaw angle deflections vary with age.



P1-H-174 Test-retest reliability of local dynamic stability when walking long distances and multiple short episodes

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BACKGROUND AND AIM: Short term local dynamic stability (LDS) could be a useful measure to identify individuals with balance impairments. LDS is shown to be decreased in fall-prone elderly and when balance is experimentally impaired, although this has only been found at the group level [1, 2]. For clinical use, differences at the individual level should also be detectable. Therefore, we investigated test-retest reliability of LDS within and between days and assessed the smallest detectable difference (SDD). In addition, we compared between-day reliability over long distances and multiple short episodes, as patients might not be able to walk long distances consecutively. METHODS: Twenty healthy subjects walked 2x500m and 40x20m at preferred walking speed on an outdoor footpath, on two non-consecutive days. We measured 3D linear trunk accelerations (Minimod, McRoberts, the Netherlands) with a sampling rate of 100 samples/s. To quantify LDS a state space, i.e. a set of vectors describing the kinematics at every point in time uniquely, has to be reconstructed. We explored several state space reconstruction methods used in literature for gait analysis, and concluded that a state space comprised of 3D-accelerations and their first and second order time-delayed copies yielded most reliable results. A bootstrapping procedure was used to assess test-retest reliability of increasing numbers of short episodes. RESULTS: For the 500m trials, LDS calculations resulted in relatively high within-day test-retest reliability (ICC=0.8) and a smallest detectable difference of 12% of LDS. However, between-day test-retest reliability was much lower, with an ICC of 0.58 and SDD of 20%, which could be due to measurement error or true biological variation. Preliminary analysis of the first 21 short episodes shows between-day ICCs ranging from 0.22-0.63 and SDDs from 24-63% depending on the number of episodes averaged. After 9 episodes, the increase in ICC (0.58) and decrease in SDD (28%) appears limited, as can been seen in the figure. Further analysis is required to show the optimal number of short episodes for reliable estimation of LDS. CONCLUSIONS: Since test-retest reliability of LDS is comparable between walking long distances and multiple short episodes, this indicates that multiple shorter episodes can be used to quantify short term LDS. At the individual level, only large differences can be detected, in line with [2]. Overall, due to the influence of biological variation and measurement error, local dynamic stability measures can only be used to detect relatively large changes at the individual level.

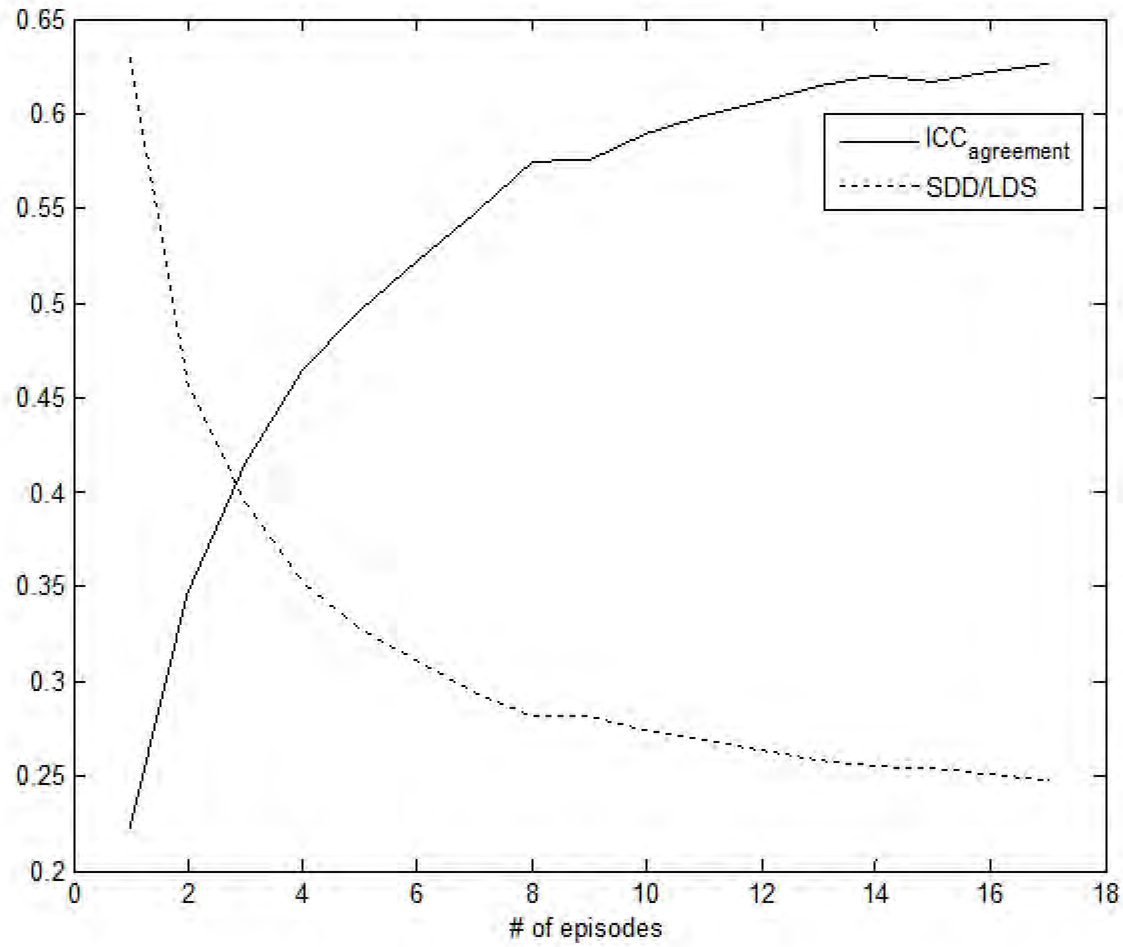

Figure: Bootstrap results; Intraclass correlation and corresponding smallest detectable difference dependent on number of episodes averaged.

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P1-H-175 Evaluation of the FAMP-coach: A tool to optimize the knee axis in clinical gait analysis

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BACKGROUND AND AIM: Three dimensional gait analysis is widely used for clinical and research purposes. The most common model for (clinical) gait analysis is the Vicon Clinical Manager (VCM) model, which is incorporated in the standard Vicon software. However, VCM is highly sensitive to variations in marker placement. Due to inconsistent marker placement, the knee axis orientation is particularly prone

to errors. Therefore, we developed the from Functional Axis to Marker Placement (FAMP) coach [1]. This tool uses a functional method to optimize the knee axis [2], and guides the user to place the knee and thigh markers on their optimal positions. The aim of the study was to evaluate the FAMP-coach protocol with respect to the inter-observer reliability of the knee kinematics during gait. METHODS: An adult with spastic hemiplegic cerebral palsy (CP) and a healthy control were measured by at least six physiotherapists. Each measurement consisted of two conditions of three gait trials. For the first condition, all markers were placed on the anatomical landmarks using the standard protocol for the VCM model. For the second condition, the knee and thigh markers were (re)placed using the FAMP-coach protocol. The mean left knee kinematics of the sagittal, frontal and transverse plane were calculated per subject per physiotherapist. The interobserver reliabilities were determined by the intra class correlation (ICC) and the averaged standard deviation (SD) over these gait cycles. RESULTS: Table 1 shows the ICC and SD of the sagittal, frontal and transverse plane knee kinematics for the VCM and FAMP protocol for both the control and CP subject. CONCLUSIONS: The interobserver reliability for the frontal plane knee kinematics was improved using the FAMP-coach protocol. The FAMP-coach protocol could not improve the excellent interobserver reliability for the sagittal plane, nor the poor interobserver reliability for the transverse plane knee kinematics. The latter may be caused by interobserver variability in the shank marker and the pelvic markers, as the FAMP-coach is dependent on the virtual position of the hip joint center estimated with the pelvic markers. In the future, the FAMP-coach may be improved by the use of a functional hip joint center.

Table 1.

Subject	Protocol	ICC			SD (°)		
		Sagittal	Frontal	Transverse	Sagittal	Frontal	Transverse
Control	VCM	0.98	0.44	0.15	2.7	3.7	8.7
	FAMP	0.99	0.80	0.21	2.0	2.4	5.7
CP	VCM	0.97	0.10	0.21	2.8	4.2	9.3
	FAMP	0.98	0.72	0.13	2.3	1.8	10.3

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P1-H-176 Potential utility of using a body-worn sensor in the community-setting to augment the assessment of mobility in cohort studies of aging

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BACKGROUND AND AIM: Community-based cohort studies of aging have generally relied on simple measures (e.g., timed walk) to quantify gait and mobility. We hypothesized that more precise spatial-temporal measures of gait derived from a body-worn sensor (accelerometer on the belt) could enhance standard gait testing in participants' homes. METHODS: 300 participants of the Rush Memory and Aging Project, a community-based cohort study (mean age 83.78±6.9 yrs, 76% female), were recruited from the Rush Memory and Aging Project. Subjects performed 2 8 feet walks, one 32 feet walk, and 2 Timed Up and Go (TUG) trials. During these trials, subjects wore a small, light-weight 3-D accelerometer on their lower back. The signal from the accelerometer was used to derive measures of step-to-step variability such as step and stride regularity, step symmetry1, and various frequency measures2. TUG acceleration measures3 were derived as well. We stratified the participants based the presence or absence of mobility disability (MD) using the Rosow-Breslau scale of mobility disability and compared their gait measures. Multivariate analysis was used to identify differences between groups (MD vs. Non-MD). All analyses were adjusted for age and gender. RESULTS: The groups differed with respect to step and stride regularity, average step and stride duration, frequency measure, and various TUG measures (especially in the Stand-to-Sit sub-task). TUG acceleration duration was significantly higher in the MD group (MD: 22.61±8.62, Non-MD:16.91±3.16, p<0.0001). CONCLUSION: Older subjects with mobility disability walk with increased variability and display less step-to-step consistency. Gait testing with a body-worn sensor in the community-setting provides a wider range of spatial-temporal gait measures which may enhance the identification of older persons with mobility impairments at risk for developing disability.

P1-H-177 Measuring arm swing during gait in patients with Parkinson´s disease using wearable sensors: A feasibility study

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BACKGROUND AND AIM: Reduced arm swing is a known hallmark of gait in Parkinson´s disease (PD). In the clinical setting arm swing has primarily been described in an observational manner that does not lend itself to quantification. Thus, little is known about the magnitude of decreased amplitude or asymmetry and its relation to disease symptoms in PD. The objective of this study was to quantify arm swing amplitude and symmetry during normal over-ground walking in patients with PD using wearable sensors and to compare it to the movement observed in healthy controls. METHODS: Three synchronized miniature arrays of accelerometers and gyroscopes (XSENS Xbus) were placed on the lower back (L4-5 area) and on the proximal wrists of both arms during gait. Patients walked at their self-selected comfortable speed for one minute in a well-lit 25 meter corridor. Data was extracted and analyzed using a custom-made algorithm in MatLab for both range of motion and asymmetry of arm swing. Comparisons were made between left and right arms, affected and less affected arms and results were compared to data collected from a healthy control group. RESULTS: 11 patients with PD (mean age 56.6 ±8.0 years, 7 females, mean disease duration 3.5±2.0 years, Hoehn &Yahr stage: II-III) and 13 healthy controls (mean age 52.1 ±9.5, 9 females) participated in this study. None of the participants reported any upper-extremity orthopedic problems that may impair mobility. 5 patients with PD reported more pronounced motor symptoms on the left arm. Arm swing range was significantly lower in the PD group than in the control group (23.9±14.5 deg vs. 42.5±14.9 deg p=0.03). Among healthy controls there was a tendency for greater arm swing range of the dominant arm as compared to the non-dominant arm (amplitude 50.8±9.9 deg in the dominant arm vs. in the non-dominant 43.2±13.8

deg; p=0.08). Patients with PD demonstrated a significantly higher degree of left-right asymmetry; with mean amplitude of 23.3±14.1 deg on the more affected side and 31.2±22.8 deg on the less affected side (p=0.04). Peak amplitude on the more affected side was moderately correlated to disease duration (r=0.61 p=0.05). CONCLUSIONS: These preliminary results suggest that an automated algorithm based on data from wearable sensors is able to meaningfully quantify arm swing amplitude and asymmetry. Whereas in healthy controls, arm swing asymmetry is likely related to side dominancy, in patients with PD this feature distinguishes between the more affected and less disease affected arms. Additional studies are needed to more fully evaluate clinical utility and the potential of this new approach.

P1-H-178 Physical activity and physical function 4 months after a hip fracture

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BACKGROUND AND AIM: Physical activity (PA) may play an important role for the regain of function after a hip fracture. PA in older adults is mainly performed as part of daily life activities, and measures of total PA during one or several days are therefore expected to be relevant measures of PA in this population. The aim of this study is to investigate how measures of daily physical activity correlate with physical function four months after a hip fracture. METHODS: Data from the first 131 patients from a larger RCT study including 400 hip fracture patients were analyzed. Daily physical activity was monitored continuously over four days by a single axis accelerometer worn on the thigh. As a first step, preliminary analysis of one day was performed. Outcome measures were type of activity (time spent in upright activities), frequency of activity (number of upright events), duration of activity (mean length of upright events) and variability in activity pattern (coefficient of variation in length of upright events). The Short Physical Performance Battery (SPPB) was used to assess physical function at 4 months, being presented as separate scores on chair-stand, balance and gait tests (all scored on a 0-4 scale) as well as the total SPPB score (0-12, with 12 as the best score). Gait speed was derived from the SPPB 4 m gait test. RESULTS: Four months after the fracture participants spent on average 3 hours and 24 minutes (± 2 hours and 22 minutes) daily on upright activities. On average they had 45.8 (±24.0) events in upright during the day and duration of events was on average 4.2 (±2.3) minutes, with variability between events of 121.4 (±36.5) %. Mean total SPPB score was 5.29 (±3.22). Score on chair-stand test was 1.03 (±1.33), balance score was 1.98 (±1.53), and gait score was 2.11 (±0.98). Participants had a preferred gait speed of 0.56 (±0.22) m/s. The physical activity outcomes showed low to moderate correlations with measures of physical function (Pearson's r-vales from 0.32 to 0.61), see Table 1. The highest correlation was found between upright time and total SPPB (r=0.61). CONCLUSION: Upright time correlated moderately with SPPB. Most physical activity outcomes measure a different aspect than measures of function indicating that both groups of outcomes are needed in order to understand factors contributing to functioning after a hip fracture.

Table 1. Correlations

	Speed (m/s)	SPPB (0-12)	Chair (0-4)	Balance (0-4)	Gait (0-4)

Upright time (minutes)	.50	.61	.60	.54	.45
Upright events (no.)	.35	.39	.41	.38	.30
Event length (mean)	.37	.50	.47	.48	.37
Event length (max)	.45	.52	.55	.42	.42
Activity pattern (CoV%)	.40	.41	.45	.32	.33

P1-H-179 Identifying real world activity levels using a novel shoe based sensor

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BACKGROUND AND AIM: Advances in wearable sensor technologies and signal processing techniques may provide the ability to accurately monitor activity levels of people with stroke in the real world as they go about their everyday activities. These devices could be used to assess outcomes in clinical rehabilitation trials and as a method to increase activity through real time feedback. The purpose of this study was to determine the validity of a novel shoe based sensor (SmartShoe) to accurately identify activity levels in people with stroke as they went about their everyday lives in their home and community. METHODS: Twelve people with chronic stroke were recruited to participate. The SmartShoe sensor system consists of a flexible insole with 5 embedded force-sensitive resistors that is worn inside a user's shoe and a 3-dimensional accelerometer that is clipped to the back of the shoe. Plantar pressure and foot acceleration data were sampled at 100Hz and sent via BlueTooth to a mobile phone carried by the participant. Participants were met in their home where they donned and wore the SmartShoe system for 2 hours. A researcher videotaped participants while they went about their everyday activities. A previously developed and validated Artificial Neural Network (ANN) was used to process the pressure and acceleration data to identify time spent in sitting, standing, and walking during the 2-hour period. Intraclass Correlation Coefficients (ICC2,1) and the Bland Altman method were used to determine the validity of the SmartShoe to identify activity levels by analyzing the agreement between SmartShoe identified time in sitting, standing, and walking and actual time spent in these activities identified by a researcher from the video data. RESULTS: There was a moderate to high level of agreement between SmartShoe identified time in sitting (ICC2,1=0.87) standing (ICC2,1=0.72) and walking (ICC2,1=0.80) and actual time spent in these activities. The Bland Altman analysis revealed a mean difference of 590 seconds for sitting, 343 seconds for standing, and 130 seconds for walking between SmartShoe identified time and actual time spent in these activities. CONCLUSIONS: Our findings indicate that the SmartShoe is able to accurately identify when people with stroke are sitting, standing, or walking in their home and community. To the best of our knowledge this is the first study in people with stroke that has validated a wearable sensor's ability to monitor activity in a real world environment by comparing sensor findings to actual activity levels from video recordings. The SmartShoe could be used to assess outcomes in rehabilitation trials and possibly as a means to self-monitor, set goals, and receive behavioral enhancing feedback to increase activity levels.

P1-H-180 Wearable inertial sensors for gait & posture analysis

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BACKGROUND AND AIM: Much of gait and posture research over the last 30 years has been conducted in a clinic or laboratory setting with equipment that requires a large space, considerable investment, and well trained staff. Often subjects are heavily instrumented with an array of sensors that require a lot of time to precisely place and calibrate. These environments and this instrumentation can cause stress and anxiety in subjects, which may impact their performance. METHODS AND RESULTS: The recent availability of low-cost high-performance wearable kinematic sensors offers new opportunities to study gait and posture in natural environments over long periods of time. There are now several devices that are commercially available that can continuously record high-bandwidth data (0-30 Hz or more) from an array of sensors including triaxial accelerometers, gyroscopes, magnetometers, and static pressure sensors. Some of these devices are able to record throughout the entire day, are compact and unobtrusive so that they do not attract unwanted attention, and do not require any interconnecting wires between sensors. Wireless technology permits these devices to synchronize their data capture to ensure precise timing. In some cases sensors embedded in smart phones with built-in data acquisition, GPS, storage, data management, and high-resolution touchscreen interfaces provide a low-cost unobtrusive option for researchers, who benefit from the economy of scale made possible with high-volume consumer electronics. For example, one group recently used sensors in a smart phone to evaluate anticipatory postural adjustments before the beginning of normal gait in healthy subjects. These technologies can also be used therapeutically. By providing feedback either continuously or as a daily summary, people with gait and posture disorders can measure the impact of their therapies and more easily track their progress, which also improves therapeutic compliance. New challenges arise when quantifying gait and posture during normal daily activities in natural environments. The inability to precisely control the environment and conditions can increase variability and bias in the measurements. New algorithms are required with high sensitivity and specificity to detect postural transitions, gait, and posture. Some of these challenges can be overcome through the use of long-term recordings in which the performance can be averaged across many naturally occurring events. CONCLUSION: This new approach to measuring posture and gait offers many new opportunities and challenges for researchers, clinicians, clinical trialists, and patients. This technology is likely to have a big impact on the field.

P1-H-181 Repeatability of sensor based peak power assessment during the sit-to-stand transfer in young female adults

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BACKGROUND AND AIM: Muscle strength and power are related to functional performance in older persons. A recent study demonstrated that the power to lift the center of mass during the sit-to-stand (STS) transfer can be estimated with hybrid motion sensors [1]. For clinical assessment of STS power,

acceptable repeatability is required. So far repeatability of STS peak power assessment based on motion sensors is unknown. Therefore, this study investigated test-retest reliability of sensor based STS performance measures in young female adults. METHODS: Ten healthy young female adults (age: 21.9±1.2 yrs) participated in this study. Three normal and three fast STS transfers were performed during test and retest, which were separated by 5-7 days. STS performance was analysed using a wireless matchbox-sized hybrid motion sensor measuring 3D-accelerations (±2 g), 3D-angular velocities (±300 deg/s), and 3D-orientation in the earth-magnetic-field (±2 Gauss). Data were sampled at 50Hz. The sensor was attached to the right trochanter major femoris. Peak power, duration and maximal jerk were calculated as STS performance measures based on the motion sensor data [1]. The STS performance measures were scaled to body dimensions [2]. Intra-class correlation coefficients (ICC) were calculated to determine relative test-retest reliability and were interpreted as follows: excellent reliability = 0.75; moderate to good reliability 0.40-0.74; poor reliability <0.40. Confidence intervals for the mean difference between test and retest were calculated to investigate absolute test-retest reliability. Confidence intervals containing zero were considered to indicate good absolute test-retest reliability. RESULTS: Table 1. Mean and standard deviation of STS performance measures for test and retest (n=10). Also intra-class correlation coefficients and 95% confidence intervals are shown. CONCLUSIONS: Results demonstrated that average STS duration and average STS peak power calculated based on motion sensor data have excellent relative repeatability and good absolute repeatability in young female adults. Average maximal jerk showed mixed repeatability results. This pilot study shows that sensor based assessment of STS duration and STS peak power are reproducible in young female adults. A similar study with older persons as subjects is in progress.

STS measures	**Test**	**Retest**	**ICC**[a]	**Difference (mean±SD)**	**95% confidence interval**	
					Lower limit	***Upper limit***
Normal STS duration (s)	1.32±0.20	1.30±0.16	0.78	-0.02±0.16	-0.12	0.08
Normal STS duration°	3.15±0.47	3.10±0.40	0.79	-0.05±0.37	-0.28	0.18
Normal STS peak power°	0.85±0.12	0.85±0.14	0.94	0.00±0.06	-0.04	0.04
Normal STS maximal jerk°	0.46±0.11	0.52±0.14	0.74	0.06±0.11	-0.01	0.13
Fast STS duration (s)	0.85±0.11	0.88±0.12	0.91	0.03±0.07	-0.01	0.08
Fast STS duration°	2.02±0.24	2.10±0.28	0.89	0.08±0.16	-0.02	0.18
Fast STS peak power°	1.42±0.24	1.45±0.29	0.88	0.03±0.17	-0.08	0.14
Fast STS maximal jerk°	1.04±0.13	0.89±0.20	0.23	-0.15±0.22	-0.29	-0.01

[a] average measure, two-way mixed, type consistency intra class correlation coefficient.
° dimensionless numbers after scaling to body dimensions.

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P1-H-182 uTUG: A smartphone application for home-based TUG testing

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BACKGROUND AND AIM: The Timed Up and Go (TUG) is one of the most used clinical tests to assess mobility. An instrumented Timed Up and Go makes use of a measurement system (e.g. an accelerometer [1]) to compute a set of parameters able to more subtly investigate balance and gait. We present here a novel Smartphone (SP) application, called uTUG, that makes use of the accelerometer embedded in the SP. The application performs signal processing, computes a set of significant parameters, and sends them to a remote server. METHODS: We implemented the uTUG application on an Android SP to keep all the advantages in terms of high-performance computation and the availability of an open platform; the validity of the embedded accelerometer has been proven in a previous work [2]. A number of state-of-the-art parameters [3], was used to characterize gait and transitions; cadence was computed by identifying the heel strikes [2]. uTUG has a friendly interface designed to account for usability of older users, with only a "Start/Stop" button. At the "Start" the application starts collecting accelerometer data. At the end of the test, by pressing the Stop button, the data acquisition is quitted and the data processing starts. All the parameters are calculated and stored in the SP. The application also includes the possibility to "guide" the subject in the test: it automatically detects when the subject is sitting quietly, at the beginning and at the end of the test, and provides him/her an audio cue acting as a start/stop trigger command. The sit down detection is obtained by means of a threshold on the 3D acceleration module. uTUG also allows to automatically send to a remote server (via SSL connection) the raw data acquired and the TUG parameters calculated. We examined 49 healthy adults (59±16 years) wearing the SP (Motorola Droid 2) on the lower back by means of an off-the-shelf case belt. At the end of each TUG the accelerometer raw data and the parameters were sent to a remote server equipped with MATLAB. We compared parameter values calculated by the uTUG application and by the MATLAB implementation of the algorithms. RESULTS: The results (Table 1) show that uTUG application calculates the same values calculated by the MATLAB algorithms. We observed that the thresholds used for the automatic start/stop audio cue are effective, at least for healthy subjects. CONCLUSIONS: uTUG application is easy to use and the audio cue for the "automatic start/stop" command can be considered as an added value for its use in the home environment. The remote transmission of raw data and TUG results are useful both in terms of a remote check of subject's mobility and for the automatic creation of a database of TUG data which may find future applications in fall prevention.

a)

b)

Table 1

PARAMETER	MA Values Mean Value (Standard Deviation)	(MA – uTUG) Values Mean Value (Standard Deviation)
Total Duration [s]	18,68 (3,66)	0 (0)
Sit to Stand Duration [s]	1,36 (0,32)	0 (0)
RMS Acc. AP Sit to Stand [m/s²]	1,87 (0,56)	7,9014e-10 (4,8401e-09)
RMS Acc. ML Sit to Stand [m/s²]	0,98 (0,18)	2,4180e-08 (1,3524e-08)
Max Acc. AP Stand to Sit [m/s²]	1,23 (1,32)	3,4044e-08 (7,5138e-08)
Gait Duration [s]	13,50 (3,03)	0 (0)
Mean Cadence [s]	0,37 (0,06)	0 (0)
Cadence Standard Deviation [s]	0,05 (0,03)	0 (0)
Cadence Coefficient of Variation [%]	8,55 (5,33)	0 (0)
Maximum overall computation time of the smartphone: 1 second; it depends on the Smartphone CPU and memory loading at that moment.		
MA: MATLAB algorithms implementation; **uTUG**: uTUG algorithms implementation; **Acc.** = Acceleration; **AP** = Antero-Posterior; **ML** = Medio-Lateral; **RMS** = Root Mean Square;		

Figure 1: a) uTUG Home Screen; b) Comparison between parameters values calculated by the uTUG application and by the MATLAB implementation

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P1-H-183 Learned-non use of the paretic foot in gait after stroke: Evidence from a study on joint power

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BACKGROUND AND AIM: Over a century ago Sherrington demonstrated in monkeys that a deafferented upper limb is doomed to loose motricity, which can be recovered if compensation through the spared limb is prevented. Taub named this phenomenon "learned-non use" (LNU). The author based his observation on the discrepancy between bedside examination and the showy limping of most stroke patients. In hemiparetic gait it is known that the power provided when the paretic limb is in rear position is 3 to 5 times lower, compared to the next double-stance. Yet, to date no proof is available that this asymmetry reflects LNU of otherwise recruitable muscles. In this work, a study on joint power during walking with flexed knees ("crouch" gait), gives support to this hypothesis. METHODS: Six healthy adults were enrolled as controls. A sample of five stroke patients were studied. The subjects had to walk on a split-belt force treadmill. EMG from lower limb were recorded wirelessly. A comfortable speed for most hemiplegic patients on the treadmill was 0.3 m/s. Once equipped, the subjects were requested to walk on the treadmill at a speed of 0.3 m/s. The walking trial was repeated with knees held at about 30° flexion. One series of 6 strides was analyzed. No subject reported unbalance or discomfort. Only the joint power in the sagittal plane is considered. For each muscle group, the sign of the power output (positive during muscle shortening, negative otherwise) was identified by the direction of joint rotation (e.g. positive power is assumed to be provided by the plantar flexor muscles, if the analysis of ground reaction forces led to evidence of power making the ankle to rotate towards flexion). RESULTS: Controls: stride length and stride periods ranged 0.46-0.53 m and 1.61-1.78 s. Compared to spontaneous gait, crouching entailed a 65% increase of ankle peak power. Patients: the stride length and periods on the "affected" step were 0.17-0.29 m and 1.20-1.32 s. Compared to controls, the ankle power was on average 37% lower on the affected side and 33% higher on the sound side. Power on the affected side was 54% lower compared to sound side. Compared to controls, the ankle power was 9.6% lower on the affected side and 23% higher on the sound side. Power on the affected side was 26% lower compared to sound side. Compared to spontaneous gait, crouching entailed a 145% increase of ankle peak power on the affected side, and a 54% increase on the sound side. CONCLUSIONS: During hemiplegic gait virtually no power is provided at the ankle of the paretic lower limb. By contrast, during crouched gait the ankle resumes its propulsive role, through an active plantar flexion and an appreciable power output. The asymmetry is remarkably reduced. This indicates that lower limb weakness at least partly stems from an adaptive behavior fostering the use of the sound lower limb, despite an available residual power from the paretic limb.

P1-H-184 Contact force computation from inverse dynamics: Application to gait analysis

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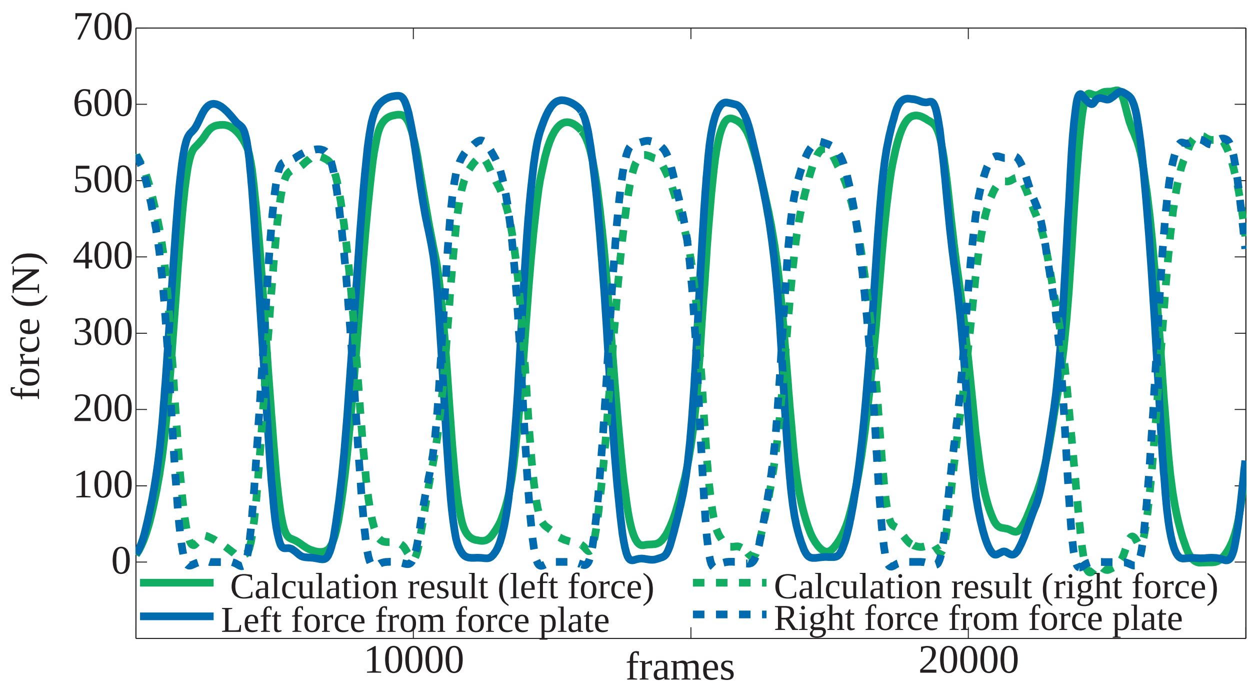
BACKGROUND AND AIM: To understand gait, motion data and contact forces on the ground are crucial. Conventional approaches use motion capture and several force plates. However, when right/left information is needed, the use of force plates is difficult. In particular when each foot must step on different force plate or curve trajectories are required [1],[2]. Wearable devices offer a solution to this issue, still they are not recommended for patients, as unconsciously gait becomes awkward. Minimal and natural equipment is thus desired. Indirect measurement or computation of the ground reaction is strongly needed. In precedent studies, we developed a method to identify the dynamics parameters of the body [3], using the motion data and one force plate. Using the identified parameters it is possible to accurately compute the generalized forces. Here we propose to separate this generalized effort into the contribution of the right and the left leg, in order to estimate the external force at each contact point. During single support phase it is trivial to compute the ground reaction force. However, the distinction is non-trivial when there is more than one contact point. We propose an algorithm that outputs ground force of both legs regardless of the use of force plates. METHODS: We estimate the contact force at each foot using the position of the CoP, and the position of the foot markers to determine the contact condition. During double support phase we divide the ground force by a ratio with the position of the right and left foot and the position of the CoP in each state. Because the vertical force Fz occupies most of the ground force we work only on the vertical component in this study. By comparing it with ground force from force plate, we inspect the validity of the algorithm. RESULTS: A valid subject is used to validate our algorithm. Motion capture data for computation, as well as force data for validation are recorded. The figure shows the comparison graph of the real vertical floor force (measured by two force

plate) at both feet, with the floor force that is estimated with our proposed method. The estimation of right/left contribution in the vertical contact force using the CoP position is successful. However the extrema are slightly under- estimated. This can be attributed to the error in the contact condition estimation and filtering effects. CONCLUSIONS: We proposed and validate experimentally a method to estimate vertical ground force at each foot using only motion measurements. The results are satisfying; and of great importance for gait analysis. However, the contact condition needs refinement to estimate perfectly the extrema of the force. In addition, we will extend our research to estimate simultaneously the other components of the contact force.



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P1-H-185 Recognizing emotions conveyed by human gait

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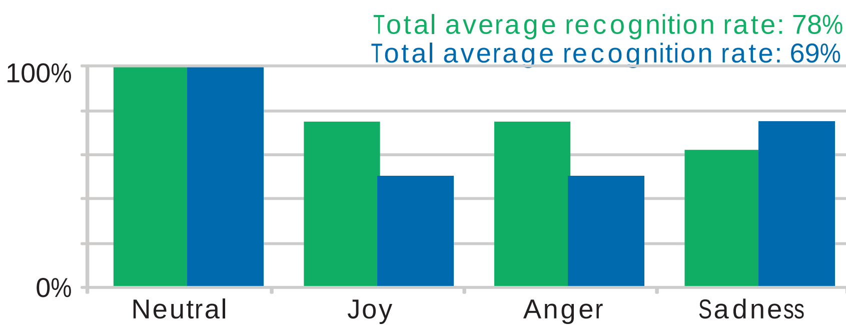
BACKGROUND AND AIM: Human emotion is an active field of study [1-3]. Gait is radically affected if one feels scared, happy, sad, angry or normal [4-5]. Intuitively, one recognizes these conveyed emotions [6]. Most of the gait studies make use of stance phase, gait cycle frequency, footsteps length, that can be easily measured [7-8]. It is important to develop algorithms to capture the emotional information. Our aim is to provide a formal study based on objective criteria to discriminate emotions [9] conveyed in gait. We base our computations on the joint angles and generalized coordinates and develop an

algorithm to identify the conveyed emotion. METHODS: We record the walking motion of 4 subjects, using a marker-set which is a custom version of the Vicon Plug-in Gait, with 4 additional markers around the neck to enhance upper body motions capture. It is difficult to provoke emotion, due to the dynamic interactions between cognition and basic emotions, thus the subjects are professional actors. They walk while simulating emotions: Neutral, Happiness, Anger, Sadness. Each motion is repeated 5 times to obtain 80 motions. The data is processed as follows: 1) Geometric model computation 2) Inverse kinematics to obtain 34 joint angles and 6 coordinates of the lower torso. 3) Similarity criteria computation, with respect to the reference motions in the database [10]. 4) Evaluation of the closest motion in the database to identify the conveyed emotion. In order to develop accurate emotion recognition, we test several possibilities. First, the model has 6DOF of the lower torso. We then add 6DOF: 3 for the waist, 3 for the neck [8]. Finally, we test two different databases. One is intra-subject database: all the reference motions are from the tested subject. The other is a mixture of motions from all candidates. RESULTS: We investigate both the importance of the number of degrees and the importance of the constitution of the database of reference motion as shown in the figure. When the database is a mixture of all candidates, mistaken motions are always mistaken with Neutral emotion. CONCLUSIONS: The 12DOF model allows a better recognition of the emotions, particularly Joy and Anger. The total increase in successful recognitions is 10%. For a given candidate, discriminate among the 4 emotions reaches 78% (green). The inter-subject recognition is less successful, with an average recognition rate of 69% (blue). Happiness and Anger are more "subject specific", while Sadness is the most variable in oneself.



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P1-H-186 **The importance of dynamics model calibration for human movement analysis**

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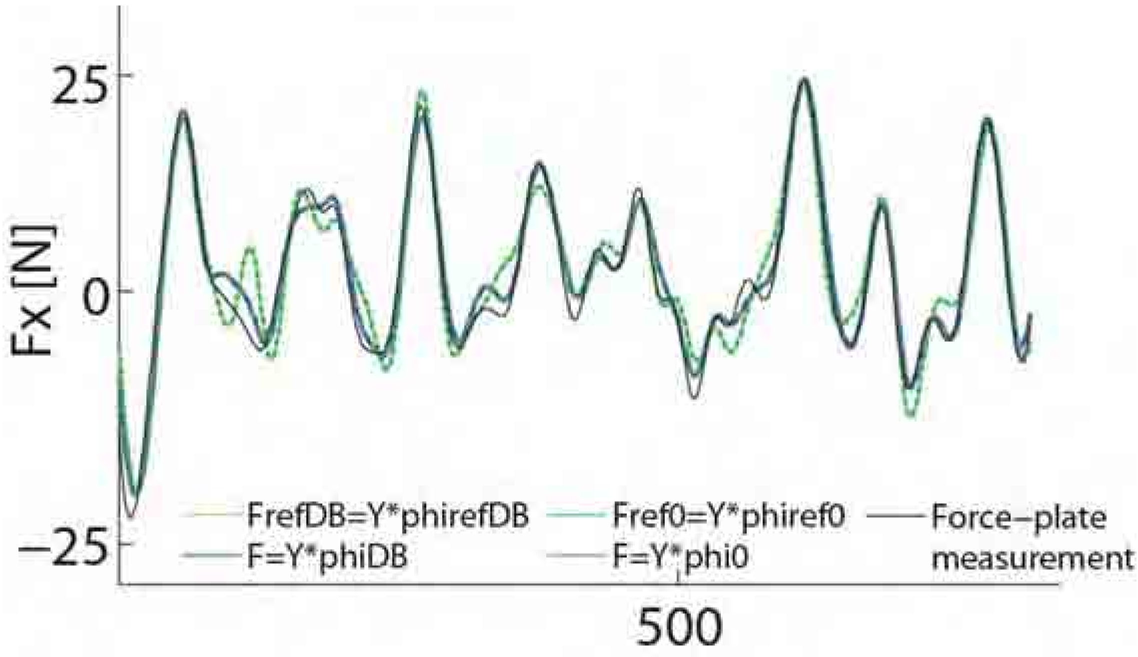
BACKGROUND AND AIM: To study human gait, it is common to use motion capture systems and contact force measurements. To access the kinematic and the kinetics information, a model of the human body is necessary. The estimation of the model geometric parameters (GP) i.e., segment length, and segment parameters (SP) i.e., mass, inertia and centre of mass positions of each segment, is a key-step. The most utilized methods are based on direct measurements for the GP; and either the use of full-body MRI and 3D modelling for the SP interpolation from literature. Literature data can be problematic, as there is uniformity neither in the landmarks nor in the model of the human-body [1]. It is shown in [2] that error in the SP affects significantly the analysis results. We have developed an identification method of the GP and SP of the human body [3] based on motion capture data and contact force measurement. We prove the importance of using appropriate model of the individual in order to calculate accurate motion information, thus of model calibration. METHODS: We use a motion capture (Motion Anal-ysis-Kistler), to capture 35 markers pasted at ana-tomical points (a variation of the Helen Haye and the Vicon marker set) [3]. A three-step procedure to study human motions is used: 1. Geometric calibration: T-pose to compute the GP. The length of the segments and a number of anatomical data is computed from the marker static 3D positions. Additionally, using literature data-base interpolation we calculate a set of SP that we call SPinter. 2. Dynamics calibration: with our developed identification method [3], we compute the SP. This set is called SPident. 3. Gait capture: We compare the contact force measured by the force plate FFP, to the computed contact force Finter and Fident obtained respectively using SPinter and SPident during gait. RESULTS: Using SPident more accurate results are obtained. The interpolated parameters SPinter give a global error 7 times greater, and depending on the considered data, the error can be up to 20 times greater. For example, the moment around x and around y. The black line shows FFP. It is easy to notice on Fz the period when the subject walks off and on the force plates. The blue and green lines show respectively the computed contact force Finter and Fident When the candidate is on the force plate, Fident and FFP are very similar. However Finter is dramatically different to FFP: considerable errors are obtained on Fy, Mx, My and Mz. CONCLUSIONS: We proved that the geometric and dynamics calibration of the human body model is crucial in gait analysis. Using interpolated data from literature can lead to dramatic computational errors. We propose to use dynamics identification systematically for individual model adjustments.



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P1-H-187 New gait analysis method based on wiimote technology and fusion with inertial sensors

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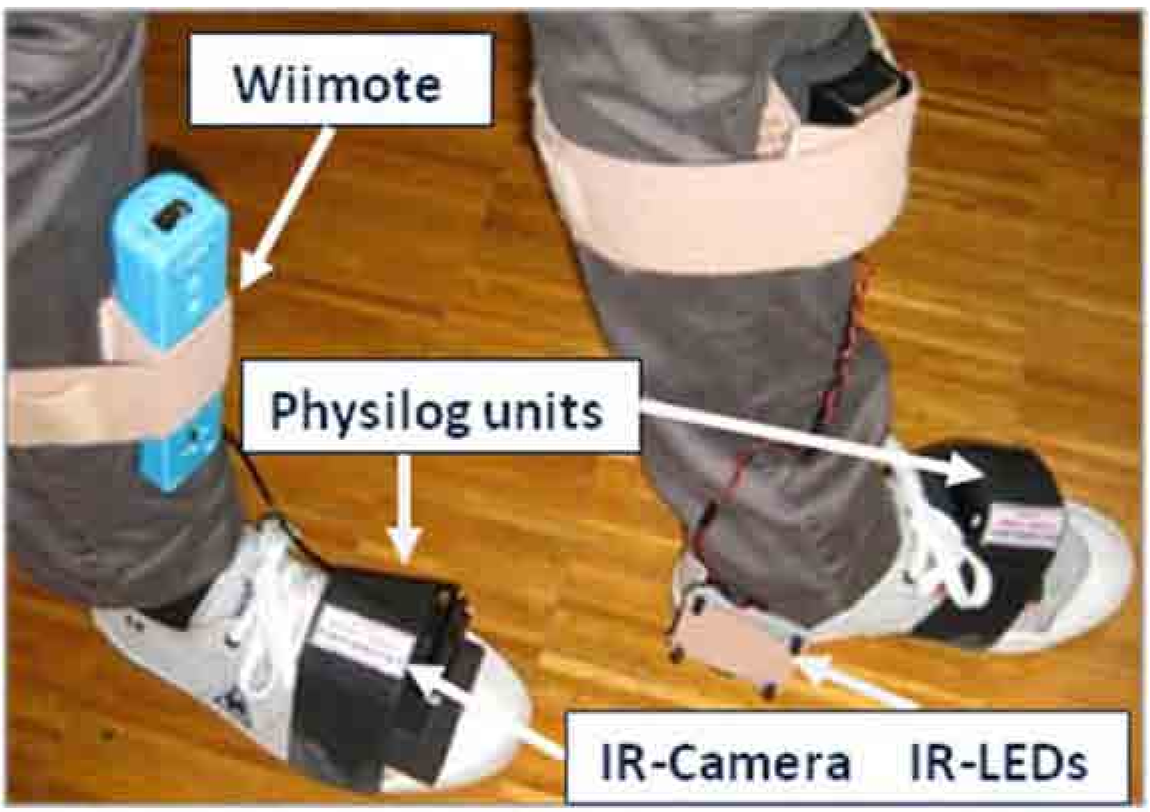
BACKGROUND AND AIM: Recently, ambulatory systems based on inertial sensors have been proposed and validated, showing a good potential for providing quantitative evaluation of gait in natural conditions [1, 2]. However, inertial sensors have limited performances for providing relative distances and orientations on a long-term basis due to drift. This study aims at describing an original method using infrared (IR) LED tracking technology from a micro camera (Wiimote), and its fusion with existing inertial sensor based gait assessment methods. METHODS: The small IR-Camera (1cmx1cm) of the Wiimote was deported and fixed on the forefront of one shoe to track a custom-made board of 4 IR-LEDs fixed on the rear part of the counter-lateral shoe. Camera data is streamed to a PC using Bluetooth. Two additional Physilog® units featuring accelerometers, gyroscopes and a data logger were fixed on the feet and used for estimating double-support phases (DS). A system of equations was designed in order to estimate periodically relative positions (e.g. distance between feet as a combination of Step length and Step width), as well as relative azimuth orientation between feet, based on IR-LED coordinates at each DS. The method was preliminary validated on the workbench using fixed positions and orientations. Both systems were then mounted on foot (fig. 1) and synchronized a posteriori. Three young healthy adults were asked to walk 10 times at self selected speed with the system. Optical motion capture system

(Vicon) was used as a reference. RESULTS: On the measurement workbench for distances ranging from 20 to 70cm (respectively orientations between -80 and 80°), accuracy±precision of relative distance was 2.32±2.16cm (respectively 9.96±6.02° for orientations), showing good agreement with reference system, and also an excellent test-retest repeatability (ICC(1,1)= [0.995-0.999]). During gait trials with subjects using the wearable prototype, average accuracy±precision were 15±6.23cm and 8±6.4° for relative distance and orientation respectively. Results could be considered promising and provides a proof-of-concept of fusing IR-LED tracking and inertial sensors. However owing that this validation was provided only with 3 subjects, further studies are needed to fully validate the system on pathologic populations. CONCLUSIONS: This study laid the first groundwork for non-drifted ambulatory estimation of relative distance and orientations parameters based on the fusion of portable IR-LED tracking with inertial sensors. The system, using existing Wiimote technology, is low-cost, wireless, and easy to use in practice for functional assessment, and has the great advantage of being non-sensitive to drift over long-time periods. The proposed method has a great potential in biomechanics since it could be further adapted to other limbs.



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P1-H-188 Analysis of running using shoe sensors and EMG, application to the study of people after hip resurfacing

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BACKGROUND AND AIM: In patients with hip resurfacing, whether or not regular sporting activity should be limited or even prohibited because of the danger of the implant becoming loose is still discussed [1]. The aim of this study is to provide a new wearable system based on foot-worn inertial sensors and EMG electrodes with dedicated algorithm allowing objective evaluation of the effect of running in the unilateral hip resurfacing patients. METHODS: Measurements were achieved using an ambulatory system Physilog® composed of inertial sensors (3-D accelerometers and 3D gyroscopes) attached on top of both feet and EMG electrodes fixed on main muscles involved in hip motion: Gluteus Maximus (GX), Gluteus Medius (GM) and Rectus Femoris (RF). Signals were recorded synchronously at 200Hz. A 3D gait assessment algorithm [2] was adapted to running locomotion to get spatio-temporal parameters including stride length, stride velocity, foot clearance and gait cycle time. EMG patterns were obtained after MVC normalization and filtering of the signals, and segmented between foot impacts for each cycle detected on inertial sensors signals. Based on an auto-adaptative threshold, the number and timing (i.e. coordination) of muscles activations were extracted. 5 control subjects and patients with hip resurfacing were recruited and asked to run at different speed (self-selected, slow and fast) on a stadium while wearing the system. RESULTS: The method shows good technical validity since the average difference between the proposed method and reference stopwatch measurement was below 5% for velocity estimation. EMG cyclic patterns were obtained for each muscle on right and left side for GX, GM an RF with nearly 100% of sensibility. The number and the timing of muscle cyclic activations showed comparable results with literature [3], with the advantage of being robust to different speeds and subjects through the auto-adaptative threshold computation, and extracted on a large number of running cycles. A tendency for higher foot clearance was observed in healthy side of patients with hip resurfacing. Furthermore, a tendency of asymmetry of RF activation pattern was observed between healthy and pathologic side of patients. CONCLUSIONS: The proposed system gives an objective evaluation of running performance through quantitative parameters extracted in natural conditions, combining both kinematic and muscular aspects. It has a good potential for future studies since it allows both an inter-subject comparison (between healthy and pathologic subjects) and an intra-subject comparison (between healthy and operated leg). It already reveals interesting tendencies, but further measurements with more subjects are needed to investigate clinical significance of pathologic and healthy running patterns.

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Session 2

I - Development of Posture and Gait

P2-I-1 Effects of diapers on infant walking

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BACKGROUND AND AIM: At the onset of independent walking, infants take short, widely placed steps. Over the course of several months, they learn to take longer, narrower steps [1]. During this same period, however, many infants wear diapers--a perturbation that introduces bulk between the legs, potentially exacerbating their already immature gait. The current study investigated the effects of diapers on infants' developing walking skill. METHODS: Footfall data were collected from 30 13-month-old and 30 19-month-old infants walking repeatedly over a GaitRite carpet while naked, wearing a thin disposable diaper, and in a bulky cloth diaper. In addition, disruptions of alternating gait, including missteps and falls, were identified from video recordings. RESULTS: Wearing diapers significantly reduced infants' walking skill. Steps taken in diapers were significantly wider and shorter than those taken while naked, both characteristic of immature walking, p's < .001. This detriment was substantial: the cost to infants' skill from wearing a cloth diaper was equivalent to losing 8 weeks of walking experience. Although the cloth diaper induced the largest decrements, the thin disposable diaper--similar or identical to the type worn daily by 90% of the sample--significantly altered infants' walking as well, p = .001. Wearing diapers also had a functional cost: More infants misstepped or fell while wearing diapers than while walking naked, p < .05. CONCLUSIONS: Infants learn to walk in the context of an on-going biomechanical perturbation in the form of their own diaper. Moreover, previously reported historical and cross-cultural differences in infant walking are likely confounded with differences in diapering practices.

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P2-I-2 Can your shoes change the way you walk?

Erika Nerozzi[1], Diane Beker[1], Claudio Tentoni[1]

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BACKGROUND AND AIM: Fashion has strongly influenced the design of footwear throughout the ages, compromising the natural functionality of the shoe. The goal of this study is to investigate how different shoe constructions can modify the normal walking pattern and subsequently our feet and body balance. METHODS: We measured the degree of the first metatarsal joint in 18 participants (22 to 42 years old) with a goniometer placed on the floor. Exclusion criteria were: osteoporosis, arthritis, feet pathology, diabetes or any neurological or vestibular conditions that had been diagnosed. We asked each person to do two balance tests barefoot: stationary test with left and right foot separately (sec. max 30) and Fukuda test. Subsequent testing: standing in a natural position with eyes open and closed and walking straight over a E.P.S. platform by LorAn Engineering S.r.l. Eleven females were tested in four conditions: 1) barefoot 2) flat shoes 3) medium heel shoes 4) high heel shoes; and seven males were tested in 3 conditions: 1) barefoot 2) moccasin shoes 3) tennis shoes. We did 20 randomized trials for each situation. All subjects were tested wearing the same type of footwear supplied byCamper® in relation to the their foot size and considering the heel height that affects the ankle angle (female 0, 3, 5, 7 cm. - male 0, 3, 4 cm.). The written informed consent was obtained from each subject. RESULTS: We examined the influence of the shoe on the postural stability of adults when walking or standing under the same conditions, and increasing dependence on foot proprioception with eyes closed or with different shoes. High heels altered trunk stability in standing, with or without eyes closed, and the gait pattern in walking. In standing, increased heel height and eyes closed condition revealed a difference in anterior-posterior trunk stability in female ($p<0.05$). In both groups increased medial-lateral motion of the trunk under the eyes-closed condition. Mean foot pressure is mainly concentrated in anterior medial and lateral part of the foot, in particular with the high heel. In gait analysis total single support time is shorter barefoot for both groups and appreciable differences are shown in the distribution of the body weight with medium and high heel for female ($p<0.05$). CONCLUSIONS: The question raised by Camper® was to understand if the shoes tested produced positive or negative effects in participant's posture.Our findings report elevated pressures under some region of the foot in relation of different kind of shoes, creating new motor patterns and different posture. In high heels, the plantar pressure in the heel and midfoot shifted to the anterior medial-lateral foot, increasing participant's discomfort. The plantar-flexed ankle position adopted when wearing elevated heel height shoes might contribute to larger vertical and horizontal ground reaction forces.

P2-I-3 Comparison between an electronic baropodometer® and the system for tridimensional motion analysis Vicon

Erika Nerozzi[1], Simone Ciacci[1], Claudio Tentoni[1]

[1]University of Bologna

BACKGROUND AND AIM: In the human body there are many afferences interacting to control posture and gait, and plantar information is primary since the proprioception of the foot determines total postural control. The information deriving from the visual receptors are significant, but the plantar cutaneous meccanoceptors are irreplaceable in determining postural adjustments. We want to compare data from two different devices in order to analyse the deviation of the first metatarsal or hallux valgus in an easy and complete way. METHODS: We recruited 10 subjects (65 to 75 years), moderately active,

living in Bologna. Terms of inclusion were a medical certificate attesting to doing moderate physical activity and the acceptance of informed consent. A second selection has been defined with a questionnaire. Exclusion criteria were: presence of labirintic, metabolic and vascular diseases. We created two groups: hallux valgus (HV) degree of 1st metatarsal >15° and a normal group (N) <15°. We tested both groups 3 times with an Elettronic Baropodometer® by Physical Support s.r.l. (Rome, Italy) and with an optoelectronic stereophotogrammetric system for tridimensional motion analysis (VICON 460, Oxford Metrics, UK) to collect the kinematic data. We measured the participant a static position for 10 seconds and a natural deambulation at a normal speed on the baropodometer platform. Both devices recorded the data at the same time. Our intention was to analyse gait: step length, total step time, single support time, double support time with both devices, centre of pressure (COP) with the baropodometer and the kinematic data of the point among the four anterior and posterior iliac crests, considered the centre of the Pelvis (MEDH) with Vicon system. RESULTS: Stabilometric data recorded with the baropodometer for HV subjects evidenced a different total pathway characterized by a slower and shorter path length that covered less surface compared to normal, in gait analysis step length is longer than normal subject and total foot contact time is less. There are no significant differences between the results obtained with Vicon system. CONCLUSIONS: Using a baropodometer, that does not require a lengthy calibration and does not use markers placed on the body, is much easier and faster for obtaining data from a greater number of people, especially in the elderly population that often does not give much importance to the problems of the feet. This can certainly be useful for the hallux valgus study to prevent behaviors that may cause this disease to develop. These controls on a greater number of elderly people could reduce the high incidence of falls due to reduced postural control in subjects with hallux valgus. A future study could analyze the foot angle during the loading with Vicon and body weight distribution with a baropodometer in order to understand if these variables are related by using the comparison of the same equipment with the addition of a force plate.

P2-I-4 EMG activity during treadmill stepping: Young children with myelomeningocele

Jennifer Sansom[1], Caroline Teulier[2], Beverly D Ulrich[1]

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BACKGROUND AND AIMS: Myelomeningocele (MMC) is a form of spina bifida in which a lesion occurs in the spinal cord during embryogenesis. Ensuing spinal sensorimotor deficits often delay walking onset and cause difficulties w/gait control. Previous research in infants w/MMC shows that some steps can be elicited during the first year post-birth, but the frequency is lower than in healthy infants [1]. Little is known about the underlying muscle activities they use to produce steps. Our goal was to examine the activation patterns for 4 primary gait muscles in infants w/MMC when stepping on a pediatric treadmill (TM). METHOD: Participants were 12 infants w/MMC at 1, 6, 12 months old. We placed EMG electrodes bilaterally: lateral gastrocnemius (LG), tibialis anterior (TA), rectus femoris (RF), and biceps femoris (BF); sampling rate 1200 Hz. We supported babies upright on a TM for 12-20s trials at 6 speeds. We behavior coded step occurrence, gait events (toe off, touchdown) and non-stepping leg movements. For each baby/month, we included 1 (min) to 4 (max) strides in analyses. We objectively determined onset/end of muscle activations and applied algorithms to each cycle's rectified filtered EMG traces [2].

Normalization of frequency histograms and 'on' activity duration summation was performed per Spencer and Thelen's procedures [3]. RESULTS: Step characteristics: Infants significantly increased flat-footed contact at touchdown w/age (F(2,10)=4.23,p=.047). Muscle activation patterns: We analyzed 16 muscle states to determine percent of time for 'on' activity during strides. Our results show passive behavior, no muscles active, occurred ~1/2 the time (F(2,126)=4.25,p=.016). When muscles were active, they tended to work in isolation w/LG activity significant during stance (F(1,128)=2.94,p=.089). Agonist-antagonist co-activation was low when muscles were active, averaging 20.86%. Probability: Overall probabilities were low w/little variation across the cycle, but higher at month 1 than 6 and 12. The LG (F(2,63)=3.151,p=.050) and RF(F(2,69)=4.128,p=.020) were statistically significant. Early vs. Late walkers: Follow-up data show that infants w/MMC who walked earlier produced significantly more LG muscle activity than later walkers (F(1,10)=3.37,p=.095). CONCLUSION: Results show that when infants w/MMC step while supported on a TM they show increasing kinematic quality w/age, show greater activation of single gait muscles, and relatively low concurrent activation in the lower leg agonist-antagonists. Further, infants who eventually learned to walk and did so earliest, generated more LG muscle activity than later walkers during treadmill stepping. In future intervention studies, efforts may need to focus on the LG as key to facilitating development of control and strength needed to walk.

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P2-I-5 Learning postural control in children ? Plasticity or exploratory learning?

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BACKGROUND AND AIM: The ability to maintain postural control is dependent upon sensory feedback mechanisms as well as stored motor programs within the CNS, feed-forward mechanisms. The latter are probably partly already stored in the human genome (ontogenesis) and partly generated through experience (i.e. adaptation), emulating the general process of memory formation. Although the development of postural control in children has been extensively researched, surprisingly few studies have had the actual learning or adaptation as the primary objective. Children are considered to have a greater central nervous plasticity than adults and the methodology of learning a new task is different than adults, so it would be conceivable that children's postural learning also differ from adults. The aim was to compare children and adults in adaptation to a postural challenge. METHODS: Posturography with vibratory calf stimulation delivered on 5 consecutive days and after 3 months to a child group (n=13 age 7-9) and an adult group (n=12 age 15-32). RESULTS: The children did not reduce their torque variance during each test as the adults did. The statistics revealed similar significant decrease of induced torque variance between tests in both groups regardless visual condition (p<0.001), though with larger slope coefficients in the children group, indicating a larger reduction of torque. In the children group the mean of elicited torque on the 2nd day was on a much lower level then they finished on day 1 (p<0.01), in contrast to the adults. The children seemed to have adapted the most between the 1st and 2nd day,

and further training hardly decreased the amount of induced torque variance. The adults responded to the vibratory perturbation with a forward leaning, presumably a better position to withstand the perturbation. No homogeneous strategy to withstand the perturbation could be discerned in the children group, when studying the raw data. CONCLUSIONS: Children have more efficient or stronger postural consolidation processes, possibly attributed to the difference in central nervous plasticity or the nature of the children to learn through exploring the task at hand.

P2-I-6 Children with a visual impairment learn to walk more cautiously

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BACKGROUND AND AIM: A visual impairment can have a major impact on motor development and skill acquisition. Independent walking is an important skill that highly contributes to independence and therefore has a large impact on the quality of life. Development of independent walking might be more hallenging for children with a visual impairment than for their normally sighted peers. METHODS: Gait of children and adults with a visual impairment (ages 1-44, n = 28) was compared to that of age-related individuals with normal vision (n = 60). Participants walked barefoot at preferred speed while their gait was recorded by a Vicon system. Walking speed, heading angle, step frequency, stride length, step width, stance phase duration and double support time were determined. Differences between groups, relationships with age and possible interaction effects were investigated. RESULTS: Significant differences between groups were a slower walking speed, a shorter stride length, a prolonged duration of stance and of double support in the individuals with a visual impairment. Relationships of gait parameters with age were observed and pointed towards an overall improvement in gait efficiency. CONCLUSIONS: The observed differences in gait parameters between normally sighted and individuals with low vision may be considered either as adaptations to balance problems or as strategies to allow to foot to probe the ground.

P2-I-7 Thinking while walking through virtual worlds: Differences in dual-task performance between children, young, and older adults

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BACKGROUND AND AIM: Age-comparative studies in which participants perform a motor and a cognitive task concurrently often report higher dual-task costs in old adults and children as compared to young adults, presumably because those age groups invest more cognitive resources into seemingly automatized motor tasks (e.g., Li, Lindenberger, Freund, & Baltes, 2001). METHODS: The current study asked 9-year old children, young (20-30 years) and old adults (60-70 years) to walk on a treadmill while concurrently performing a working memory task, N-back. Participants walked as fast and accurately as

possible through four different virtual worlds, either on a broad or a narrow track, and either on even ground or while balancing through a skyscraper setting. Using a VICON motion analysis system, the treadmill adjusted its' speed to participants' walking velocities. Dependent variables were walking speed and number of missteps on the narrow track. Older adults were assumed to prioritize their walking performance, whereas children were predicted to be more risk-taking in the motor domain. RESULTS: All age groups decreased their walking speed when cognitively challenged, and when walking on a narrow as compared to a broad track. Contrary to predictions, old adults walked even faster and committed more missteps in the skyscraper setting than on even ground. N-back performance decreased in all age groups when walking in different virtual worlds. Older adults showed the most pronounced linear decrease with walking task difficulty. CONCLUSIONS: The high cognitive dual-task costs of old adults indicate that they focus their attention on the motor task when this task is most challenging and threatens their balance. However, this resource investment does not lead to superior levels of motor performance, as demonstrated by an increase in missteps on the narrow track. Young adults are most successfull in dealing with this cognitive-motor dual-task situation.

P2-I-8 Comparison of balance performance between adolescent men with and without intellectual disability

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BACKGROUND AND AIM: The prevalence of intellectual disability (ID) is about 1.5 % in the western countries. Research reports that impairments of balance seem more common among adult individuals with an ID compared to those without an ID. The balance ability for adolescent people with an ID is not known, but falls are more common compared to peers without an ID. The aim of this study was to investigate balance among adolescent men aged between 16-20 years with a mild to moderate ID, compared to a group of age-matched men without ID. METHODS: A group of 60 men with an ID and a control group of 67 men without an ID were investigated. Three balance tests which represent different aspect of balance were used: Timed Up and Go Test, Modified Functional Reach Test and a Force Platform Test. Independent-samples t test was applied to compare differences in means between the two groups. RESULTS: On a group level, adolescent men with an ID have significantly lower scores in all three balance tests. CONCLUSION: Balance impairments seem existent already at adolescence which could lead to falls and injuries.

P2-I-9 Kinematic differences of the maximum velocity phase sprinting stride between adult national level and novice prepubescent male sprinters

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BACKGROUND AND AIM: Speed improvement during adolescence is attributed to the increment of stride length [1], while stride frequency is characterized as ontogenetically stable [2]. The purpose of the

present study was to compare the kinematic parameters of adult and prepubescent male athletes in the maximum velocity phase of a sprinting test. METHODS: Fourteen adult male national level sprinters (group A; age: 21.4 ± 3.7 years, body height: 1.75 ± 0.06 m, body mass: 68.0 ± 8.4 kg, mean ± SD respectively) and ten novice prepubescent athletes (group B; age: 10.8 ± 1.0 years, body height: 1.49 ± 0.09 m, body mass: 40.3 ± 8.3 kg) participated in this study. Group A and group B executed a 50-m and 40-m maximal sprinting test respectively on a rubber surfaced indoor track. Three consecutive support phases of the sprinting strides were recorded at the last 10m mark with a stationary JVC GR-DVL 9600EG (Victor Co., Japan) digital video camera (sampling frequency: 100fps). Eight-teen anatomical points of the body and selected points in the filming view were manually digitized in each field. Stride time (ST), contact time (TC), stride frequency (SF), stride length (SL), velocity (V) and the alteration of Body Center of Mass' height (H) were assessed for the recorded strides. Furthermore, thigh inclination (TI), knee joint angular velocity (KAV), ankle (ANK) and knee (KNE) joint angles were calculated for the support and swing leg. Digitization, smoothing and analyses were conducted using the A.P.A.S. System 2007 software (Ariel Dynamics Inc., Trabuco Canyon, CA). Differences between groups were examined by independent samples t-test with the level of statistical significance set at $p = .05$ (SPSS 10.0.1, SPSS, Chicago, Il). RESULTS: V (9.6 ± 0.6 m/sec vs. 6.4 ± 0.7 m/sec, A vs. B respectively) and SL (2.08 ± 0.15 m vs. 1.56 ± 0.17 m) were significantly ($p < .05$) larger in A. SF (4.54 ± 0.27 Hz vs. 4.03 ± 0.41 Hz), ST (0.22 ± 0.01 sec vs. 0.25 ± 0.02 sec) and TC (0.09 ± 0.01 sec vs. 0.13 ± 0.02 sec) were smaller ($p < .05$) in B. H was smaller ($p < .05$) in A. Swing leg's KAV and KNE were significantly different ($p < .05$), while support leg's joint angles did not differ ($p > .05$) between groups at the instants of touchdown and take-off. Finally, TI at take-off was larger ($p < .05$) in B (-15.1 ± 7.2 deg vs. -26.7 ± 5.6 deg). CONCLUSIONS: TC, SF and SL found for group B were in agreement with previous findings [1]. The rotational kinematics (TI, KNE, KAV) observed for the swing leg in group B were identified as diagnostics of inefficient sprinting mechanics [3]. Further research is needed to explore the influence of maturation on the development of the neuromuscular parameters of maximum velocity sprint running during adolescence.

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P2-I-10 Assessing postural and motor performance in rehabilitation using adaptive task difficulty in a training game

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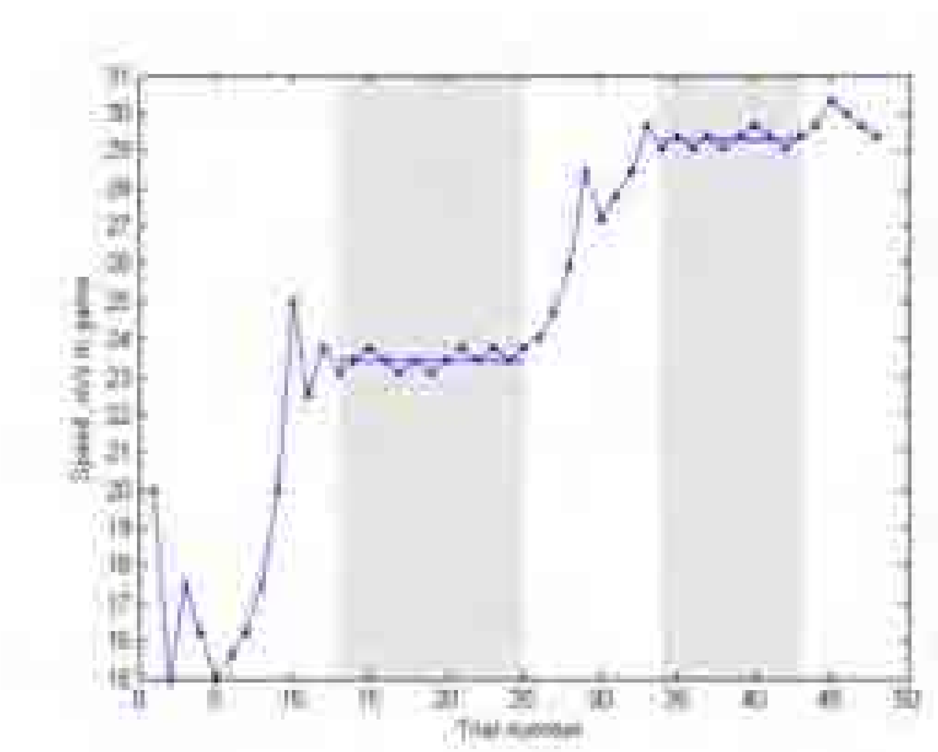
BACKGROUND AND AIM: Rehabilitation using virtual reality and computer games (in stroke and cerebral palsy (CP) for example) has aroused considerable interest [1]. Children with mild CP diplegia can walk, but their gait is usually impaired, in part by poor control of the trunk and pelvis [2]. We have developed a game controlled by trunk or pelvic motion for the CAREN VR system (Motek Medical, The Netherlands) with the intention of improving control in CP [3]. For the game to remain interesting the level of difficulty needs match the subject's performance, which varies over time and between subjects [1]. Our game incorporates a method for adjusting difficulty automatically, which also provides a measure of performance. METHODS: Subjects steered a dragon through a cave to hit a series of spherical bubbles which appeared in unpredictable locations. AP tilt of the trunk or pelvis controlled the up/down speed of the dragon, ML rotation left/right. All subjects (CP diplegia, aged 6-10) played using trunk and pelvis at the start and end of the experiment in several postures, two training subjects played 11 additional sessions using trunk and pelvis over 6 weeks, two control subjects played 11 sessions using a joystick. Forward speed of the dragon was controlled by a psychophysical algorithm (PEST) [4] which increased speed when a bubble was hit and decreased speed for a miss. Increment size reduced over time, and speed (and hit rate) converged towards a settled value as performance in this type of task is analogous to the sensory detection of signals for which PEST was designed [5]. The maximum settled speed during a test provided a measure of performance. RESULTS: With trunk or pelvic control stable speeds were achieved in a majority of tests (grey bands in Figure), but not always. Learning effects, motor pathology and subject compliance could lead to variable performance. During a number of tests settled performance was robust in that it was impaired neither by hiatuses in the timing of stimulus presentation, nor by occasional movement of the platform which supported the subject. Settled speeds tended to increase over the course of training. With joystick control settled speeds were generally higher, but tended not to improve to the same extent over time. CONCLUSIONS: This technique is capable of providing a measure of motor performance to monitor changes over time, and maintains the playability of the training game over a wide range of motor skills.



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P2-I-11 Proprioceptive integration in adolescent idiopathic scoliosis (AIS)

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BACKGROUND AND AIM: An original procedure that consists in applying very slow oscillations below the detection threshold of the semicircular canal system was adopted to challenge the proprioceptive information in sensory integration of postural control in 10 adolescents with idiopathic scoliosis (AIS) and 10 control subjects (CS). The aim of the present study was to investigate the proprioceptive contribution to postural control in adolescents with scoliosis which expresses spinal deformity during a crucial transitional period of ontogenesis. Simoneau et al. (2006b) reported that AIS, compared to control adolescents, rely much more on ankle proprioception to control the amplitude of the balance control commands. We adopted the working hypothesis that AIS do not neglect proprioceptive information to control their posture probably because of their vestibular deficits (Sahlstrand and Petruson, 1979; Sahlstrand et al, 1979; Wiener-Vacher and Mazda, 1998). METHODS: Ten AIS patients with moderate spinal deformity (mean age 14 years 6 months, SD /- 1 year 5 months, 10° < Cobb Angle > 35°) and ten control adolescents (mean age 14 years 4 months, SD /- 1 year 2 months) participated in this experiment. We asked adolescents to maintain vertical stance while very slow sinusoidal oscillations in the frontal plane were applied to the supporting platform at 0.01 Hz (below the detection threshold of the semicircular canal system) with the eyes open and closed. Two postural components, orientation and segmental stabilization, were analysed at head, shoulder, trunk and pelvis levels. RESULTS: Moderate spinal deformity did not affect vertical orientation control and segmental stabilization strategies. Visual cues improve postural control in both CA and AIS and all adolescents seem more dependent on visual cues than adults to control posture. Orientation and stabilization control improve from adolescents to young adults indicating that development of postural control continues up to late periods in the course of ontogenesis. In our study, it seems that developmental effect is dominant with respect to pathologic effect. CONCLUSION: By contrast with our initiate speculation, AIS as CS transitory neglect proprioceptive information to control their posture in response to very slow oscillations of the support. These apparent opposite results between our study and the literature suggest the existence of different afferent pathways for proprioceptive information subserving different parts in sensory integration of postural control. We conclude that the static proprioceptive system, as assessed from our protocol, is not affected by the idiopathic scoliosis, while the dynamic proprioceptive system would be

mainly affected. At the present time, this latter hypothesis is tested in perceptual and postural tasks, assessing by tendon-vibration stimulations.

P2-I-12 A stored obstacle representation successfully guided lead limb but not trail limb trajectories during obstacle crossing

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BACKGROUND AND AIM: It is well known that vision is used on-line to guide adaptive locomotion. However, vision can also be used open-loop. For example, the trail limb is not visible during crossing, but foot elevation is scaled as a function of obstacle height (Patla et al., 1996). Both lead and trail limb were guided open-loop to successfully cross an obstacle when vision was not available during approach (Mohagheghi et al., 2004). These observations support the concept that knowledge of obstacle characteristics can be used to guide locomotor behavior in the absence of vision. We defined this visuospatial knowledge as a 'stored obstacle representation'. This concept has also been observed in quadruped locomotor research. Cats and horses accurately modified the hindlimb trajectory based on remembered obstacle size and position (McVea & Pearson, 2006; Whishaw et al., 2009). Therefore, it is reasonable to conclude that a stored obstacle representation can be used to control adaptive gait. The purpose of this study was to further examine the concept of a stored obstacle representation in humans. METHODS: Nineteen young subjects stepped over an obstacle in the middle of an 8 m walkway for 75 trials. In the first 25 trials, subjects stepped over an obstacle. A strip of white tape was placed at the obstacle location. The obstacle was removed for the next 25 trials and subjects were asked to step over the tape as if the obstacle was still in place (virtual obstacle). The obstacle was returned for the last 25 trials. A failure was defined as any trial where the foot would have contacted the obstacle if it was in place. RESULTS AND CONCLUSION: Subjects successfully cleared the virtual obstacle for the lead, but not the trail limb (failure rate 2 and 38%, respectively). The lower failure rate for the lead limb could be due to the visibility of the lead limb and/or more awareness of the lead limb versus the trail limb. Alternatively, while concurrent vision of the position of the bottom edge (due to the tape) was adequate for lead limb clearance, for the trail limb, vision of the top edge in the preceding step may be more critical due to the steep trail limb trajectory necessary to clear the obstacle. Lead minimum foot clearance (MFC) variability was significantly higher for the virtual obstacle compared to the real obstacle; this is consistent with previous research that on-line visual control is necessary to fine-tune the trajectory (Patla, 1998). However, trail limb MFC variability also increased, but on-line visual control is never available for the trail limb. One possible reason for higher trail MFC variability is that the trail limb trajectory becomes dependent on the lead limb trajectory when using an obstacle representation, but this needs to be further explored. These preliminary findings support the idea that a stored obstacle representation can be used to guide the lead limb, but not the trail limb.

J - Coordination of Posture and Gait II

P2-J-13 Curb negotiation under different ambient lighting in older adults with macular degeneration

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BACKGROUND AND AIM: Negotiating a curb requires knowledge of the height of, and distance to, the curb. Visual input normally provides this crucial information. With simulated visual impairment and lower ambient lighting foot clearance height and variability have been shown to increase when encountering a change in ground level. The aim of this study was to determine the effect of macular degeneration (MD), a major cause of visual impairment among older adults, on the ability to negotiate a curb under different ambient lighting conditions. METHODS: Older adults with MD (N=4; age = 79 /- 8 yrs.; better eye, best-corrected visual acuity range: 20/90 - 20/200) and healthy control subjects (N=5; age = 76 /- 5 yrs.; better eye, best-corrected visual acuity range: 20/15 - 20/40) were instructed to walk (2 - 4 m) and either step up or down a curb (height = 15 cm). Subjects performed this task under normal light (600 lux), dim light (0.7 lux), or following a sudden reduction in light (600 to 0.7 lux). Our analysis focused on the step down in this study. A motion capture system recorded time-varying positions of markers on the foot and a force plate recorded the step down to the lower level. We analyzed foot placement distance before and after the curb, vertical and horizontal heel clearance, and peak loading force using separate two-way (Group x Lighting) ANOVAs and Tukey's HSD for post-hoc tests (alpha level = 0.05). RESULTS: Our results demonstrated that control subject's lead foot (i.e., the first foot to step down) stepped closer to the curb than older adults with MD (Group main effect, P = 0.015) suggesting they were more confident of the curb location. During the sudden reduction of light condition, less peak force was exhibited on the down step (Lighting main effect, P < 0.001). In addition, there was increased vertical clearance of the curb with the lead foot (Lighting main effect, P = 0.024) and trail foot (Lighting main effect, P = 0.023) in the sudden light reduction condition. Furthermore, in the sudden light reduction condition older adults with MD demonstrated increased heel horizontal clearance from the curb edge during their descent trajectory before they touched the ground (Lighting main effect, P = 0.014). CONCLUSION: Our results suggest that older adults with MD chose to step further away from the curb to ensure safety or because they were unable to adequately see the curb edge. Interestingly, even though both groups stepped down with less peak load in the sudden reduction of light condition, control subjects tended to step down with a more confident step than the older adults with MD. Specifically, control subjects showed less heel clearance at the level of the curb despite both groups stepping higher initially than in other lighting conditions. This study was supported by an Applied Research Grant from CNIB.

P2-J-14 The ability to guide foot placement to specific targets under different ambient lighting is impaired in older adults with macular degeneration

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BACKGROUND AND AIM: Stepping to precise ground locations, to avoid a hazard for instance, requires visual information regarding the target of interest in order to accurately guide the foot. While walking under relatively challenging conditions, saccades are typically made to the next location while the stepping foot is still in contact with ground (i.e., the end of stance phase). This allows visual information of the next target to be incorporated into the formation of a stepping command for the subsequent step. In older adults with macular degeneration (MD), central vision loss may hinder fixation of targets resulting in less information regarding their location. The aim of this study was to determine the ability of older adults with MD to accurately step to targets during walking and in different ambient lighting conditions. METHODS: Older adults with MD (N=4; age = 79 /- 8 yrs.; better eye, best-corrected visual acuity range: 20/90 - 20/200) and healthy control subjects (N=5; age = 76 /- 5 yrs.; better eye, best-corrected visual acuity range: 20/15 - 20/40) were instructed to walk along a 6 m long walkway and step on a series of four randomly positioned targets (20 x 15 cm; medium contrast). Subject performed this task under normal light (600 lux), dim light (0.7 lux), or following a sudden reduction in light (600 to 0.7 lux). A motion capture system recorded time-varying positions of markers on the foot. Foot placement error, defined as the vector distance between the middle of the stepping foot and middle of the target, was averaged across the four targets. The mean and variability (SD) of this error were analyzed using two-way (Group x Lighting) ANOVAs and Tukey's HSD post-hoc tests (alpha level = 0.05). RESULTS: Preliminary results demonstrated that for all subjects mean stepping error to targets in the sudden reduction of light condition was significantly increased relative to both the normal and dim lighting conditions (Lighting main effect, $P < 0.001$). Older adults with MD had greater variability in foot placement error than controls independent of the ambient lighting conditions (Group main effect, P = <0.0001). However, the sudden reduction of light condition posed the greatest challenge as evident by greater variability in foot placement error (Lighting main effect, $P = 0.003$). CONCLUSION: The variability seen in older adults with MD compared to controls suggests that their impaired central visual field may hinder their ability to make precise steps. Also, a sudden reduction in light is more difficult for older adults with MD to accurately place the foot in a specified location. This suggests that the dark adaptation impairment of this population significantly impedes guiding accurate foot placements.

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P2-J-15 People with Parkinson's disease and healthy adults: Whole-body coordination when turning in response to a visual trigger

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BACKGROUND AND AIM: Turning round is a common everyday activity that can often lead to instability. People with Parkinson?s disease (PwPD) are at risk of falls; restricted head movements, flexed posture and reduced axial rotation are characteristic. Clinicians often describe PwPD as moving en bloc with little dissociation between head, trunk and lower limbs. The aim of this study was to investigate the sequence, latency response and velocity of the body segments during a 180° turn. METHODS: PwPD and healthy controls (HC) were asked to turn 180° in response to a central visual trigger to both preferred and unpreferred directions. The onset latency of the eye movements was captured by an eye camera (VNG Ulmer) and the head, shoulder, pelvis and feet movements were measured by CODAMotion. We recorded the motor section of the UPDRS, Hoehn and Yahr (H&Y) scale, Freezing of Gait and fall frequency. RESULTS: Thirty-one PwPD (14 females, mean age 68 years, mean time with PD 7 years, mean motor UPDRS score 16) and 15 HC (10 females, mean age 67 years) participated. Twenty were mild H&Y 1&2; 11 were moderate H&Y 3 &4; 15 were non-freezers and 16 freezers; 13 were repeat fallers and 18 single or non-fallers. The preferred direction of turn for two thirds of both groups (PwPD 20, HC 10) was to the right. A top down sequencing of body segments was evident although the eyes followed the head in both groups and in both directions. The latency responses of the head, shoulder, pelvis and feet of PwPD were significantly slower than the HC when turning to the unpreferred direction but only the latency response of the shoulder and pelvis were significantly slower than the HC when moved in the preferred direction (Table 1). The velocities of movement for all segments of the body in both directions were significantly slower than the HC (Table 2). CONCLUSIONS: Turning by both PwPD and HC was not initiated by using the eyes, although the sequential profile of movement was top down it began with the head (the eyes followed the head). The direction of turn influenced the latency response. When turning to the preferred direction only the shoulders and pelvis were significantly slower in their response rate to that of the HC. When turning to the unpreferred direction, head shoulders pelvis and feet were significantly slower in their response than the HC. In contrast, the velocities of the body segments through the turn in both directions were significantly slower than that of HC. Turning challenges people with PD. They are slower to move than people of similar ages and slower to respond to a trigger which in everyday life could be a perturbation that could place them at risk of instability. Both PwPD and healthy people of a similar age did not move their eyes to initiate the turn movement and although there was a top down profile the sequencing was not distinctive, suggesting an en bloc movement.

Table 1 Latencies of movement

Latency		Preferred				non Preferred		
	Group	N	Mean	Std. Dev	P=	Mean	Std. Dev	P=
HEAD	PWPD	31	.523	.1696	.120	.521	.1169	.002
	HC	15	.444	.1336		.414	.0584	
SHOULDERS	PWPD	31	.537	.1665	.049	.529	.1430	.001

	HC	15	.439	.1255		.39067	.0627	
PELVIS	PWPD	31	.725	.2139	.007	.525	.1186	.005
	HC	15	.552	.1480		.420	.0848	
FEET	PWPD	31	.887	.3737	.135	.937	.3863	.008
	HC	15	.732	.1745		.646	.1193	
EYES	PWPD	31	.554	.2032	.703	.599	.1903	.066
	HC	15	.531	.1648		.497	.0929	

Table 2 Velocity of movement

Velocity		Preferred				Non preferred			
	Group	N	Mean	Std. Dev	P=	N	Mean	Std. Dev	P=
Head	PWPD	31	49.597	22.7818	.000	31	47.062	22.7572	.000
	HC	15	85.470	17.5634		14	88.229	23.3217	
Shoulder	PWPD	31	43.609	18.3770	.000	31	42.785	18.4107	.000
	HC	15	75.326	13.3269		14	80.210	20.8020	
Pelvis	PWPD	30	46.365	19.8517	.000	30	47.072	22.0888	.000
	HC	15	71.984	17.9895		14	83.643	22.3224	
Left Foot	PWPD	27	53.672	32.9363	.000	25	46.246	28.6215	.000
	HC	12	119.117	53.4233		10	132.707	82.7201	
Right Foot	PWPD	28	58.675	36.9834	.000	27	51.434	27.2478	.000
	HC	12	110.428	22.8876		12	112.766	30.2844	

P2-J-16 Splitbelt walking: Adaptation differences between young and older adults

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BACKGROUND AND AIM: Human walking is highly adaptable, which allows us to walk under different circumstances. With ageing, the probability of falling increases, which may partially be due to an inability of older adults to adapt the gait pattern to the needs of the environment. Literature on visuomotor adaptations suggests however that older adults have little problems in adapting their motor behavior, but these experiments involved only simple single limb adaptations. It may be that adaptation during a more complex task like gait is compromised by ageing. METHODS: In this study, we investigated the ability of young (n=8) and older adults (n=12) to adapt their gait pattern to novel constraints using a split belt paradigm. RESULTS: Findings revealed that older adults adapted more slowly to split belt walking, and showed fewer aftereffects than young adults. Moreover, older adults initially failed to adapt their gait cycle timing to split belt walking. CONCLUSIONS: These changes in adaptability of gait have been suggested to stem from a degradation of cortico-cerebellar pathways (reduced adaptability), and cerebral structures (inability to change gait cycle timing). However, an alternative interpretation may be that the observed reduced adaptation is a compensatory strategy in view of the instability induced by the split belt paradigm.

P2-J-17 Alexander Technique is associated with increased use of degrees of freedom during quiet standing

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BACKGROUND AND AIM: The Alexander Technique (AT) is a postural education method thought to improve overall coordination such that motor performance is improved while pain and disability are reduced. Published studies indicate that the AT can reduce disability in people with Parkinson's disease (PD) (Stallibrass, Sissons, & Chalmers, 2002) and reduce pain in people with chronic back pain (Little et al., 2008). Studies also suggest that it can increase functional reach in elderly women (Dennis, 1999) and improve respiratory function (Austin & Ausubel, 1982). The AT may work by increasing dynamic regulation of tone (Cacciatore et al., 2011), and by decreasing habitual reliance on sub-optimal postural synergies (Jones, 1965). However, coordination changes underlying the effects of the AT are not yet well documented. Here, we sought to determine whether subjects with extensive AT experience have different coordination during quiet stance compared to age-matched control subjects and subjects with PD. METHODS: Quiet stance was measured with inertial sensors from three groups of 20 subjects each, matched for age, gender, and body mass: (1) trained teachers of the AT with over 1600 hours experience; (2) control subjects; (3) subjects with Parkinson's disease. Sway area was calculated for sensors placed at the sternum, lumbar, and ankle joints. RESULTS: Sway area was larger at the lumbar than at the ankle for control and PD subjects, but not for AT teachers. This suggests that AT teachers exploit degrees of freedom in knees and hips rather than moving as an inverted pendulum. CONCLUSIONS: Long-term experience with the AT may change coordination associated with well-learned activities such as quiet stance. The increase in use of degrees of freedom seen here is consistent with previous evidence for increased dynamic regulation of tone (Cacciatore et al, 2011) and suggests a more refined control of posture among people with AT training. The AT may hold promise as a rehabilitation approach for Parkinson's disease. In addition, AT teachers present an interesting

population for investigating basic principles of posture and motor control, and for raising questions about the differences between optimal and normal posture.

P2-J-18 Perception threshold of locomotor asymmetry while walking on a split-belt treadmill in healthy elderly individuals

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BACKGROUND AND AIM: Asymmetrical movements during functional tasks are well documented in people with hemiparesis following a stroke; thus, training these individuals to perform more symmetrically is one of the goals of rehabilitation therapists. However, studies reveal that individuals with hemiparesis do not perceive themselves as asymmetrical as they really are when executing the sit-to-stand task or while standing. Therefore, it would be relevant to determine whether they can better perceive their asymmetries for a repetitive task such as gait. As a first step, this study assessed how healthy subjects perceived difference between the two limbs when walking on a split-belt treadmill. METHODS: Twelve healthy elderly individuals (≥70 years old) participated in the study. They were asked to walk at their natural speed on an instrumented split-belt treadmill with both belts running at the same speed (natural gait). Afterwards, the perception threshold of locomotor asymmetry was determined using the ascending method of limits. In this condition, the speed of the belt under the dominant side was gradually increased until participants reported that they perceived themselves as walking asymmetrically. 2 trials were executed. At the perception threshold and during natural gait, the temporal parameters (stance time and double support time), vertical and anteroposterior (AP) peak ground reaction forces were identified for 5 consecutive gait cycles and then expressed as a ratio of asymmetry (slow belt/fast belt). Ratios at the perception threshold and ratios at natural gait were compared using paired Student t test. Relative differences between ratios were calculated for a better interpretation [((ratio at threshold - ratio at natural speed)/ratio at natural)*100]. RESULTS: Elderly individuals perceived their gait as asymmetrical when the ratio of belt speed was 0.89 ± 0.06 (ranged from 0.79 to 0.96). A strong association was found between the two trials ($r = 0.838$, $p<0.01$); thus, the mean value was used in subsequent analyses. Significant differences were observed between natural gait and at threshold during asymmetrical gait for the ratios of stance time and for the AP force (P1). These parameters were also the most correlated with the ratio of belt speed ($r = -0.74$; $p<0.001$ for stance time and $r = 0.42$; $p>0.05$ for P1). CONCLUSIONS: Healthy elderly individuals perceived themselves as asymmetrical when the belt speed differed by 11%. Stance time ratio showed the highest significant difference between conditions and was also highly correlated with the gait speed asymmetry suggesting that this factor should be considered in order to determine if a gait pattern is asymmetrical. In a future study, the data found at threshold will be used to determine whether stroke participants perceive adequately their asymmetrical gait.

P2-J-19 Whole-body coordination when turning on the spot in people with stroke and healthy controls

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BACKGROUND AND AIM: Turning around to interact with the environment is a common activity of daily living. The location of a target for interaction may be known or unknown prior to turning and the angle of a turn may vary depending on the task to be carried out. A stroke can compromise coordination of body movement during turning] which may pose a risk for instability and subsequent falls. The aim of this study was to investigate the kinematic sequence of rotation of body segments in people with stroke and healthy controls when turning on the spot to predictable and unpredictable targets placed at three different angles (45°, 90° and 135°). METHODS: Nine people with stroke [age: 64±9 (mean±SD) years] and nine healthy controls [age: 64±9 (mean±SD) years] were asked to stand in front of a light and either turn to a specific light (predictable condition) or locate and turn to a random light (unpredictable condition) placed at 45°, 90° or 135° to the right or left when the light in front extinguished. There were five trials for each task and the tasks were randomized. The onset latency of the horizontal eye movement was measured by an eye camera (VNG Ulmer) and that of the horizontal head, shoulder, pelvis and feet movement were measured by CODA motion. RESULTS: There was a top to bottom initiation of rotation of the segments when turning to unpredictable targets and a more simultaneous initiation of the segments when turning to predictable targets in both groups (interaction of segment and predictability: $F=27.004$, $p=0.001$). However, this was not different between the stroke and control groups (Interaction of segment, predictability and group: $F=2.887$, $p=0.082$). In the unpredictable condition, there was more simultaneous onset of eye, head and shoulder movement when turning to 45 and 90 degrees as compared to more increasing latencies for the 135 degrees condition (interaction of segment, predictability and angle: $F=19.443$, $p=0.001$). There was no difference in the sequence of the segments when turning to both sides in the stroke participants (paretic/non-paretic sides) and controls (right/left sides) (Interaction of segment, direction and group: $F=0.300$, $p=0.876$. CONCLUSIONS: Predictability of a target affects the sequence of rotation of segments during turning on the spot. The turn angle also affects the sequence when turning to unpredictable targets. The balance of an individual during a task is determined by the movement of the centre of mass within the base of support. This could be affected by the relative movement of the segments involved in the task. The clinical significance of the results of this study may be investigated by relating the sequence of the movement of the body segments to stability during turning. The similarity in the sequence between the groups may be due to motor and sensory deteriorations in the elderly.

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P2-J-20 Stepping strategies to optimize adaptability and stability during gait

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BACKGROUND AND AIM: To prevent falling during walking, not only the ability to generate a stable gait pattern is required, but also the capability to adapt this pattern in response to environmental conditions (e.g. to avoid obstacles). Previous studies demonstrated that people did not alter walking speed, but decreased step length and increased step frequency to maintain gait stability while perturbations of the walking surface were imposed[1-2]. The purpose of this study was to determine how these spatio-temporal step parameters are selected by able-bodied people to attain an adaptive gait pattern, and to examine whether these strategies interfere with strategies used to maintain gait stability. METHODS: Ten healthy subjects walked in a Computer Assisted Rehabilitation ENvironment (CAREN). To provoke an adaptive gait pattern, a gait adaptability task (GA-task) was used, in which subjects had to hit virtual targets, projected on a screen, with their knees. This task was performed both in the absence and presence of continuous quasi-random medio-lateral perturbations of the walking surface. A self-paced treadmill was used, which enabled subjects to regulate their walking speed throughout the trials. The effect of walking with and without the GA-task on walking speed, step length, step frequency, and step width was assessed. In addition, these trials were performed with and without balance perturbation. RESULTS: Compared to unconstrained walking a decrease in step length ($p<0.01$) was found in the trial where only the GA-task had to be performed, while step frequency remained unchanged. This resulted in a decrease in walking speed ($p=0.022$). When the GA-task was combined with the balance perturbation, step length further decreased, as evidenced by a significant interaction between the GA-task and the balance perturbation ($p=0.012$), again without a change in step frequency. CONCLUSIONS: To perform the GA-task subjects decreased their step length and walking speed in combination but did not change step frequency. In the situation where both adaptability and stability were challenged, walking speed and step length were further reduced, while step frequency was still kept constant. In a previous study we found that both reducing step length and increasing step frequency were used to enhance gait stability[1]. The current study shows that increasing step frequency is not the strategy of choice in situations where, besides a high degree of stability, a high degree of gait adaptability is required. We hypothesize that an increase in step frequency limits the time to respond to environmental cues and hence has a negative influence on the adaptability of walking. Enhancing both stability and adaptability thus requires a slower walking speed with shorter step length, as seen in many patients for whom walking both stable and adaptable is a challenging task.

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P2-J-21 The clinical utility of the BESTest, miniBESTest, and briefBESTest to predict falls in individuals with multiple sclerosis

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BACKGROUND AND AIMS: Quantifying clinical balance impairments to better direct therapeutic rehabilitation is important in mitigating specific impairments and minimizing fall risk. This study examined the clinical utility of the BESTest, miniBESTest, and a newer briefBESTest for inter-rater reliability, identifying people with varied neurologic disorders, and identifying the fall status of people with multiple sclerosis (MS). METHODS: Three researchers rated 20 individuals with and without diagnosed balance disorders on the BESTest. The evaluations were used to calculate scores for the miniBESTest and a newer briefBESTest assessment. The briefBESTest was defined by selecting the test item with the highest item-total correlation from each section of the BESTest. The validity and reliability of the BESTest, miniBESTest, and briefBESTest were examined. Thirteen people with MS and 13 matched controls were then assessed on the full BESTest. The effectiveness of the BESTest, miniBESTest, and briefBESTest to identify fallers from non-fallers was evaluated. RESULTS: Items of hip abductor strength, forward functional reach, one-leg stance, lateral push-and-release, stance with eyes closed on foam, and the timed-up-and-go test defined the briefBESTest. For the first cohort, intraclass correlation coefficients for all exam versions were > 0.98 across the three examiners. On average, the accuracy to identify people with or without balance disorders was 78% for the BESTest versus 72% for the miniBESTest or briefBESTest. The sensitivity and specificity to identify fallers and non-fallers with or without MS were 100% and 100% for the briefBESTest, 86% and 95% for the BESTest, and 71% and 100% for the miniBESTest. The briefBESTest was shown to be the only independent predictor of past falls when all three tests were considered ($F = 35.43$, $p < .001$). CONCLUSIONS: Although preliminary, this initial evidence suggests that the briefBESTest may be a clinically useful and feasible tool for assessing balance and gait impairment, providing an exam battery with the fewest items compared to the miniBESTest or BESTest while still including items from each theoretical system of postural control evaluated by the original BESTest.

P2-J-22 Dissociation of support surface forces and changes to muscle coordination during locomotion under postural loading conditions in people post-stroke

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BACKGROUND AND AIM: Individuals with post-stroke hemiplegia have impaired walking ability and are at high risk for slips and falls, because they are less capable of generating appropriate responses to challenging environmental conditions to prevent themselves from slipping. In individuals post-stroke, the impaired descending command control can result in the loss of independent joint control, generating increased mechanical stiffness at the ankle joint, affecting the ability to regulate forces in the most efficient directions during locomotion. The purpose of this study was to examine the ability of the paretic muscles to coordinate appropriately to dissociate shear forces relative to normal support surface forces appropriately first under body weight non-loading locomotor task, and then under a loading condition. METHODS: Non-impaired (n=11) and chronic (>6 months post stroke) stroke survivors (n=18) were positioned on a custom-designed motorized cycle ergometer. Subjects pedaled along with the motor-driven crank moving at 40rpm, generating a target normal pedal force of 40% maximal effort given visual feedback, under a seated non-body loading condition and a non-seated, body loading

condition. EMG from soleus (SOL), tibialis anterior (TA), vastus medialis (VM), rectus femoris (RF), and biceps femoris (BF), and pedal forces were collected. The force data was compared between groups and multiple regression analysis were performed to analyze EMG data. RESULTS: During the seated, non-body loading condition, shear force per unit normal force was not different between the two groups. Shear force regulation in non-impaired individuals involved modulation of ankle muscle activity. We also observed an inappropriate contribution to shear force generation by the thigh muscles in individuals post-stroke. However, during non-seated, body-loading locomotion, shear force per unit normal force increased in individuals post-stroke, but not in non-impaired subjects. CONCLUSION: Individuals post-stroke, even though they have less flexibility with muscle activity, were able to generate appropriate shear per normal forces during the seated non-body loading locomotor task, similar to non-impaired individuals. However, when postural mechanisms were involved to support body load, as in the non-seated body loading locomotor task, individuals post-stroke demonstrated inappropriately large magnitudes of shear force which might explain why people post-stroke have a higher chance of slipping on a slippery surface.

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P2-J-23 Relationship between stair ambulation with and without a handrail and centre of pressure velocities during stair ascent and descent

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BACKGROUND AND AIMS: Stair ambulation is one of the most challenging and hazardous types of locomotion for older adults and often requires the adoption of compensatory strategies such as increased handrail use to mitigate disability and increase stability. Centre of pressure (COP) velocity describes the neuromuscular response to shifts of the body's centre of mass and serves as an indicator of stability1,2. Knowledge of COP velocities may provide some understanding of the strategies to improve measured and perceived stability during stair negotiation. The aim of this study was to compare COP velocities during stair ascent and descent with and without a handrail in healthy young, older adults and to describe the pattern in older adults with a fear of falling (FOF) METHODS: COP velocities of 23 healthy young adults (23.7 3.0yrs), 26 healthy older adults (66.4 8.3 yrs), and 3 older adults with FOF (80.2 8.0yrs) were analyzed while they ascended and descended a custom 4-step staircase with and without a handrail. COP velocities were obtained using a force plate mounted on concrete blocks centred on the second step of the staircase. Differences between conditions for COP parameters were tested using a three--way ANOVA with repeated measures of condition (no handrail/handrail), direction (ascent/descent), and between subject factor. Statistics were not performed on adults with FOF; due to the small sample size only observations were made. RESULTS: During star ascent and descent, with and without a handrail, the COP velocities between healthy young and older adults were comparable. The 3 older adults with FOF demonstrated lower COP velocities during ascent and descent without the handrail and even slower COP velocities when ascending and descending stairs with the handrail. These results suggest that handrail use does not increase biomechanical stability for healthy, older adults. However, in the presence of fear of falling the use of the handrail may enhance dynamic stability, particularly during stair descent. CONCLUSIONS: This study provides the first detailed description of dynamic stability during stair ambulation with and without a handrail. Observations from those with FOF aid in understanding the nature of the compensation to improve actual and perceived stability.

Table 2. Mean (SD) cadence, COP Velocity and COP Velocity in the M-L and A-P directions during stair ascent and descent for young, older, and older adults with a fear of falling.

Measure	Condition		Young Adults	Older Adults	Fearful of Falling Older Adults
Cadence (steps/min)	Ascent*	NH	101.8 (9.0)‡	96.5 (13.9)	76.3 (15.4)
		H	97.7 (7.8)‡	96.5 (13.3)	81.5 (18.6)
	Descent*	NH	110. 8 (10.8)‡	103.8 (15.1)	85.1 (10.5)
		H	105.4 (12.8)‡	105.2 (16.0)	90.5 (26.3)
COP Velocity (cm/sec)	Ascent*	NH	28.6 (8.3)	25.5 (6.01)	25.1 (6.7)
		H	29.9 (11.9)	26.8 (5.9)	25.4 (8.2)
	Descent*	NH	42.6 (15.2)	36.4 (7.5)	34.2 (8.3)
		H	40.5 (13.9)	37.7 (7.7)	27.9 (5.4)
COP Velocity M-L Direction (cm/sec)	Ascent	NH	12.2 (4.5)	11.9 (2.9)	9.9 (3.6)
		H	11.9 (4.4)	12.1 (3.6)	9.3 (3.7)
	Descent	NH	17.9 (6.9)	17.4 (4.3)	12.1 (5.8)
		H	16.9 (6.6)	16.9 (5.4)	8.1 (4.8)
COP Velocity A-P Direction (cm/sec)	Ascent	NH	21.8 (6.8)	19.7 (5.7)	21.7 (6.1)
		H	23.6 (9.9)	21.2 (5.7)	22.1 (6.9)
	Descent	NH	34.6 (12.9)	29.5 (6.8)	30.7 (6.4)
		H	33.1 (12.4)	31.1 (7.9)	25.6 (5.1)

The values presented for COP velocity are the absolute values.
NH, no handrail; H, handrail.
* Significant difference between directions (ascent vs. descent)
‡Significant differences between stair conditions (H vs. NH)

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P2-J-24 Uncontrolled foot contact during single and dual-task walking in people with Parkinson's disease and older adults

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BACKGROUND AND AIM: Unintended or uncontrolled foot contact with the ground when walking (defined as a scuff) may put people with Parkinson's disease (PD) and older adults at risk of falls and reflect underlying problems with motor control during gait. Performing a concurrent cognitive task whilst walking (dual tasking) potentially distracts older adults and people with PD putting them at

greater risk of slips, trips and falls. We aimed to test i) whether people with PD scuff their feet when walking more frequently than age-matched controls; ii) if performing a concurrent cognitive task (dual-tasking) results in more frequent scuffing; and iii) whether more frequency scuffing is associated more severe PD motor symptoms. METHODS: Nineteen recently diagnosed people with idiopathic PD (mean ± sd) age: 67.1 ± 11.5; UPDRS III: 26.3 ± 9.2; (tested at peak dose of levodopa medication) and 19 age-matched controls (age: 65.3 ± 7.2). Participants walked around a 25 meter circuit for 2 minutes under single and dual task conditions at their preferred pace. During the dual task condition, participants were required to walk whilst being distracted by a digit recall task (normalised to digit span during sitting). Raw GAITrite data was viewed in GAITraw software. A scuff was identified when the foot contact was detected by the pressure sensors within the mat prior to normal heel contact. A mixed ANOVA was used with logarithmic transformed scuff rates to test for mean differences and factor interactions. Pearson's correlations were used to assess relationships between gait and scuff variables. RESULTS: Main effects for group ($p = .021$) and condition ($p < .001$) showed that people with PD scuffed their feet more often than controls, and participants from both groups scuffed their feet more often under dual-task conditions (Figure 1). A group by condition interaction ($p = .023$) indicated that scuff rate increased more under dual task conditions in people with PD than controls. More severe PD motor symptoms was moderately related to more frequent scuffing under single ($r = .342$, $p = .012$) and dual task ($r = .410$, $p = .002$) conditions. CONCLUSIONS: People with PD scuff their feet when walking more often than controls, particularly when distracted by a concurrent cognitive task. Increased scuffing was related to more severe motor symptoms in people with PD and may reflect deteriorating control of gait associated with the progression of the disease.

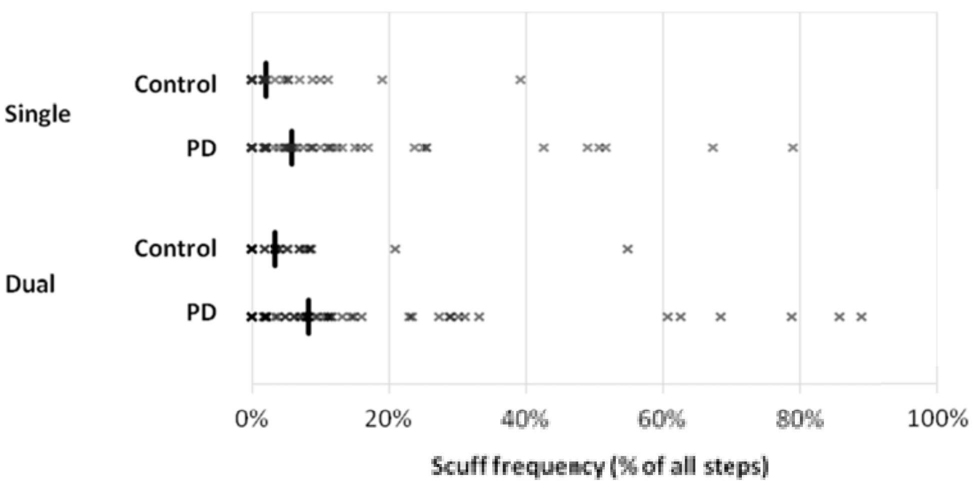

Figure 1: Scuff rate (total scuffs/total steps * 100). Vertical lines indicate group medians.

P2-J-25 Age-related differences in muscle activities on legs during stairs descending in dual task

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BACKGROUND AND AIMS: The case of falls on steps for all ages, 75% occur in people 65years and older. Previous study has been shown that decreased attentional capacitity contributes a factor to fall in older adults. The dual task methodology has been used to assess how diminished attentional capacity influences postural control on standing upright or walking in older adults. However there are few studies that investigated the effect of dual task against postural control during stairs descending in elderly. The purpose of the study was to analyze the lower limb muscles'activities and compare between older and younger adults during stairs descending under dual task condition. METHODS: Nine younger (mean21.6 years old) and 12 older (mean 72.2 years old) adults participated in the study. They performed two task conditions: descending four stairs (a single task) and descending four stairs with reciting names such as animals, vegetable and fruits (a dual task). EMG activities of the gastrocnemius lateralis and tibialis anterior on both legs were recorded with a telemetric system and analyzed RMS (the root-mean-square) amplitude of two muscles'activities on the support foot in 100 ms following each stairs contacts. RESULTS: The results demostrated older adults significantly extended the time in each step during descending stairs and decreased leg muscles'activities when they contact on each step, compared to the younger adults in dual task. Furthermore we found that older adults significantly had different muscle coactivities, which means ratios of tibia anterior by gastrocnemius lateralis, between single and dual task. CONCLUSION: We concluded that older adults were not able to utilized muscle coactivities on legs, which is the strategy particularly for elderly, in order to maintain postural control in dual task. From these results we assumed that stair descending with increase of attentional requirement makes older adults frail and easily to fall.

P2-J-26 Anticipatory postural control under external task time constraints

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BACKGROUND AND AIM: The coordination of posture and movement is an integral part of performing daily activities. While it is well known that the central nervous system (CNS) accommodates for balance disruptions induced by self-movement via anticipatory postural adjustments (APA), it is still unclear as to this control is organized within the CNS. Previous studies seeking to determine the mode of control have employed various arm (focal) actions; however, these experiments used primarily self-triggered or paced movements. The purpose of this study was to determine whether APAs are still employed with a focal task under very tight temporal constraints as dictated by the task, and whether APA generation depended on different spatial and temporal foreknowledge of the task. METHODS: Young adults (n=10) attempted to catch a small ball under 4 conditions of temporal and spatial pre-knowledge: 1) temporal condition (T): 5 s countdown to ball launch, 2) spatial condition (S): the aim of launch (upper and lower left and right) given beforehand, 3) combined condition (TS): both temporal and spatial cues, 4) control condition (C): no pre-cues. The launcher was hidden, and ball velocity (±3.4%) tightly controlled, taking 500 ms to reach the subject. Muscle activity was recorded from the legs (tibialis anterior, gastrocnemius, rectus femoris bilateral) and catching arm (deltoid, pectoralis major). Motion of the catching arm was tracked (Optitrack) while subject stood atop a force plate. Onsets were determined by a sliding 25ms time window exceeding pre-launch baseline activity (mean plus 95% confidence band) for EMG, ground reaction forces (GRF) and whole-body COM motion. Body motion induced by the arm catching motion was accounted by subtracting the acceleration effects from arm COM motion (determined via kinematics) on whole-body COM. A two way repeated-measures ANOVA compared the onsets between the fastest response time among the focal and postural muscles based on foreknowledge conditions. RESULTS: Participants made catching attempts in all trials, despite the time-constraint resulting in low catches (21% of trials) and ball contacts (hit hand or catch; 66%). The time constraints triggered rapid onsets, but no difference (p=0.91) was found between the fastest focal (168±52 ms) and postural muscle (170±52 ms; p=0.91) response, across pre-knowledge conditions (interaction: p=0.51). Temporal cuing yielded faster onsets in focal (S: 162±50 ms TS:151±49 ms) and postural (S: 157±52 ms TS:150±60 ms) muscles, with spatial cuing onsets no different than control trials in either focal (S: 181±46 ms C: 180±57 ms) or postural (S: 182±47 C: 192±34 ms) muscles. CONCLUSION: Postural muscle activity still accompanied a focal action under extreme temporal constraints. Analysis of the kinematic and kinetic analysis will reveal whether the postural muscle activity was specific to parameters of the catching action (i.e. direction, speed), or reverted to a stiffening strategy.

P2-J-27 An analysis of spatio-temporal gait characteristics in elderly with osteoporosis and a reported fear of falling

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BACKGROUND AND AIM: Osteoporosis (OP) is a common and costly, fracture-related skeletal disease. Combined with fear of falling, OP may implicate gait alterations. Furthermore, altered gait patterns while performing an added task (dual-task) have been related to an increased risk of falling. The aim was to characterize spatio-temporal gait parameters, by comparing performance during gait at maximum velocity and cognitive dual task conditions, respectively, to gait at normal velocity during single task conditions, in elderly subjects with OP and self-reported fear of falling. METHODS: 80 elderly subjects (mean age 76 years, range 64-87) with OP and fear of falling (Falls Efficacy Scale International; median score: 27) performed three conditions of gait (at normal and maximum velocity, and while performing a dual-task - consisting of counting every second letter of the Swedish alphabet) using an instrumented walkway system (GAITRite). Between gait condition divergences were analyzed with repeated measurements analysis of variance and significant main effects were explored with Tukey HSD post-hoc test. RESULTS: During gait at maximum velocity the subjects walked with significantly increased (p= 0.000) velocity, cadence, step length and swing phase %, and with reduced in double support %- as compared to gait at normal velocity. When a cognitive dual task was added, velocity and cadence were significantly decreased (p=≤0.016), whereas step width and step length variability was increased (p= ≤0.005) compared to gait at normal velocity. CONCLUSIONS: Performance of a cognitive dual-task during gait significantly altered gait velocity, step width and step length variability in subjects with OP and fear of falling- gait parameters related to an increased risk of falling. Hence, considering the increased susceptibility to fractures in this population, a gait and balance training regime, emphasizing DT conditions- might to be of importance to prevent future falls.

P2-J-28 Movement strategies in tandem stance: Differences between trained tightrope walkers and untrained subjects

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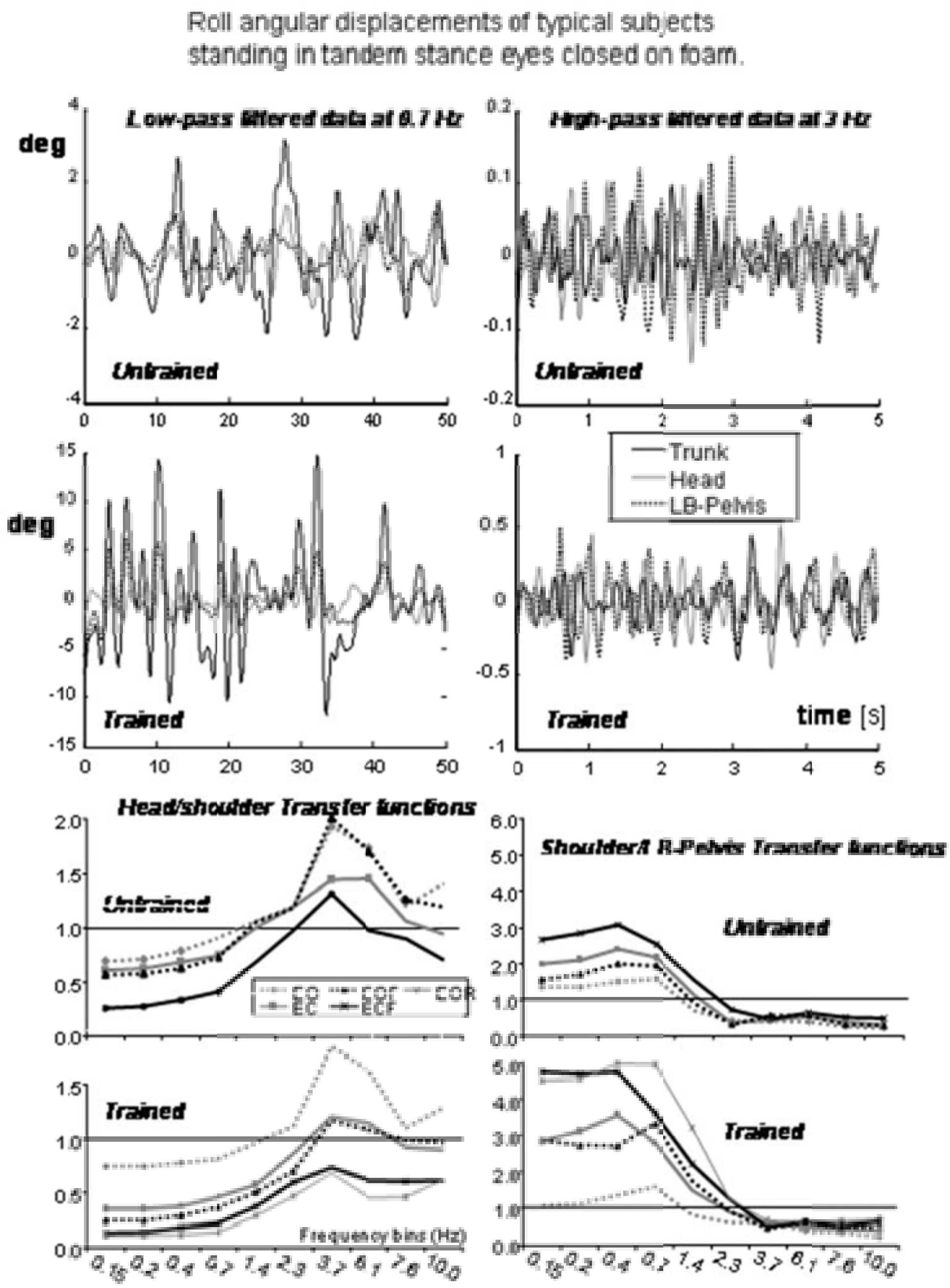
BACKGROUND AND AIM: Standing on a tightrope involves careful control of tandem stance. We asked the question whether tightrope walkers learn to control balance well for during tandem stance by changing inter-segmental movement strategies and/or sensory reweighting compared to strategies of those without training. METHODS: Seven trained circus tightrope walkers (TRWs) and 12 age- and gender-matched healthy controls (HCs) participated, performing four tandem stance tasks: standing on a firm or foam support surface, with eyes open or closed. In addition data was recorded from the TRWs standing on the tightrope. Data was recorded with 6 body-worn gyroscopes; a set of 2 mounted at the upper trunk between the shoulders (SwayStar) and an identical set at the lower-back(LB)-pelvis (L1-3, near to the location of the centre of mass), and another lighter but less accurate set (XSens) on a head band. The roll angular velocities recorded with each set were spectrally analysed and integrated for angle correlation analysis in three frequency bands: below 0.7Hz (LP), above 3 Hz (HP) and in between (BP). RESULTS: Standing on the tightrope yielded identical levels of angular velocity in power spectral density functions (PSD) as for tandem stance eyes closed on foam. Angle (see upper part figure) and angular velocity levels were larger at the head, upper trunk and pelvis for TRWs compared to HCs across sensory conditions, except for LP sway at the head and LB-pelvis. Insegemental motion gains as observed in PSD ratios and transfer functions (TFs, see figure) was different between TRWs and HCs. Less head relative to trunk motion was observed but greater trunk relative to LB-pelvis motion was observed for TRWs. For both groups, PSD ratios and TFs of head to trunk motion decreased with increasing task sensory difficulty, but increased for trunk to pelvis motion (see figure). These differences were more pronounced at low frequencies for the head on trunk, and high frequencies for the trunk on LB-pelvis motion. Low frequency angle correlation data of both groups also indicated that head motion for both groups changed from being "locked" to the trunk for the easiest sensory condition to independent of trunk motion for more difficult sensory conditions. CONCLUSIONS: We conclude that new intersegmental movement strategies are not acquired during training for standing on the tightrope. The form of sensory reweighting with task difficulty remains unchanged. Trunk responses to pelvis movements increase in gain and head responses to shoulder movements decrease with training. Because the head and lower body was kept relatively more stable in space for both groups we assume trained subjects made greater use of neck and lumbro-sacral proprioceptive inputs to control balance. The similarity of tandem stance eyes closed on foam to that of eyes open on a tightrope indicates that the foam task could be used as a safe but effective method of training tightrope walkers.



P2-J-29 Postural control between genders in young adults

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BACKGROUND AND AIM: In general, researches about postural balance control in adults present no difference between males and females (MAKI, 1990, WOLFSON, 1994 and HAGEMAN, 1995). Age and visual information are important factors for the postural balance control (LORD & MENZ, 2000 and STEINDL et al, 2006). The purpose of this study was to compare the postural balance control in a bipedal stance between males and females from 18 to 23 year-old during eyes open and eyes closed situations. METHODS: Twenty eight healthy adults with age ranging from 18 to 30 years (14 females and 14 males) participated in this study. Ethical approval and written informed consent were obtained. Three trials of each position (base closed and open eyes; base closed and eyes closed) were collected during 30 seconds using a force platform (AccuSway Plus, AMTI Inc, MA, USA) with an acquisition frequency of 100 Hz. The parameters recorded were: 90% ellipse area (AreaCOP), average velocity (COPvel) and amplitude of the center of pressure in the anteroposterior (COPap) and mediolateral (COPml) directions. The data were filtered using a 10Hz cut-off Butterworth filter. Statistical analysis was performed using SPSS software version 13.0 (SPSS Inc, Chicago, IL, USA). T-tests were used to compare the dependent variables in the different situations ($p<0.05$). RESULTS: The results are presented in Table 1. Gender differences ($p<0.05$) were observed for the COPap intra-group during EO and for COPap and AreaCOP during EC, with male having better results than female. In all the variables, the female subjects obtained better results with eyes open than with eyes closed. These results present the importance of the visual system to maintain the postural balance control (LIU et al., 2001 and LORD & MENZ, 2000). On the other hand, males just have significant poor performance at the variables of COPml and COPvel with eyes closed. Comparing genders, the results present better performance in male than female subjects in eyes open situation in COPap. In the eyes closed situation female had significantly poor results than male for COPap and AreaCOP. CONCLUSION: The results of this study are in agreement with previous researches that the visual feedback presents importance in the postural control in adults. In the gender comparisons we found males had better performance than females.

Table 1 – Intra-group and inter-group COP parameters results

	Intra-groups						Inter-groups	
	Female			Male			EO	CE
	EO	CE	*p*	EO	CE	*p*	*p*	*p*
COPml	2.11±0.35	3.52±0.96	0,02	1.94±0.37	2.96±0.51	0.02	0,21	0,06
COPap	2.23±0.42	3.27±0.74	0,03	1.81±0.45	2.27±0.48	0,06	0,02	0,00
COPvel	1.20±0.29	2.10±0.57	0.00	1.06±0,18	1.75±0.34	0.01	0,13	0,06
AreaCOP	3.55±1.27	8.06±3.30	0.00	2.65±1:15	4.49±1.76	0,08	0,06	0,00

*$p < 0.05$ significant differences

P2-J-30 Voluntary and automatic posture control in traumatic transtibial amputees

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BACKROUND AND AIM: Altered postural stability in lower limb amputees is reflected in both static and dynamic aspects of balance. Decreased balance control is a result of biomechanical (altered movement strategies) and neurophysiological changes (absence of afferent information). Altered sensory-motor integration after lower limb amputation leads to compensating and adaptive mechanisms. The aim of our study was to assess aspects of automatic and voluntary control in transtibial amputees (TTAs) compared to healthy subjects. METHODS: The experimental group consisted of thirteen TTAs due to trauma. All TTAs were users of a dynamic foot and they had no history of falls in the last year and had absence of pain or injury to the stump. The control group was made up of seventeen healthy subjects. In both groups were evaluated by dynamic computed posturography:1) body weight distribution in a quit upright stance, 2) body weight distribution within automatic posture reaction on platform translation, 3) voluntary control of maximal body inclination based on visual feedback. RESULTS: TTAs placed significantly more weight on their non-amputated leg in quit stance and within automatic posture reactions compared to healthy subjects. Preferential non-amputated leg loading was higher during platform translation. Difference between experimental group in maximal voluntary body inclination toward amputated or non-amputated leg and control group towards right or left leg was not significant. CONCLUSIONS: In situations with increased demand for automatic posture control in traumatic TTAs, the loading of non-amputated limb was higher, compared to quit stance. Within voluntary control of body inclination in sagittal plane under visual feedback the preferential usage of non-amputated leg was not obvious. Notwithstanding that under visual feedback TTAs were able to shift weight on amputated leg comparably to healthy controls; within automatic posture reactions they prefered non-amputated leg with intact aferent informations.

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P2-J-31 Effects of calf muscle fatigue on stepping down during gait

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BACKGROUND AND AIM: Ankle plantar flexors primarily regulate balance during gait (Helbostad et al., 2010) and conduct the landing strategy in stepping down (van Dieën et al., 2007). In normal gait, a delayed activity of leg muscles and an increase in the base of support were observed after inducing calf muscle fatigue (Helbostad et al., 2007; Parijat and Lockhart, 2008a,b). However, effects of muscle fatigue on the negotiation of uneven surfaces are comparatively uncharted. As balance problems caused by fatigue can increase the risk of falling, we aimed to investigate the effects of calf muscle fatigue on stepping down during ongoing gait. METHODS: Ten healthy participants (27.60±2.80 years old) were instructed to walk over an elevation in which a force plate war mounted and step down onto another, 10 cm lower force plate before and after fatiguing the plantar flexors of both legs. For the fatiguing exercise, the participants repeatedly performed the standing calf raise exercise (Berger et al., 2010), at a frequency of 0.5Hz controlled by a metronome. An optical system with 3x3 cameras was used to record kinematics parameters (100 samples/s). Ground reaction forces were recorded (1000 samples/s) by the two force plates, which were placed at the two levels around the 10cm height difference. Net moment, power and work at ankle, knee and hip joints at the landing side were estimated using a 3D linked-segment model (Kingma et al., 1996) and peak values occurring within 200 ms after landing were determined. In addition, the spatial and temporal parameters of gait components in the approach phase were determined before and after fatigue. Paired t-tests were used to evaluate the effects of fatigue. RESULTS: After calf muscles were fatigued, decreases in stride length and speed and increases in stride width were observed in the approach phase (Table 1). In the landing phase during stepping down, total negative work and the peak value of hip joint moment were significantly higher after calf muscle fatigue compared to before calf muscle fatigue. Still, the participants used the same strategy at the landing after and before fatigue (70% - heel landing, and 30% - toe landing). CONCLUSION: Calf muscle fatigue affected the landing strategy used in stepping down as reflected in a decreased approach speed, an increased base of support (step width) and an increased energy absorption by the leading leg, which were used by the participants to improve the balance.

Table 1. Means and standard deviations of spatial-temporal parameters and kinetics of the leading leg in landing before and after calf muscle fatigue.

		Before fatigue	**After fatigue**	***p*-value**
Spatial-temporal parameters				
Stride length (cm)		150.01±9.34	147.09±12.10	**0.002**
Stride width (cm)		14.83±3.97	16.07±3.88	**0.02**
Stride speed (cm/s)		133.10±13.89	130.26±14.40	**0.02**
Stride duration (s)		1.13±0.09	1.13±0.10	0.86
Single support (s)		0.97±0.07	0.95±0.08	0.08
Double support (s)		0.16±0.07	0.18±0.08	0.11
Kinetics of landing leg				
Peak moment (Nm)	Ankle	43.48±30.79	46.36±25.79	0.18
	Knee	105.98±27.45	109.50±29.61	0.20
	Hip	63.15±40.82	71.45±42.71	**0.001**
Peak power (W)	Ankle	-205.29±129.29	-207.75±108.18	0.80
	Knee	-208.66±92.42	-218.75±108.13	0.18
	Hip	-147.18±99.74	-129.05±91.16	0.12
Negative work (J)	Ankle	-14.58±8.28	-14.49±6.87	0.88
	Knee	-25.67±10.05	-27.43±12.18	0.13
	Hip	-15.66±12.62	-16.93±12.48	0.10
	Total	-55.92±18.42	-58.85±17.44	**0.02**

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P2-J-32 The influence of weight bearing asymmetry on the stepping threshold following multidirectional perturbations

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BACKGROUND AND AIM: Impaired balance is a risk factor for falls in patients with stroke. Sensorimotor deficits, such as reduced muscle strength, contribute to this loss of stability [1]. After stroke, weight-bearing asymmetry (WBA) is common and is regarded as a compensatory strategy for the reduced dynamic contribution of the paretic leg to balance control [2]. In healthy subjects, however, WBA results in poorer static balance [3]. The effect of WBA on stepping responses, which are critical for balance recovery in daily life, has not been studied. Therefore, the purpose of this study was to determine the effect of WBA on the threshold for reactive stepping in healthy subjects. METHODS: Ten healthy young participants were subjected to multidirectional stance perturbations by translations of the support surface for 3 levels of WBA (0, 10 and 20% of body weight unloading of one leg). The stepping threshold was determined iteratively for each condition and in four directions (forward, backward, leftward and rightward). The stepping threshold was defined as the highest perturbation intensity recovered with a feet-in-place response and three attempts were allowed at each intensity. The Margin of Stability (MoS) at the stepping threshold was defined as the minimum distance between the vertical projection of the Center of Mass (CoM, as determined from full-body 3D kinematics) and the edge of the base of support. RESULTS: The stepping threshold for forward and backward perturbations was not affected by WBA. In contrast, significant effects of WBA were observed on stepping thresholds for lateral perturbations. The threshold decreased (i.e. stability decreased) for perturbations towards the loaded side (i.e. translations towards the unloaded side), whereas it increased for perturbations towards the unloaded side ($p<0.01$). No significant effects of WBA were found on the MoS in any direction ($p>0.05$). CONCLUSIONS: These findings suggest that the degree of instability (i.e. MoS) at which reactive stepping occurs is not affected by WBA. In lateral perturbations, the perturbation intensity at which this critical MoS is reached depends on the degree of WBA, with higher stepping thresholds (and thus increased stability) for perturbations towards the unloaded side. Therefore, unloading of the paretic leg in patients with stroke may be an effective compensatory strategy to increase the ability to sustain perturbations towards the paretic side.

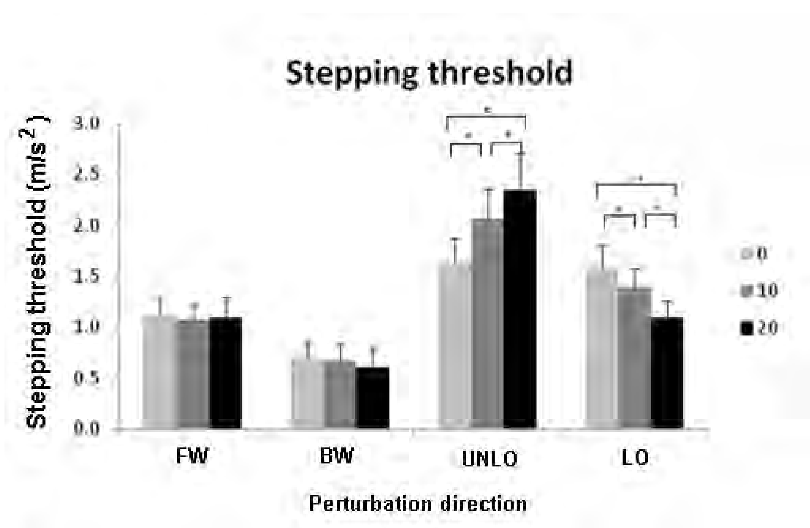

Figure 1. Stepping thresholds (in m/s^2) for different levels of weight-bearing asymmetry (0, 10 and 20% of body weight unloading of one leg). Abbreviations: FW = forward, BW = backward, UNLO = unloaded side, LO = loaded side. * = $p < 0.05$.

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P2-J-33 Dopaminergic medication does not improve balance recovery responses after multidirectional stance perturbations in Parkinson's disease.

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BACKGROUND AND AIM: Impaired balance is an important risk factor for falls in patients with Parkinson's disease (PD). Dopaminergic medication can improve some elements of postural control, but not all. Here, we focus on the effects of dopaminergic medication on reactive stepping responses, which in everyday life are critical for successful balance recovery after postural perturbations. Dopaminergic medication does not influence balance recovery responses after strictly unidirectional stance perturbations, but this is a somewhat artificial circumstance [1]. The question addressed in the present study is how dopaminergic medication affects stepping responses after multidirectional perturbations that closer resemble everyday circumstances. METHODS: Ten patients with PD were subjected to multidirectional stance perturbations by translations of the support surface. Patients were tested both in their optimal medication ON state and in the practically defined OFF state (Hoehn & Yahr stage 2-3; UPDRS motor score 30.0 ± 10.1 ON medication and 34.1 ± 12.0 OFF medication). The stepping threshold was determined iteratively for four directions (forward, backward, leftward and rightward) and was defined as the highest perturbation intensity (acceleration level) that could still be recovered with a "feet-in-place" response (i.e. without need for compensatory stepping). Three attempts were allowed at each intensity. In addition, perturbations at four fixed intensities were delivered in each direction and in a random order. To calculate step characteristics for these perturbations (i.e. step length, step onset, step duration and step velocity) 3D full-body kinematics were recorded. Stepping thresholds were compared between the ON and OFF state, as well as step characteristics for forward and backward perturbations at the highest fixed acceleration level (1.75 m/s^2 for forward perturbations and 1.5 m/s^2 for backward perturbations). RESULTS: No significant effects of dopaminergic medication were found on the stepping thresholds in any direction or on step variables for forward and backward perturbations. CONCLUSIONS: These results indicate that dopaminergic medication does not improve balance recovery responses to multidirectional stance perturbations. The findings may be explained by previous studies that suggested a contribution of degeneration of cholinergic pathways to postural disorders in patients with PD [2]. In addition, there is some evidence that acetylcholinesterase inhibitors can reduce fall rates in PD patients with frequent falls [3]. However, improvement of balance recovery responses by this type of medication remains to be proven.

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P2-J-34 Body posture stability is primarily affected during treadmill walking when compared to overground walking

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BACKGROUND AND AIM: Comparisons between gait characteristics on the ground or on a treadmill have shown limited differences so far. However, data about balance requirements in the two conditions are limited. The objective of this study was thus to compare dynamic stability during overground and treadmill gait in young and older adults. Task modifications such as no arm swing and wider steps were also used because difference in balance in the two conditions may be subtle due to high automaticity of gait. METHODS: Fifteen participants (7 young (21.4±1.0 yrs old), 8 older (70.6±14.2 yrs old)) were included in the study. They had no major health history or known balance deficits. Berg Balance score and ABC scale score did not differ between the two groups, but Timed-Up-Go was longer in the older group (6.03±0.71 vs. 7.49±0.98 sec, $p<0.01$). All scores were within normal values. 3D whole-body kinematics and ground reaction forces were measured during five one-leg stance periods and analyzed for each participant in each of the following gait tasks: natural, no arm swing and wider steps (50% of lower limb length). Each task was made in three conditions: Treadmill: belt in motion at comfortable speed determined on the treadmill; Ground: on the treadmill with belt stationary, at comfortable gait speed determined overground; and TreadmillOG: belt in motion at overground comfortable speed; with Treadmill being significantly slower than the overground comfortable speed used in Ground and TreadmillOG conditions. Step frequency was maintained constant using a metronome. Stabilizing and destabilizing forces, and stability index were computed according to Duclos et al (2009) to respectively evaluate dynamic, postural and global stability. Their mean value was compared between tasks, conditions and groups using ANOVA and post hoc t-tests. RESULTS: Global stability was reduced when walking at overgound speed on the treadmill (TreadmillOG), compared to the two other conditions ($p<0.05$), which were similar to each other ($p=0.39$). No difference was observed between tasks or groups for global stability. In terms of postural stability, walking with wider steps was more unstable than natural walking or without arm swing; body posture was also more unstable when walking on the treadmill (Treadmill and TreadmillOG were not significantly different, $p=0.42$) compared to on the ground ($p<0.001$). Body posture of the older group was more stable than for the young group, on the ground only. In terms of dynamic stability, the tendency of natural and wider step gait to be more stable than no arm swing was not confirmed statistically ($0.05<p<0.1$). CONCLUSIONS: Walking on a treadmill primarily affected postural stability compared to overground, while comfortable speed overground or on the treadmill were more stable than walking at faster than comfortable speed on the treadmill. Further study with more participants is needed to better understand the determinants of dynamic stability.

P2-J-35 Effects of arm movement amplitude on the initial trunk muscle activation pattern during rapid bilateral shoulder flexions in standing

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BACKGROUND AND AIM: Rapid arm movements are frequently used to perturb postural equilibrium and evaluate associated trunk muscle responses. Often the focus lies on the onset latencies of trunk muscle activation, particularly of the transversus abdominis muscle (TrA), associated with movement initiation. The hypothesis investigated here was that the amplitude of a rapid shoulder flexion movement would influence the onset latency and level of initial activation of trunk muscles. METHODS: Eleven healthy male subjects performed rapid bilateral shoulder flexions in standing. The start position was with arms along the sides (0°) and the end position was either 45° or 90° of flexion. Each movement was repeated three consecutive times. Kinematics was recorded in 3D with an optoelectronic system. Bilateral EMG recordings were made from TrA and obliquus internus (OI) with intramuscular fine-wire electrodes, and from rectus abdominis (RA), erector spinae (ES) and anterior deltoideus (Delt) with surface electrodes. Trunk muscle EMG onset latency was measured relative to the activation onset of the ipsilateral Delt. The magnitude of activation, normalized to that during maximal voluntary contraction (MVC), was measured during a 100 ms interval starting 50 ms before the start of the acceleration of the arm. RESULTS: Duration of the acceleration of the arm, mean velocity and mean acceleration increased with movement amplitude; 0.17-0.19 s, 2.0-3.6 rad/s, and 28.5-40.1 rad/s2, respectively. The sequencing of trunk muscle onsets was the same regardless of movement amplitude, with ES being the first muscle activated followed by TrA, RA and OI (Fig 1A). The latencies shortened with increased amplitude for all muscles except ES (Fig 1A). Regarding the magnitude of activation, TrA displayed a significant increase of activation with the larger movement amplitude; OI and RA did not change their level of activation, whereas there was a trend towards an increase for ES (Fig 1B). CONCLUSIONS: Increasing the amplitude of rapid shoulder flexion from 45 to 90° significantly increased the arm acceleration, and thus the perturbation on the trunk. This larger perturbation was associated with specific modulations of trunk muscle activation. Although all onset latencies were within the realm of feedforward control, there was a clear shortening of abdominal muscle latencies, indicating a change in preprogramming in anticipation of the larger perturbation. Interestingly, only TrA showed a simultaneous modulation of activation amplitude. An augmented demand for general spine stabilization may underlie the increased TrA activation, or part thereof. The tendency towards increased ES amplitude is compatible with the larger reactive trunk flexion moment induced by the larger arm movement. Another implication of these data is that arm movement amplitude should be standardized when using rapid shoulder flexions to test activation patterns of abdominal muscles.

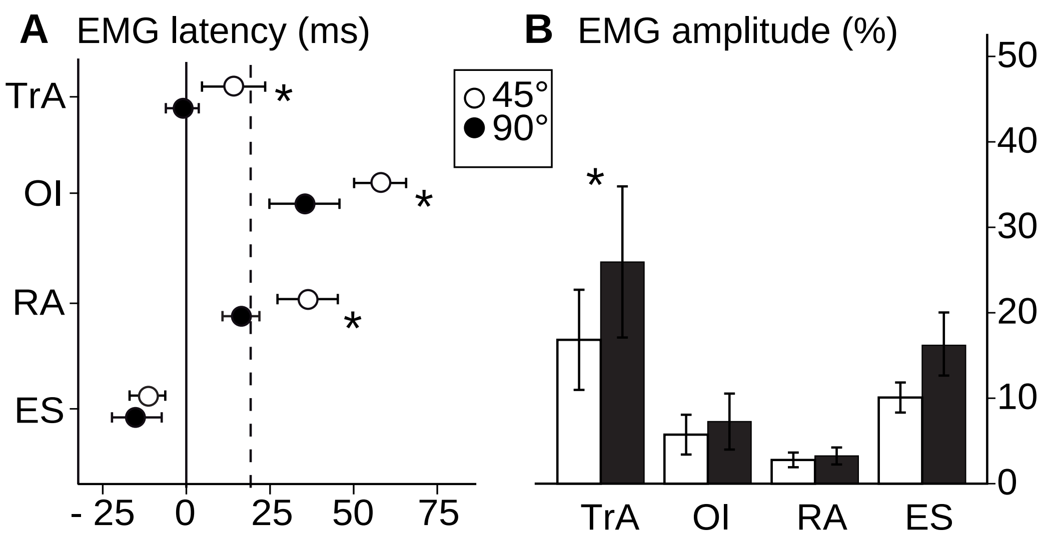

Figure 1 A. Mean onset latency, in ms, relative to the onset of Delt activation (continuous vertical line) and to the onset of the arm movement (dashed vertical line), respectively, and B. Mean EMG amplitude, in % of that during MVC, at the start of acceleration of the arm, for the four trunk muscles and the two shoulder flexion amplitudes. Error bars represent 95% CI and * indicate a significant (p<0.05) difference between movement amplitudes.

P2-J-36 How are anticipatory postural adjustments affected by changes in postural constraint?

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BACKGROUND AND AIM: Understanding of how the CNS adapts balance strategies when postural set is changed is evolving. Modification to postural set changes the demands to maintain balance and, during arm movements, could affect the postural adjustment or focal movement. This study investigated how APAs and focal arm movements are affected by changes in base of support, position of the COM, and illusory changes in back and ankle muscle length. It was hypothesized that nervous system would use an adaptable strategy to change anticipatory adjustment and focal movement to maintain postural stability. METHODS: Ten participants performed simple (SRT) and complex (CRT) reaction time arm movements in different postural conditions; flat surface, short base, leaning forward or backward, vibration to back or ankle muscles.. Ground reaction forces(GRFs), arm reaction time and arm acceleration were recorded. The time between onsets of forces and moments and that of arm acceleration were calculated (relative latency). Variables were compared between conditions with repeated-measure analysis of variance RESULTS: Reaction time was faster in the SRT task (P<0.0005), but was not affected by the changes in postural set (P>0.07). Peak arm acceleration did not differ between conditions. GRFs were affected by changes in postural set and task. In the CRT condition on a flatbase with changes in anteroposterior and vertical shear forces and moments initiated together and

before the onset of arm movement (anticipatory postural adjustment). In shortbase, back and ankle vibration, and forward lean condition, changes in vertical and anteroposterior shear forces initiated before arm movement and not different from flat surface condition (P>0.2). Force onsets were delayed in backward lean. Unlike the flatbase, changes in moment in the sagittal plane and COP began after the onset of the vertical and shear forces (all: p< 0.00001) in short base, forward lean, and backward lean. CONCLUSIONS: These data suggest that, when challenging postural conditions are imposed on individuals with a healthy nervous system, anticipatory changes in moments and shear forces are decoupled and APAs primarily involve anticipatory change in shear forces. This is consistent with use of a "hip" strategy. Focal arm movement was not affected by postural changes. Healthy individuals with an intact control system have postural strategies that adapt to changes in postural set and this adaptation is relevant to the condition.

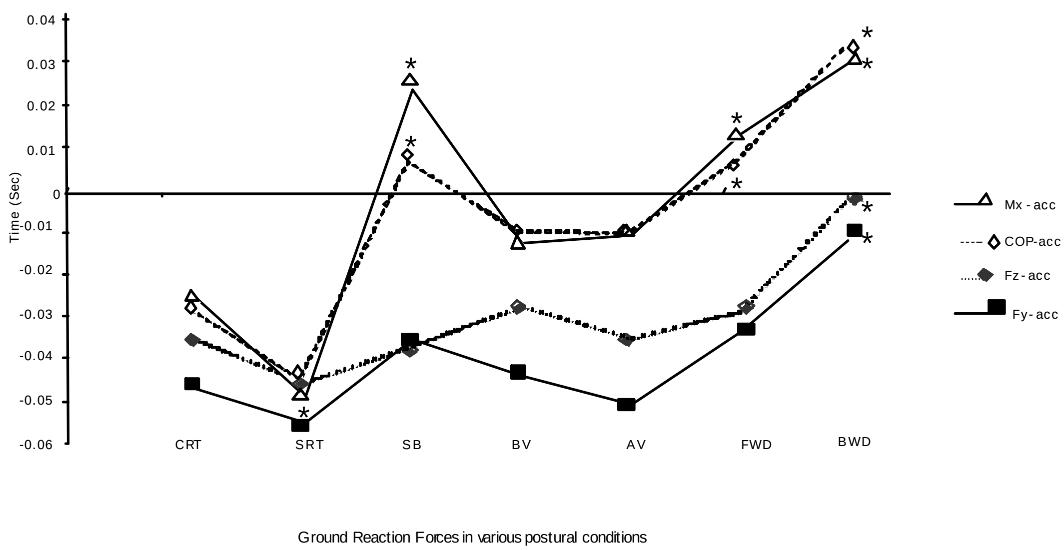

Fig.1

Ground Reaction Forces in various postural conditions

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P2-J-37 Kinematics of pelvis and lower extremity in walking with pregnancy-related lumbopelvic pain postpartum

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BACKGROUND AND AIM: The exact cause of pregnancy-related lumbopelvic pain is still unclear, and both aetiology and pathogenesis are quite indistinct. Women with pregnancy-related lumbopelvic pain are known to have problems with locomotion, and especially gait. Few studies have been published that quantitatively capture the kinematics in these women during pregnancy and post partum. This study compares kinematics of the pelvis, hip, knee and ankle during gait between women with or without pregnancy-related lumbopelvic pain postpartum. Gait analysis in women with PLPP might provide insight into pathophysiology of PLPP and thus improved treatment of this patient group. METHODS: We conducted a case-control study including twenty postpartum women. We included nine women with pregnancy-related lumbopelvic pain, and 11 women without pain. A three-dimensional gait analysis was performed. The women walked at preferred velocity on a treadmill. Kinematic outcome parameters were; preferred gait velocity, forward/backward tilt, lateral tilt and rotation of the pelvis, flexion/extension of the hip and knee, plantar flexion/dorsal flexion of the ankle, stride length, stride time and stance time. The results were adjusted for velocity. RESULTS: Compared to women without lumbopelvic pain, the women with pregnancy-related lumbopelvic pain had statistically significantly lower walking velocity, less total range of pelvic rotation, more forward tilted pelvis, less total range of hip flexion/extension and stride time. CONCLUSIONS: The study showed differences between women with and without lumbopelvic pain in walking velocity, pelvic- and hip kinematics and stride time. The group with pregnancy-related lumbopelvic pain did not only walk slower, but also differently. The kinematics did not change only due to velocity. Further investigations are warranted to establish if the results in the group with lumbopelvic pain are caused by pain or a reason for developing pain.

P2-J-38 Postural stability of obese males and females

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BACKGROUND AND AIM: Although obesity has shown to be related with impaired postural balance and males might have more pronounced sway than females, studies evaluating the interaction between body mass index and gender on the postural sway of healthy adults are scarce. METHODS: To assess the influence of body mass index group (lean/ overweight/ obese) and gender on the postural sway during quiet upright stance, 90 women and 90 men, aged 12 to 67 years old, accepted to participate. The centre of pressure during quiet upright stance was recorded at 40 Hz, using a force platform, during 4 conditions (eyes open/closed, on hard/soft surface). Statistical analysis was performed using multivariate analysis of covariance, considering the repeated measures with the eyes open and closed. RESULTS: Compared to lean and overweight subjects, obese subjects showed a larger increase of sway (length and area of sway) when closing their eyes, while standing on a hard surface. During the four sensory conditions, gender differences were observed, with no interaction with the body mass index group. These results were not related to the age of the subjects. CONCLUSIONS: Compared to non-obese subjects, the postural stability of obese subjects may be more vulnerable when vision is not available.

P2-J-39 Standing and Walking Balance and Daily Physical Activity in Older Adults

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BACKGROUND AND AIM: Physical activity is important in prevention of many chronic diseases and physical disability; however, many older adults are inactive. Standing/walking balance likely contributes to older adults' participation in physical activity but this association has not been sufficiently studied. We aim to build on this previous work by studying the association between standing/walking balance and physical activity measured by an accelerometer in community-dwelling older adults. METHODS: Ninety-six community-dwelling older adults (mean age 77.6 ± 5.9 years) who ambulated independently participated in this cross-sectional study. Measures of standing balance included tandem and one-leg standing times up to 30 seconds. Measures of walking balance included a narrow walk and gait characteristics believed to represent balance (gait speed, step width, and double support time). Physical activity was measured using a GT1M ActiGraph accelerometer (ActiGraph LLC, Pensacola, FL) worn on the waist during waking hours for 7 days and was summarized as the mean counts per minute per day averaged over the 7 days. Pearson correlation (r) and linear regression were used to examine the association between standing/walking balance and physical activity. RESULTS: Physical activity was associated with one-leg standing (r=0.42), tandem stance (r=0.30), narrow walk (r= -0.31), gait speed (r=0.50), step width (r= -0.40), and double support time (r= -0.43); all p<0.01. Adjusting for gait speed, one-leg standing (r=0.23, p=0.05) and step width (r= -0.24, p=0.03) associations still persisted. In the regression model, one-leg standing (â=0.28, p<0.01), gait speed (â=0.24, p=0.03), and step width (â= -0.26, p=0.02) explained 32.3% of the variance in physical activity. CONCLUSIONS: Our finding that standing/walking balance was associated with physical activity in older adults contradicts previous research. The use of accelerometers likely captured low and moderate intensity activity common in older adults and often difficult to capture with a questionnaire. Direction of the association is unknown; longitudinal studies are needed to determine if balance contributes to daily physical activity or if daily physical activity contributes to balance.

P2-J-40 Effect of sitting Tai Chi on dynamic sitting balance control in community-dwelling people with spinal cord injury: A pilot study

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BACKGROUND AND AIM: Previous research has shown that control of sitting balance is associated with the level of injury in people with spinal cord injury (SCI). Balance control is an important ability for functional activities such as negotiating curbs or getting on and off a bus for wheelchair users. Tai Chi is a mind-body exercise with slow, soft and fluid movements which is documented as improving balance. However, traditional Tai Chi is in standing position which is not suitable for wheelchair users. Sitting Tai Chi is an exercise which may be appropriate for people with SCI. A number of studies on older persons have proven that sitting Tai Chi can benefit their balance control, limb muscle strength, and cardiopulmonary function. However, the benefits of sitting Tai Chi in people with SCI are not known. This study examines the effect of sitting Tai Chi exercise on balance control in people with SCI. METHODS: It is a prospective intervention study. Sixteen people with SCI between levels C3-L5, 1 to 40 years post-injury participated in the study. Nine people with SCI were allocated to undergo sitting Tai Chi training (90-minute session, 3 times per week for 12 weeks). Seven participated in social activities as

controls. Dynamic sitting balance tests were evaluated under the supported (their own wheelchair) and unsupported sitting conditions which included (i) limits of stability (LOS) test and (ii) sequential weight shifting test. Outcome measures of LOS test included (1) reaction time (RT) - the time from the appearance of a response signal to the onset of voluntary shifting of center of pressure (COP) toward the target position; (2) maximum excursion (ME) - the maximum displacement of the COP in the 8 target locations; (3) directional control (DC) - a comparison of the amount of movement of COP in the on-target direction (toward the target) to the amount of off-target direction (away from the target). For sequential weight shifting test, the total time (TT) and directional control (DC) required for subjects to sequentially hitting the 12 targets was computed. RESULTS: Repeated measures MANOVA showed significant group by time interaction effects on balance control. Post hoc analysis demonstrated that Tai Chi practitioners achieved significant balance improvements as shown in the limits of stability test (RT: $p = 0.042$; ME: $p = 0.016$; DC: $p = 0.025$) and in the sequential weight shifting test (TT: $p =0.035$; DC: $p =0.033$) than in the controls. CONCLUSIONS: Twelve weeks of sitting Tai Chi training can improve the dynamic sitting balance for community-dwelling people with SCI. Clinicians can suggest sitting Tai Chi as an exercise for people with SCI who can continue to practice the exercise even after being discharged from hospital as a means to maintain health.

P2-J-41 Effects of unilateral knee extensor muscle fatigue on perturbation reaction during treadmill walking

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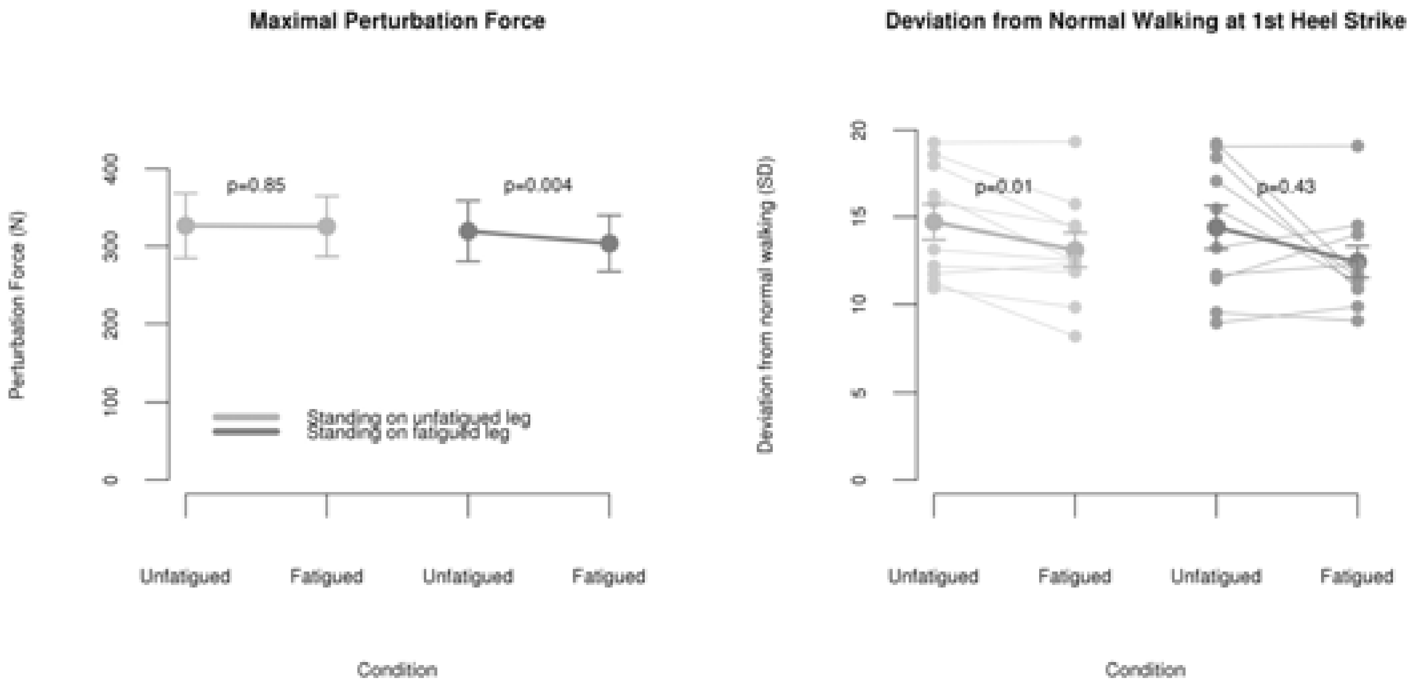
BACKGROUND AND AIM: Unilateral muscle strength loss and sensory loss in a leg is often present in patients, for example with spinal canal narrowing. Unilateral muscle fatigue causes similar symptoms and may be useful as a model for mild unilateral impairments. Studies on gait perturbations indicate that whether a subject will recover balance is largely dependent on the reaction during the first step (Redfern et al., 2001). Furthermore, bilateral knee extensor fatigue increased slip-induced fall likelihood (Parijat & Lockhart, 2008). It is unknown if subjects with unilateral muscle fatigue react differently to lateral gait perturbations when standing on the fatigued or the unfatigued leg. The aim was to assess the effect of unilateral knee extensor muscle fatigue on lateral perturbations during gait. METHODS: 10 healthy subjects (Nmale=4, age 63.4 (SD 5.5) years) participated. Trunk and feet kinematics of 5 minutes of unperturbed and 15 minutes of perturbed treadmill walking at 3.0 km/h were collected as reference data. The perturbations were applied to the trunk by pulling the subject over a distance of ~8 cm laterally at the moment of contralateral heel contact. The fatiguing protocol consisted of 9 blocks of unilateral knee bending until task failure, alternated with 100 seconds of perturbed walking. The perturbation force was measured and the deviation (of the kinematic state of the trunk) from normal walking at the first step after the perturbation, expressed in standard deviations of the normal walking pattern, was calculated. Differences between unfatigued and fatigued perturbation reactions were tested with Wilcoxon signed-rank tests. The difference between pre and post fatigue voluntary maximal knee extensor torque was used as a muscle fatigue indicator. RESULTS: The fatiguing exercise resulted in

a decrease of knee extensor torque of 17% (p<0.001) The figure shows that compared to unfatigued walking, subjects were more easily perturbed when standing on their fatigued leg (p<0.001) but not when standing on their unfatigued leg (p=0.85). In both legs the initial deviation from normal walking did not differer between the fatigued and unfatigued state (fatigued p=0.22, unfatigued p=0.31). Compared to unfatigued walking, subjects were more recovered after the first step when fatigued and standing on their unfatigued leg during perturbations (p=0.01), but not when fatigued and standing on their fatigued leg (p=0.43). CONCLUSIONS: Subject are more easily perturbed when standing on the fatigued leg. When subjects are fatigued and standing on their unfatigued leg during lateral perturbations, the recovery in the period until the first heel strike is larger compared to the unfatigued condition. Subjects demonstrated a diverse reaction when being perturbed when standing on the fatigued leg.



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P2-J-42 Between-day reliability and smallest detectable differences of variability and stability of gait during treadmill walking

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BACKGROUND AND AIM: Between-day reliability of gait parameters is important when assessing the effects of interventions on gait performance. Between-day group-level reliability for gait variability has been reported as fair to moderate based on a small number of studies (Lord et al. 2011). The relatively low reliability may partly be due to the low number of measured strides (Owings and Grabiner 2003). Between-day group-level reliability has not been investigated for gait stability. The aim was investigate between-day group-level and individual-level reliability of stability and variability of gait with 20 and 150 strides. METHODS: 16 healthy elderly subjects (Nmale=7, age 65.6 (SD 5.9) years) participated. Trunk and feet kinematics of 5 minutes of treadmill walking at 3.0 km/h were collected during 2 trials on 2 days. METHODS: Gait stability was quantified by the short-term Lyapunov exponent of anterior-posterior and medio-lateral trunk velocity (LEap and LEml respectively). The LE indicates the averaged short-term rate of divergence of two, initially infinitesimally close, trajectories through state-space. Variability of gait was quantified by the standard deviation of stride times (STV) and step widths (SWV). All analyses were done separately on a selection of 20 and 150 strides from the trials to investigate the effect of number of strides. Group level reliability was quantified by the intraclass correlation coefficient (ICC). Reliability of assessment of change at the individual level was assessed by the smallest detectable difference (SDD). ICC and SDD (expressed as percentage of grand mean) were calculated from the extracted variance components using generalizability theory. RESULTS: Variability measures demonstrated moderate ICCs and poor SDDs when 150 strides were analysed (Table 1). Stability of gait measures demonstrated fair to moderate ICCs and poor to moderate SDDs when 150 strides were analysed. The results further show that increasing the number of strides resulted in increased ICCs for all gait parameters. The SDDs of gait variability were dependent on the number of strides, while the SDDs of gait stability were not. CONCLUSIONS: These results imply that group-level interventions should be done on relatively large groups of subjects because of limited reliability, and that variability and stability of gait parameters are not ready for clinical (individual level) assessment of gait.

Table 1. Between-day ICC and SDD for stride-time-variability (STV), step-width-variability (SWV), short-term anterior-posterior and medio-lateral Lyapunov exponent (LE_{ap}, LE_{ml}).

	ICC		SDD (% grand mean)	
Gait parameter	20 strides	150 strides	20 strides	150 strides
STV	0.40	0.67	83.6	63.0
SWV	0.51	0.73	80.6	50.7
LE_{ap}	0.22	0.46	21.4	21.9
LE_{ml}	0.49	0.58	50.1	49.4

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P2-J-43 Balance Reactivation for Patients with Atactic Disorder during Recovery Stroke Period by Technique of Focused Dosed Center-of-Gravity Shift

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BACKGROUND AND AIM: Stroke is one of the greatest risk factors for falling, and the risk of facture is higher than in stroke patients than in healthy elderly people. Presently, therapeutic physical trainings as well as apparatus trainings with biofeedback are used to recover the balance. The aim of our research is to create and evaluate an effectiveness of balance recovery methodology based on focused dose center of gravity shift in combination with other resources for the patients during recovery post-stroke period. METHODS: 55 patients with Atactic Syndrome during recovery post-stroke period were included into our investigation. The first group (n=25) contained the patients whose comprehensive treatment included standard drug therapy together with the suggested technique of balance correction. The second group (n=30) was presented by those patients whose Recovery Comprehensive Treatment included Standard Drug Therapy combined with moto-rehabilitation and bio-feedback balance exercises. The task of Balance Correction Exercises was to create the dosed stress mode in the postural system while standing and walking. The mode was generating through keeping balance as a patient was doing easy Statolocomotor exercises accompanied by the simultaneous provocative center-of-gravity shift as a result of patient's holding a pole with distal loading. Each patient had both before and after the course of treatment physical examination, neurological status assessment, objective evaluation of balance by Computer Stabilometry (CS), balance clinical function - by Berg Balance Scale, walking function - by Dynamic Gait Index. RESULTS: In the first group patients had significant improvement by the stabilometry and scales (Wilcoxon nonparametric test: $p<0,05$). In the second group patients had significant improvement by the stabilometry and scales (Wilcoxon nonparametric test: $p<0,05$) too. The comparison of the CS in the 1 group before the treatment with the data of the CS in the 2 group before the treatment and the CS data the in the 1 group after the treatment and the CS data in the 2 group after the treatment shows no statistically significant differences. CONCLUSIONS: The suggested technique, to our mind, lets enhance patient's stability while standing and walking, decrease the risk of falls during walking with vestibular loads, help create a new movement stereotype. The advantage of proposed technique is that it is of low cost although its efficiency is comparable with high-tech modern methods of balance correction and may be used for outpatient treatment.

P2-J-44 Changes in anticipatory postural adjustments following a 6-week treatment for chronic low back pain

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BACKGROUND AND AIM: Chronic low back pain (LBP) is associated with altered neural control of movement such as delayed anticipatory postural adjustments (APAs) [1]. Clinical interventions targetting muscle impairments are promoted but treatment effects remain equivocal. This study compared the effects of 2 treatments in persons with LBP on clinical outcomes and muscle onsets during an asymmetric straight leg raise (ASLR) task in order to quantify changes in the APA following treatment. Differences in muscle onsets of a healthy control (CON) group and the LBP group pre-treatment are also reported. METHODS: 31 subjects with chronic LBP were recruited and assigned to one of 2, 6-week treatments: stabilization (STB) (n = 19, 10 female) or Movement Systems Impairment (MSI) [2] directed exercises (n = 12, 8 female). LBP subjects reported on pain and disability (Numeric Pain Index, McGill Pain Questionnaire, Oswestry Disability Index) and underwent 2 testing sessions, 7 weeks apart, during which EMG data from the trunk and left lower limb were recorded using surface electrodes as the subjects performed 4 rapid, ASLRs with each leg. An age- and sex-matched CON group with no history of LBP (n = 18, 11 female) also completed the same protocol. A mixed model repeated measures ANOVA, with fixed effects of treatment group (STB and MSI) and session (pre- and post-treatment) was used to determine differences in EMG onsets within the LBP groups. Post-hoc analyses for significant interactions ($p < 0.05$) were performed using the least squares means method. Differences in EMG onsets between the LBP group pre-treatment and the CON group for each muscle were assessed by unpaired t-tests. RESULTS: Pre-treatment, although mean onset latencies for most muscles were similar between the CON and LBP groups, the LBP group demonstrated earlier onsets of the ipsilateral internal oblique and rectus femoris muscles than the CON group. Post-treatment, both LBP groups showed similar improvements in pain and function, yet displayed differences in EMG onsets. The STB group demonstrated significantly earlier onsets in both the ipsilateral internal oblique and contralateral rectus abdominis muscles compared to the MSI group. CONCLUSION: Pre-treatment, persons with LBP may not exhibit delayed APAs during the ASLR. In fact, the LBP group's muscle onsets were earlier and asymmetric (i.e. both ipsi- and contralateral) in some trunk muscles compared to the CON group. Post-treatment, the STB group compared to the MSI group had earlier onsets in some trunk muscles that may reflect a re-organization of motor control during the ASLR task. These changes in control did not associate with clinical measures, which may be due to small sample size and high variability.

ACKNOWLEDGEMENTS:
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P2-J-45 Treatment does not improve anticipatory postural adjustments in persons with chronic low back pain

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BACKGROUND AND AIMS: Chronic low back pain (LBP) associates with altered neural control of movement such as delayed anticipatory postural adjustments (APAs) with leg movement [1]. Persons with LBP also exhibit decreased inter-trial variability in the timing of their APA [2], suggesting that they may be less capable of modulating the APA. In this study we compared the APA in persons with LBP during both a supported and unsupported leg raising task before and after 2 different exercise protocols, both of which could influence the APA. METHODS: 34 persons with chronic LBP were recruited and randomly assigned to one of 2, 6-week treatments: stabilization (STB) (n = 12) or Movement Systems Impairment (MSI) based exercises (n = 22). They completed the Numeric Pain and Oswestry Disability Indexes and performed 4 trials each of a supported and unsupported left leg raising task, pre- and post-treatment. The unsupported and supported conditions reflect tasks that do and do not, respectively, require and APA in control subjects [3]. EMG data from the trunk and lower limb and forces under the feet were recorded using surface electrodes and force plates, respectively. Mixed model repeated measures ANOVAs, with fixed effects of treatment group (STB and MSI), visit (pre- and post-treatment), and muscle (EMG data only) were used to determine differences in incidence of muscle activation as well as incidence and amplitude of loading under the right leg. Post-hoc analyses for significant interactions ($p < 0.05$) were performed using the least squares means method. RESULTS: Pre-treatment subjects with LBP exhibited a similar incidence of APAs (i.e., loading under the right leg) regardless of limb support ($F = 2.0$, $P > 0.05$): the APA occurred in 76% and 69% of unsupported trials versus 78% and 83% of supported trials for the MSI and STB groups, respectively. Post-treatment, both groups exhibited similar significant decreases in pain and disability scores ($F = 27.8$, $P < 0.05$ and $F = 25.1$, $P < 0.05$, respectively) and significant increases in incidence of APAs ($F = 10.2$, $P < 0.05$) for the supported (92% and 74% of trials, MSI and STB, respectively) and unsupported tasks (91% and 85% of trials, MSI and STB, respectively). Neither force amplitude under the right leg ($F = 0.3$, $P > 0.05$), nor incidence of muscle activation ($F = 4.0$, $P > 0.05$) differed significantly between treatment group or visit. CONCLUSIONS: Despite improvements in lumbar pain and disability scores, neither treatment program was effective in re-establishing the APA in persons with chronic LBP. Subjects tended to utilize a generalized APA response (i.e. contralateral leg loading) regardless of task requirements pre-treatment. Post-treatment both exercise protocols tended to increase the frequency of this over-generalized APA response.

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P2-J-46 Mobility following TBI: Relationships with joint power generation and motor skill level

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BACKGROUND AND AIMS: Reduced balance, spasticity, contractures, muscle weakness and motor skill levels may all contribute to mobility limitations following TBI, yet the key physical impairments that

contribute to mobility limitations remain unclear. The aim of this study was to determine which physical impairments best predict mobility performance after a period of six months of rehabilitation. METHODS: Participants with TBI were selected if they were receiving therapy for mobility limitations but were able to walk without physical assistance. The clinical assessment included measures of balance, spasticity and contracture and 3DGA was used to quantify joint power generation and motor skill level on 31 adults with severe TBI. Mobility outcome was quantified with the high-level mobility assessment tool (HiMAT). RESULTS: Two variables, ankle joint power generation during the push-off phase of gait and motor skill level, explained 66.5% of the variability in mobility outcome. Balance, strength and mobility performance all improved significantly over the six months of rehabilitation. Only two participants had contractures which impacted on mobility. Balance disorders were prevalent and improved with rehabilitation, yet contributed to only a limited extent to the level of recovery in mobility. CONCLUSIONS: Ankle joint power generation at push-off was the strongest predictor of mobility outcome after six months of rehabilitation.

P2-J-47 High level mobility in adults born with very low birth weight and adults with traumatic brain injury

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BACKGROUND AND AIM: Persons born preterm with very low birth weight (VLBW) and persons with traumatic brain injury (TBI) have similar brain abnormalities, such as reduced white matter and connectivity. However, few studies have assessed advanced motor abilities and none have compared mobility functions in adult VLBW and TBI populations. Mobility functions in adults can be assessed using a novel assessment tool, the High level Mobility Assessment Tool (HiMAT). Although originally developed for mild to moderate TBI (Williams et al. 2004), we have shown it to be a valuable clinical tool for advanced mobility functions in adults born with VLBW as well (Evensen et al. 2011). Our aim was to investigate high level mobility functions in VLBW adults and adults with TBI, compared to matched controls. METHODS: Participants consisted of 35 subjects (mean age 22.5 ± 0.7 yrs) born preterm with birth weight below 1500 grams and 20 subjects (mean age 22.9 ± 2.0 yrs) with chronic traumatic brain injury. The VLBW group included three subjects with cerebral palsy (CP). Two TBI participants were not able to complete all test items due to pain. Each group was matched with its own control group, consisting of 24 subjects each from the same geographical area matched by age and sex. Mean age in the control group was 22.8 ± 0.5 yrs for VLBW and 23.3 ± 1.8 yrs for TBI. Advanced mobility functions were assessed by the HiMAT, which consists of 13 timed mobility tasks, with a maximum total HiMAT score of 54. RESULTS: Mean total HiMAT score in the VLBW group was 45.1 ± 7.8 compared to 49.9 ± 3.5 in its control group (U = 256, p=0.011). Five of the 13 mobility task scores were significantly different from the control group: "walking backwards", "running", "hop affected leg", "bound affected leg", and "bound non-affected leg". When the three subjects with CP were excluded, mean total HiMAT score was

46.8 ± 5.5 in the VLBW group (U=256, p=0.033) and three mobility task scores remained significantly different from the controls: "walking backwards", "hop affected leg" and "bound non-affected leg". Mean total HiMAT score in the TBI group was 47.0 ± 7.7 compared to 50.3 ± 3.9 for the controls (U=193, p=0.116). Three of 13 mobility tasks differed significantly from the control group: "walking", "walk over obstacle" and "bound non-affected leg". When the two subjects who reported pain were excluded from the analysis, mean total HiMAT score was 48.9 ± 4.9 (U=193, p=0.264), with "walking" and "walk over obstacle" remaining significantly different from the control group. CONCLUSIONS: Compared to controls, adults born with VLBW had reduced overall high level mobility. In addition, both adults with VLBW and adults with TBI had reduced function in specific mobility tasks. Further analyses will focus on odds ratios of having mobility problems and association between mobility tasks and background variables.

P2-J-48 Motor planning is affected by cognitive load in Parkinson's patients with freezing of gait when approaching obstacles

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BACKGROUND AND AIM: Recent research has shown that Parkinson's patients who experience freezing of gait (PD-FOG) might have deficits in motor planning [1,2]. The present study evaluated the hypothesis that the cognitive load associated with planning has a greater influence on locomotor behaviour in PD FOG (compared to PD non-FOG). As such, gait parameters in PD FOG might be more affected by a secondary task when comparing the three steps just prior to (Late), and the three steps prior to the 'late' steps before an obstacle. These 'late' three steps are considered critical for planning of anticipatory and crossing adjustments. METHODS: Twenty-seven non-demented patients with PD (14 PD patients with FOG and 13 PD non-freezers matched on age and UPDRS scores) and 14 age-matched controls walked and stepped over a horizontal obstacle set at 15% of the participant's height. The last six steps before crossing were split into two phases (Early = three steps furthest from the obstacle; Late = three steps just prior to the obstacle). RESULTS: Results showed interactions between cognitive load and group for step time variability (p=0.011) and step length variability (p=0.006), but only in the Late phase of the obstacle approach. When comparing the delta of the change between phases, an interaction was revealed only for step time variability (p=0.002). These interactions revealed that the consistency of spatial and temporal step parameters in PD-FOG was disproportionally affected by the secondary mental task, but only when imminent gait modifications were necessary to avoid an obstacle. CONCLUSIONS: Parameters identified in the current study have been related to FOG in previous studies, although no FOG episodes were observed in this study. The abnormalities in gait parameters we observed in the PD patients with FOG might be associated with increased cognitive effort to plan and maintain appropriate gait adjustments.

P2-J-49 Linear and angular coordination in cerebellar ataxia during straight and circular walking

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BACKGROUND AND AIM: Turning is essential during walking, allowing us to steer our locomotion. To navigate around a circle, both linear and angular components of locomotion must be coordinated in several body segments. Damage to the cerebellum not only results in ataxia, hypermetric stepping and lateral postural sway while walking straight but also impairs spatial navigation during turning. Understanding neural control of straight and curvilinear locomotion is important to gain insight in the difficulties during turning. Thus, the aim of this study was to compare the linear and angular movement of the feet, pelvis, trunk and head during straight and circular walking in patients with cerebellar ataxia and age-matched healthy control subjects. METHODS: Eight subjects with cerebellar ataxia (CA) mean age 58 (range 48-68 yrs) and a control group of eight age-matched healthy subjects, mean age 57 (range 47-64 yrs), walked eyes-open following a straight line on the floor or around a circle of 1.2 m radius. Coordination and variability of linear and angular motion of the feet, pelvis, trunk and head were computed from marker positions recorded with an eight-camera motion analysis system. Linear and angular components of the movements were analyzed with repeated measurement ANOVAs to test for the effect between groups and body segments. Tukey post-hoc analysis was used to explore significant main effect or interactions. Pearson product moment correlation was used to explore the correlation between the angular and linear components. RESULTS: CA and controls both modulated their step length in relation to the walking task i.e., step length decreased during circular walking as compared to straight walking. During circular walking both groups took 13 % shorter steps with their inner foot in comparison to their outer foot. However, the CA group had higher step length variability during circular walking in comparison to controls and to straight walking. When walking around a circle the controls placed the inner foot with a larger step angle as compared to the outer foot while the CA group did not show a difference in the step angle between feet. On average, there were no group differences in linear and angular variability in any of the segments (head, trunk, pelvis and feet) when walking straight ahead, however, during circular walking, an increased angular (35%) variability was seen in the CA group. In addition, the relationship between the linear and angular components of the feet (step length and step angle) was very high in the control group (r=0.86) but poor (r=0.26) in the CA group during circular walking. CONCLUSION: The results suggest that the cerebellum coordinates or adapts the linear and angular components of locomotion and that cerebellar damage influences curvilinear walking, especially the angular control, to a greater extent than straight walking.

P2-J-50 Coordination of whole-body horizontal and vertical momenta during sit-to-walk after stroke

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BACKGROUND AND AIM: Gait initiation from sitting (sit-to-walk, STW) is frequently performed in subjects with mobility disorders, such as stroke. Sufficient and well-tuned forward and upward momenta (mass x velocity) of the whole-body's center of mass (CoM) are required for a successful STW. The coordination of these motor strategies has, however, not yet been described post-stroke. Few clinical methods capture the process of locomotor coordination during daily activities. A clinical

instrument aimed at assessing the fluidity during STW has been suggested, i.e. The Fluidity Scale (FS) for the rise-to-walk task (Dion et al, 2003). The aim of this study was to describe the coordination of CoM horizontal and vertical momenta and fluidity during STW in subjects with post-stroke hemiparesis as compared with matched controls. A further aim was to investigate the correlation between some observer-based measures of mobility, including FS, and a laboratory-based measure of fluidity during STW. METHODS: Ten subjects with stroke (> 6 months post onset) and ten control subjects participated. A movement analysis system (8 cameras) collected 3D- data from 38 reflective markers within a whole-body setup. A 13-segment model was defined. Peak magnitudes and peak timing variables of horizontal and vertical momenta were assessed in 6 trials/ subject, and analyzed with a mixed model ANOVA. From the kinematic data, a fluidity index (FI) was calculated (Malouin et al, 2003). Simultaneously with the laboratory-based data collection, the transfer was assessed by the use of FS. Additionally, Timed Up and Go (TUG) and 10m Timed walk was used for assessing mobility. The significance level was set at $p < 0.05$. RESULTS: The stroke subjects generated significantly less peak horizontal and peak vertical momenta as compared with controls (Figure 1). Latencies from STW-onset and seat-off to the momenta peaks differed significantly between the two groups. However, the relative time interval between peak horizontal and peak vertical momentum did not differ across the groups. The subjects post-stroke displayed lower scores on the FS as well as lower percentages of the FI. The scores on FS demonstrated a strong relation to the FI (r_s= 0.84) as well as to Timed 10m walk (r_s= 0.74) and a moderate relation to TUG (r_s= -0.53). CONCLUSIONS: The subjects with stroke moved slower while rising to walk than the controls, which was demonstrated by the significant differences regarding both scaling and timing of horizontal and vertical CoM momenta. A strong relation between the scores of FS and the calculated FI indicates that FS has a good potential of becoming a valid clinical measure regarding the process of STW.

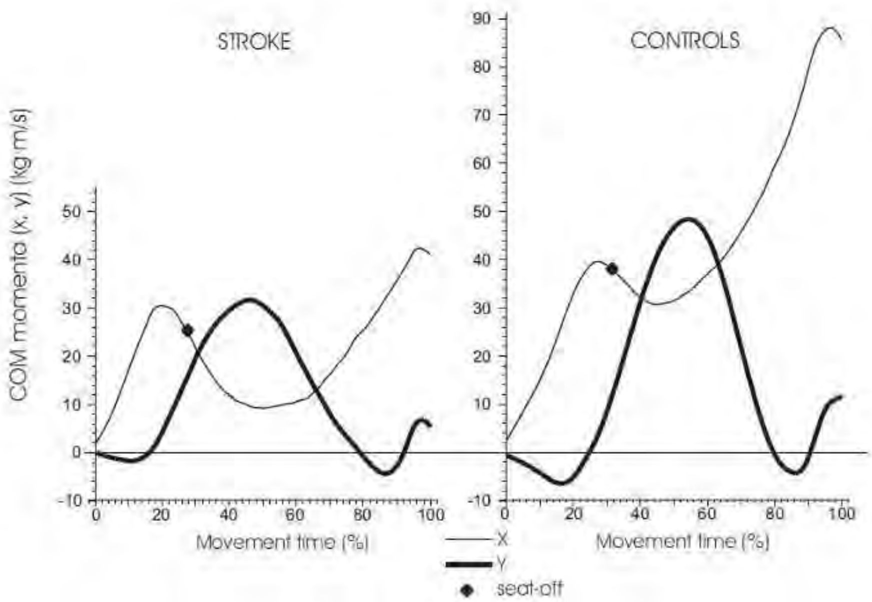

Figure 1. Mean graphs of center of mass (CoM) horizontal (x;thin line) and vertical (y;thick line) momenta in the control and stroke group. The x-axis represents normalized time, i.e. 100% movement time from onset to 2nd toe-off.

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P2-J-51 Head-pelvis dissociation during turning in healthy subjects who mimic bradykinetic gait

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BACKGROUND AND AIM: Turning is a common task which puts a greater demand on balance maintenance than walking. It is characterized by different spatiotemporal features of the limbs at the inner and outer side of the turning arc. Analysis of the speed dependency of axial movement may help to obtain a better picture of motor performance during turning in subjects with or without pathology. Therefore, the aim of the study was to investigate whether trunk rotation is speed dependent in healthy subjects, to enable comparison with patients with Parkinson's disease. METHODS: Eleven healthy subjects participated in the study. They were asked to perform a 5-meter walk towards 2 retro-reflective markers placed 0.5 meters away from each other and turn 180° around the markers at preferred and slow (Parkinsonian) speed (74 steps/min as indicated by a metronome). Each measurement was repeated 3 times and average scores were used for analysis. Spatiotemporal features were measured using an 8 camera gait analysis system (Vicon Motion System) using 31 infrared light-emitting markers. Onset of head, trunk and pelvic rotation, head-pelvis separation and average turn velocity were

analyzed. Dissociation curves of all trials (head-pelvis separation) were analyzed graphically and statistically compared per 5° pelvic rotation (10-170°, 33 data points). Repeated measures analysis of variance (ANOVA) was used with three (head, thorax and pelvis) by two (normal and slow speeds) within-subject factors to compare onset of rotation and turn velocity. Paired T-test was used to compare maximum separation. RESULTS: The average head-pelvic turning velocity in the normal condition was 95.4°/sec. At turning onset, the head preceded the thorax and pelvic rotation in all subjects during slow as well as normal conditions. However, in turning at a slower speed, onset of the head and pelvis rotation was considerably delayed (at 792.7 vs. 350.2 and 256.8 vs. 206.0 mm in front of the turning marker, for slow and normal speed respectively) (Figure 1). The maximum head-pelvis separation was 35.4°. Turn preparation was speed-dependent as the maximum separation decreased significantly when turning at slow speed (34.8° vs. 24.9°, $p<0.01$). The moment of maximal separation was independent of turn velocity. The subjects reached the moment of maximum separation at 69.8° during slow and at 71.2° pelvic rotation during normal speed, $p=0.86$. CONCLUSIONs: When healthy controls mimicked bradykinetic gait, the normal cranio-caudal sequence of the head preceding the pelvic rotation, was significantly decreased, as was the maximum head pelvic dissociation. These results confirm the speed dependency of the characteristic 'en-bloc' movement observed in PD patients, which hinders a straightforward interpretation of 'en-bloc' movements as being pathological.

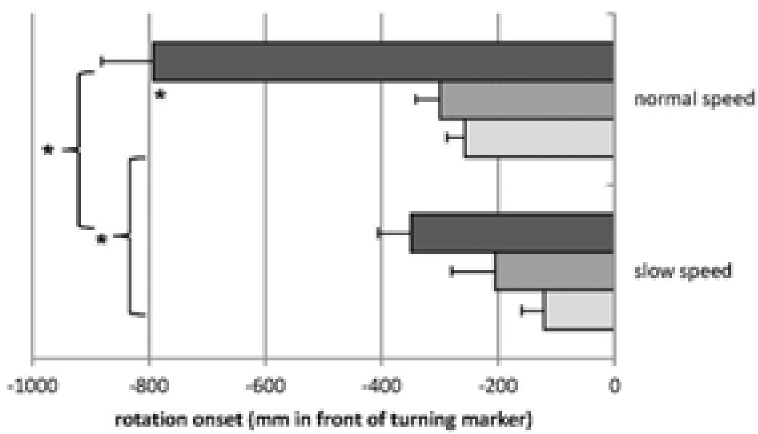

Figure 1: The onset of head ■, thorax ■ and pelvic □ rotation expressed in mm distance from the retroreflective turning markers placed on the ground, difference between normal and slow speed (ANOVA repeated measures), * = $p<0.05$.

P2-J-52 Role of the basal ganglia in postural control during gait initiation in human

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BACKGROUND AND AIM: In human, the neural pathways involved in gait and posutral controls are still not well identified. Different cortical regions, the basal ganglia (BG) system and the brainstem mesencephalic region have been recently pointed out in the control of these process. However, few is known about the specific role of these different brain regions in the control of both gait and balance. In a view to better understand the role of the different BG structures, we analyzed the postural control during the gait initiation in patients with different striato-pallidal lesions (SPL) in comparison to patients with nigrostriatal lesions (Parkinson's disease -PD) and controls. METHODS: Nine patients with bilateral SPL (mean age: 34,9 ± 11,4 years) were included and compared to 9 patients PD (mean age: 55,2 ± 3,5 years, mean disease duration: 10,7 ± 6,6 years) in ON and OFF states, and 7 controls. Clinical evaluation and gait initiation biomechanical parameters were assessed in all subjects. The different parts duration of gait initation, length, anteroposterior and vertical velocities of the centre of gravity, and the braking index (which reflets the postural control), were calculated for each subject. In SPL patients, the SPL were localized on brain MRI. RESULTS: Patients with bilateral SPL had no or minor parkinsonian signs (UPDRS III: 4,29 ± 4,39) and 2 presented a cognitive impairment (MMS: 25,9 ± 3,0). PD patients had moderate to severe parkinsonian motor disability (UPDRS III: 34,8 ± 13,7), responsive to levodopa therapy (UPDRS III: 12,1 ± 7,5), with no cognitive decline. In SPL patients, gait initiation parameters were not different from controls, except the braking index which was impaired in 4 patients. Conversely, PD patients showed a significant decrease in step length, maximal velocity of the first step and braking index, partially improved with levodopa treatment. In SPL patients with a defect in braking index, lesions were preferentially localized in the putamen bilaterally. In patients with a normal braking index, lesions were localized in the caudate nucleus and/or globus pallidus. CONCLUSION: These results suggest that postural control during gait initiation process is controlled by the BG system, in particular in the putamen, lesioned in half of SPL patients and dysfunctional in all PD patients.

P2-J-53 Walk ratio is effective in describing a specific gait pattern in patients post-stroke across walking speeds

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BACKGROUND AND AIM: Walking speed is determined by step length and cadence, and these two variables are closely correlated with walking speed. Consequently, to identify differences in step length and cadence due to walking abnormalities, data must be adjusted for the effect of speed or comparable speeds should be obtained. Alternatively variables that are invariant of walking speed should be used. One variable proposed to be invariant of walking speed is a ratio between step length and cadence called walk ratio (WR) [1-3]. The purpose of this study was to investigate if WR could identify a walking pattern typical for patients post-stroke and if WR was in fact invariant of speed for this population. METHODS: Forty-eight patients post-stroke and thirty references where examined during overground walking at slow, preferred and fast walking speed conditions. Temporospatial walking characteristics were obtained by using a kinematic sensor attached over the lower back. Groups were compared during different absolute walking speeds and at similar absolute walking speed. RESULTS: WR was found to be invariant of speed at preferred and fast walking speed in both populations, but was lower in patients

than in references. WR was effective in discriminating patients from references both during identical and different absolute walking speed. Step length alone also had good discriminating ability at different walking speed conditions, but was less effective when absolute walking speed was similar. Cadence had the lowest discriminating ability independent of whether walking speed was different or similar. CONCLUSIONS: The combined knowledge of WR and walking speed has potential to give valuable information about walking capacity and walking patterns in patients post-stroke.

ACKNOWLEDGEMENTS:
The Norwegian Fund for Post Graduate Training in Physiotherapy for funding of the PhD project

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P2-J-54 Coordination of segments reorientation during on-the-spot turns in individuals with Parkinson's disease "off" and "on" medication

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BACKGROUND AND AIM: Postural instability is one of the cardinal symptoms of Parkinson's disease [1]. Postural instability in people with Parkinson's disease is exaggerated in specific circumstances such as turning [2, 3] and many of the falls among people with Parkinson's disease occur during turning. Turning requires systematic reorientation of axial segments towards the new direction. Lack of coordination in segments reorientation during turning may compromise the individual's balance. The purpose of this study was to examine the effects of Parkinson's disease, in "off" and "on" dopaminergic medication states, on the coordination of segment reorientation during on-the-spot turns. METHODS: Fourteen individuals with Parkinson's disease and nineteen age-matched healthy controls participated in this study. Four Optotrak 3D imaging system cameras (Northern Digital Inc., Canada) were used to record the performance of the participants as they made 45° and 90° on-the-spot turns. The sequence and timing of body segments reorientation were determined using the Optotrak data. To examine the potential effects of dopaminergic medications on the sequence and timing of segments reorientation, individuals with Parkinson's disease were tested "off" and "on" dopaminergic medication. RESULTS: During both small and large turns, healthy controls reoriented their head, shoulder, and pelvis simultaneously, followed by mediolateral foot displacement. Individuals with Parkinson's disease, in the "off" state, displayed temporal coordination patterns similar to the healthy controls. However, individuals with PD "off" medication differed from healthy controls with respect to the velocity and magnitude of reorientation. Each segment's velocity was significantly smaller for individuals with Parkinson's disease compared with healthy controls during both small and large turns. The early magnitudes of segments rotation were also smaller for individuals with Parkinson's disease. When "on"

medication, PD participants showed a minor disruption to the temporal pattern of coordination: shoulder reorientation was delayed for 45° turns and pelvis reorientation was delayed for 90° turns. CONCLUSIONS: We conclude that Parkinson's disease does not appear to disturb the sequence and timing of segments reorientation during on-the-spot turns. However, it reduces the velocity and early magnitude of segments reorientation. The latter is improved by dopaminergic medication. Dopaminergic medication has minor influence on the temporal coordination of body segments.

ACKNOWLEDGEMENT:
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P2-J-55 The effect of visual dependence and dizziness on postural sway in elderly fallers

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BACKGROUND AND AIM: Dizziness is a commonly reported symptom in the elderly (1). Many elderly people with balance problems also develop Visual Dependence (VD). This greater dependence on visual information for spatial orientation and postural control has also been linked with falls (2). The aim of this study was to assess the effect of immersive optokinetic visual stimuli (OKS) on postural sway in a group of elderly people referred to a hospital falls clinic. METHODS: One hundred elderly people (41 males, mean age 85.5 years) referred to a hospital falls clinic were recruited for this study. Initial assessment included the Roll Vection Test (RVT) to determine level of VD. Self reported dizziness was also determined. Each subject stood in front of a large rotating disc (96 deg/s, 16rpm) displaying a low frequency spatial pattern. The task was to align a straight edge to its perceived vertical position after 30 seconds presentation of a background of roll vection stimulus. The test was repeated 6 times with the error in perceived vertical from true vertical measured after each trial. Each subject also completed two 30 sec balance trials for each of 6 conditions presented in a randomised order - eyes open (EO), eyes closed (EC), and 4 optokinetic visual stimuli including two roll vection stimuli, clockwise (CW) and counter-clockwise (CCW), and two optic flow stimuli, forward (FW) and backward (BW). Postural sway was characterized by the centre of pressure (CoP) trajectory under the subjects' feet recorded while standing on two force platforms (AMTI, USA). Data was summarised using descriptive statistics. RESULTS: Most of the group (86%) had 1 or more falls in the previous 12 months. 36% of the participants reported suffering dizziness. The mean error in perceived vertical for the roll vection test was 5.84 deg. 34% of participants were classified as VD with scores >6.5 deg. on the RVT. When analysing those participants with self reported dizziness and in those classified as VD, there was a significantly shorter CoP pathlength for EO, EC and all 4 OKS conditions ($p<0.05$, Fig 1). CONCLUSIONS: The present data provides evidence that VD and dizziness are common in elderly fallers and that both of these factors contribute independently to the development of a stiffening strategy to maintain standing balance.

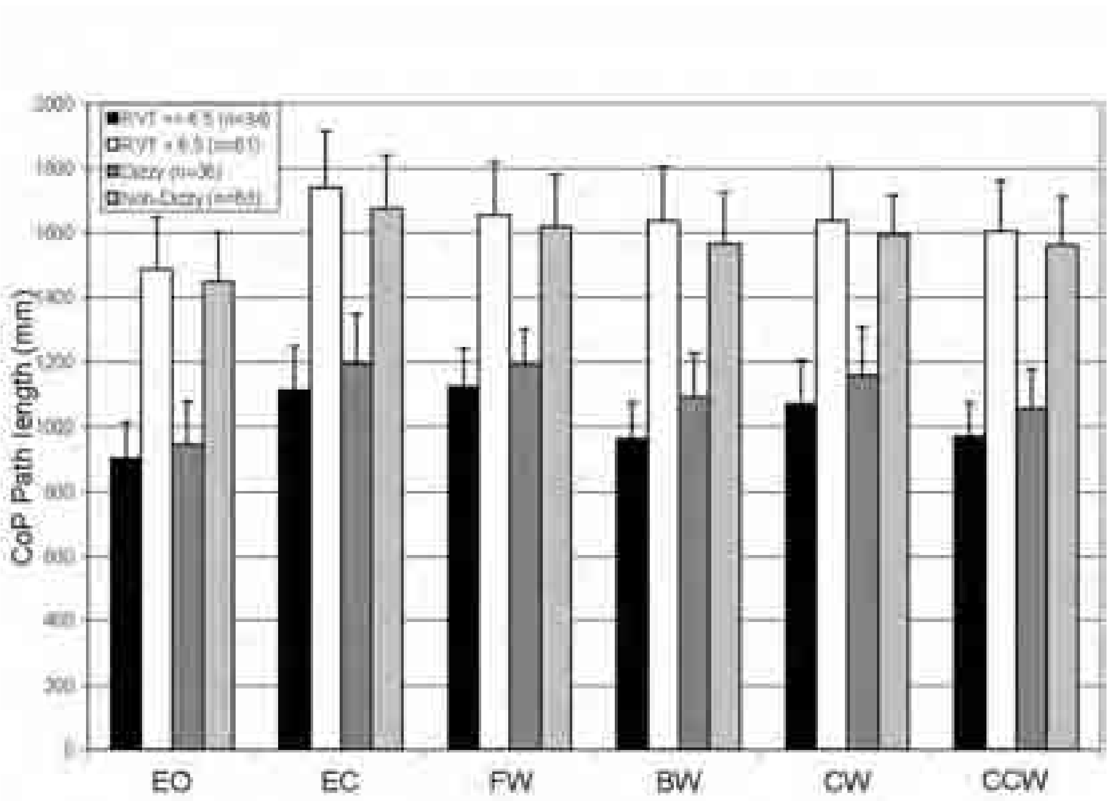

Fig 1 Mean (+SE) sway for each balance condition based on perception of vertical (RVT) and dizziness (dizzy vs non-dizzy).

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P2-J-56 Backward gait disturbances as an early manifestation of Progressive Supranuclear Palsy

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CASE REPORT: Progressive Supranuclear Palsy (PSP) is an atypical parkinsonism with rapid progression and severe gait and postural disturbances. Early symptoms are usually gaze palsy, parkinsonism and falls during walking. We present 59 year old patient with atypical early symptoms. In July 2008 the first symptoms of the disease - isolated freezing of backward gait appeared. He was diagnosed with Pure Akinesia Freezing of Gait (PAFG). Three months later he developed mild parkinsonian syndrome (slight hypertonia, bradykinesia and subcortical dyzartry). In the third year of follow up mild supranuclear palsy occured. Head MRI revealed general atrophy with enlarged ventricular system, atrophy of midbrain. HmPAO-Tc-99m SPECT of brain revealed global hypoperfusion. Initial response to L-dopa was insufficient (about 15% of improvement) with the dose 1500mg/d, then ropinirol was added (6mg/d). Transient improvement was observed after donepezil 10mg/d and later after intensive rehabilitation. Treatment does not affect the gaze palsy. This is an unusual presentation of gait disturbances in atypical parkinsonism. Interesting effects of acetylocholinesteraze inhibitor as well as rehabilitation without typical progression within 3 years.

ACKNOWLEDGEMENT:
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P2-J-57 A cane improves postural recovery from a slip during walking in people with Parkinson's disease

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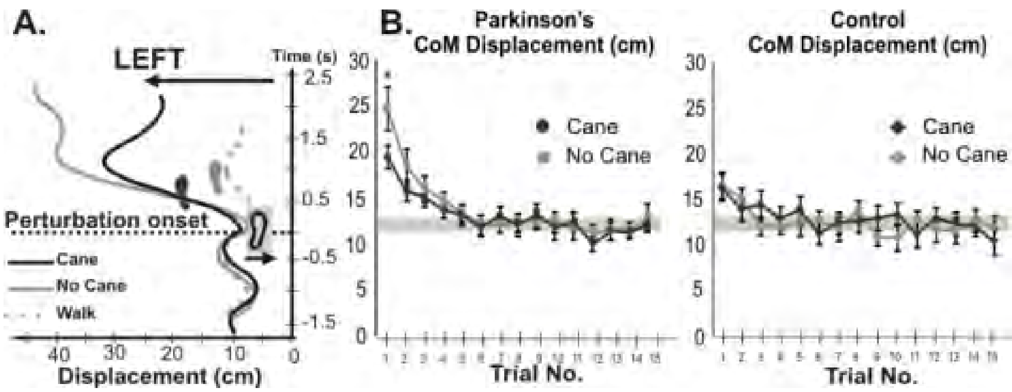
BACKGROUND AND AIM: A cane is commonly prescribed to improve postural stability in people with gait disorders such as Parkinson's disease (PD). However, it is still unknown whether a cane can improve postural responses to external perturbations while walking. Aims: This study assessed the cane effect on postural recovery from a slip and examined postural adaptation capability to repeated surface perturbation in PD. METHODS: Fourteen PD and 11 control subjects (CT) walked 5-meters across a movable force platform. The slip consisted of a 15-cm rightward translation of the force platform at 30 cm/s, triggered at the loading phase of the right foot. Two conditions - with an instrumented cane and without a cane, 15 trials each, were collected in a random order. The cane was held in the right hand and touched the ground in the same cycle as the left foot. Outcomes included mediolateral (ML) displacement of body CoM due to the slip and compensatory step width and step length during the first step after the perturbation. RESULTS: The rightward slip induced a leftward displacement of the CoM (Fig.1A) and postural adjustments to return the CoM to the right. This was accomplished by widening step width (increased 6.1 and 5.3 cm in PD and CT, respectively) and shortening step length (decreased 16.5 and 14.1 cm in PD and CT, respectively). Cane use improved postural recovery after a slip in PD, as seen by smaller CoM displacement in the first trial with a cane (Fig.1B). In contrast, a cane showed no effect on postural recovery after a slip in CT. The beneficial effect of a cane in PD, however, occurred only in the first perturbation and corresponded to level of instability during the first no-cane condition. Cane advantage could be explained by the provision of larger ML base of support. At the end of slip exposure, both PD and CT decreased ML CoM displacement to the same level, suggesting postural adaptation capability was preserved in PD. However, slow learning rate was evident in PD as they required more trials (PD 6 trials vs. CT 3 trials) for adapting their recovery (Fig.1B). CONCLUSIONS: The use of a cane improves postural recovery from an unpracticed slip in patients with Parkinson's disease, but not in the healthy control subjects. Balance in PD could be improved when training with repeated perturbation exposure.

Fig.1 (A) CoM excursion during unperturbed walking and perturbed walking with (bold) or without (gray) a cane. (B) group average of CoM displacement during the cane and no cane conditions in PD and CT subjects.



P2-J-58 Quiet stance before and after deep brain stimulation surgery in STN and GPi

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BACKGROUND AND AIM: Deep Brain Stimulation (DBS) is becoming a common treatment for Parkinson's Disease (PD), particularly when the disease progresses and is not well controlled by medication. A number of studies have shown that DBS helps reduce the cardinal symptoms of PD (tremor, rigidity, and bradykinesia). Less is known about the effect of DBS on postural control. Aim: To compare the effects of DBS in the subthalamic nucleus (STN) and in the globus pallidus (GPi) on postural sway during quiet standing before and after surgery in a randomized, control study. METHODS: Subjects were randomized into bilateral DBS electrode placement into the GPi (N=16) or STN (N=17). Before DBS surgery, the PD subjects were tested OFF and ON levodopa medication. Six months after surgery, the subjects were retested four times - in the OFF and ON levodopa and DBS states. We also tested 17 healthy control subjects and 9 PD control subjects (at baseline and 6 months later). Subjects stood with each foot on a separate force plate for three trials of one minute of quiet stance with eyes open. A movement analysis system with eight video cameras recorded the kinematics of body segments. The quiet stance variables extracted from the center of pressure data included: root mean square distance (RMS), mean velocity, centroid frequency, and sway area. In addition, we reconstructed the shank, thigh, and trunk segment angles with respect to vertical to characterize postural alignment. RESULTS: At baseline, the PD subjects had larger RMS, sway area, sway velocity and smaller centroid frequency compared to healthy control subjects ($p<0.01$). The PD subjects also had a more flexed posture. A comparison of the best treatment states before surgery (ON levodopa) and after surgery (ON levodopa and DBS stimulation) showed significant improvements in mean velocity ($p<0.01$), centroid frequency ($p<0.01$), and sway area ($p<0.01$) for the GPi group but no improvements for the STN group. Also, the trunk and thigh alignment slightly improved in the GPi, but not the STN, group. CONCLUSIONS: DBS in the GPi, but not in the STN, improves postural alignment and control of postural sway. The improvement in control of postural sway with DBS contrasts with the effects of levodopa, which increases sway velocity and sway area .

P2-J-59 The influence of visual control on postural stability in patients with early Parkinson’s disease

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INTRODUCTION AND THE AIM: Postural disturbances are one of the core features of idiopathic Parkinson's disease (PD). The aim of the study was the evaluation of the influence of visual control on postural stability in patients with early PD. METHODS: 50 patients with idiopathic PD and 50 subjects without the features of the central nervous system injury (the control group) were included into the study. Clinical diagnosis of idiopathic PD was established by movement disorders specialist basing on the United Kingdom Parkinson's Disease Society Brain Bank clinical diagnostic criteria. Only patients in early stage of PD without evident postural instability (I and II stage of the disease according to the Hoehn & Yahr scale (H&Y)) were included into the study. All PD patients and control group were evaluated with posturography with and without visual control (eyes open and eyes closed). The range of the displacement of the foot pressure centre in the frontal plane (COPx) and in the saggital plane, as well as the total path length of the foot pressure centre in both axis (COPxy) was tested during the easy standing with and without the visual control. RESULTS: Significant disturbances of postural stability in both frontal and saggital plane were observed in group of patients in stage I and II of H&Y. The values of the sways in the group of patients in stage II and the control group were similar. The length of the total path both under the sight control and without it was similar to the group of patients in the stage I and II of H&Y. The lack of the sight control shortened the total path of patients in stage II by 25.7 mm in comparison to the control group. CONCLUSIONS: The effect of visual control has a significant influence on the parameters of the postural stability in Parkinson's disease patients.

P2-J-60 The effect of controlling for step length on gait asymmetry in Parkinson's disease

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BACKGROUND AND AIM: Freezing of gait, a common gait disturbance in Parkinson's disease (PD) occurs more often at shortened step lengths and in the presence of the sequence effect [1]. Gait asymmetry has also been implicated in freezing of gait in PD however the effect of controlling for step length on asymmetry has not been investigated. This study aimed to investigate the effect of controlling for step length on asymmetry of gait and to determine if this gait feature predicted freezing in PD. METHODS: Footstep patterns of 16 participants with PD and freezing of gait, ten people with PD but no freezing and ten healthy controls were recorded on an electronic walk-way system. Participants performed 4 trials walking at 5 different step lengths - preferred, 100% (SL100), 75% (SL75), 50% (SL50) and 25% (SL25) of their normalized step lengths. The absolute asymmetry value of swing time was calculated from the average of left and right sides for each of the four walking trials. RESULTS: When comparing asymmetry between SL100 and SL25, swing time asymmetry was greater at SL25 in all three groups. Asymmetry of swing time did not differ between PD groups in the normalized step length conditions after adjusting for either preferred step length or disease severity. Asymmetry of gait was not predictive of freezing at SL25, where the incidence of freezing of gait was greatest. CONCLUSIONS: Asymmetry of gait is affected by the background step length and may not be a factor in determining freezing of gait in PD.

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P2-J-61 The effect of Dyskinesia on gait in Parkinson's Disease

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BACKGROUND AND AIM: Dyskinesia, a common motor complication of antiparkinsonian medications, is reported to affect between 20% and 90% of people with Parkinson's disease (PD). Excessive dyskinesia can interfere with voluntary movements thereby limiting activities of daily living. Despite the prevalence of dyskinesia in PD, little is known about the effect on gait. This study aimed to compare the gait pattern of people with PD with dyskinesia to a group with PD but no dyskinesia. METHODS: Forty one people with PD, 21 with dyskinesia and 20 with no dyskinesia, had their footstep patterns recorded on an electronic walkway system. They performed three trials walking at preferred speed, with trials two and three used in the analysis. Gait parameters included in the analysis were gait speed, stride length, single and double limb stance time. Parametric and non parametric tests were used to compare group characteristics for age, height, Mini Mental State Examination scores, disease duration, Unified Parkinson's Disease rating Scale (UPDRS) scores and Hoehn and Yahr stage scores. A one-way between groups ANCOVA was conducted to compare gait characteristics between groups while adjusting for UPDRS scores, disease duration and height. RESULTS: There were no group differences in age, height, MMSE scores and Hoehn and Yahr scores; the dyskinetic group had milder disease severity (lower score on UPDRS motor section) ($P=0.009$) and longer disease duration ($P<0.001$). After adjusting for UPDRS scores, disease duration and height, the dyskinetic group had longer single stance time ($P=0.024$); the remaining gait parameters were not significantly different between groups. Variability (expressed as the coefficient of variability, COV) of stride length and double support times were greater in the dyskinetic group ($P<0.05$). CONCLUSIONS: Dyskinesia may contribute to greater gait variability in people with PD. Increased variability of stride length and double support time is associated with increased risk of falls in the elderly. Findings from this current study suggest dyskinesia may be associated with increased risk of falls in people with PD. Further investigation of the contribution of dyskinesia to the risk of falls in PD is warranted.

P2-J-62 Lateral balance control during walking: Can the Extrapolated Centre of Mass model predict foot placement during lateral external perturbations?

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BACKGROUND AND AIM: Balance control in bipedal walking poses challenges in the unstable lateral direction. The previously developed XcoM model [1] extends the classical inverted pendulum with a velocity component of the Centre of Mass (CoM) to determine foot placement and stability margins. It is hypothesised that a wide stride is more stable than a small one. The model is tested for unperturbed

normal walking, but it is unknown how it compares to real-life foot adjustments in response to external perturbations. This study investigates the validity of the model when lateral perturbations are applied during two phases of the gait cycle. METHODS: Ten healthy subjects (5 men, 5 women, age 24.1 ± 2.2, mean ± s.d.) walked on a treadmill and were pushed laterally during the double stance phase and the swing phase, in random steps using a linear motor. CoM movements and foot placement were recorded using a VICON system. We compared the measured foot placement with the one calculated by the model. The model calculated foot placement of the upcoming step was based on the measured CoM position, velocity and the present foot position at the moment of toe-off. RESULTS: In response to lateral perturbations during the double support phase opposite to the CoM movement, the XcoM model predicted a decreased step width in the upcoming step, as the situation is more stable. This was followed by an increased step width in the next step, creating more stability. Compared to the model calculations, the pattern in the measured foot placement showed qualitatively the same pattern, although humans react one step later. Furthermore, the XcoM model was not accurate in predicting the exact foot placement. For the perturbations during the swing phase a different pattern was observed. Humans were able to adapt their foot placement during the swing phase. However, the model was not effectively dealing with this adaptation. CONCLUSIONS: The model gives qualitatively good predictions. However, to obtain quantitative good predictions the model should be adapted. Model calculations are very sensitive for the estimation of step time. This estimation is difficult as only swing time is included and step time should be lengthened with the double support phase. Furthermore, other human compensation methods for instability, like trunk movements, were not included in the inverted pendulum model; therefore humans are able to walk with smaller step widths than calculated by the model. The model currently falls short in predicting foot placement when the perturbation occurs during the swing phase as it determines foot placement at the start of swing (toe-off). We are now extending the model to continuously monitor the CoM movement to make online corrections.

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P2-J-63 Backward walking: Wider steps as stabilizing strategy

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[1]KULeuven

BACKGROUND AND AIM: Gait parameters in backward walking (BW) have been reported to be more variable than in forward walking (FW) [1]. The aim of the current study was to test whether the increased variability in BW is related to decreased dynamic stability. We therefore evaluated stability related gait parameters during both FW and BW. METHODS: Nine healthy participants (1.74±0.07m; 64.7±7.2kg; 26.5±3.1yrs; 4 males) walked FW and BW at 1.11 m/s (4km/hr) for 7 minutes each, on a treadmill while 3D ground reaction forces were recorded. Instants of heel strike and toe-off were determined based on the center of pressure (CoP) [2]. We calculated step width, step width variability and stride time variability. We estimated the center of mass (CoM) based on the CoP and calculated the "extrapolated center of mass" (XCoM) and the safety margin between the XCoM and the base of support [3]. Moreover, we calculated short term maximum Lyapunov exponents (λs) following Bruijn's protocol, and applied this to the medio-lateral displacement of the estimated CoM [4]. We included 300 strides in the evaluation of all measures. RESULTS: BW was more variable in both step width and stride time than FW. Moreover, steps were wider, the safety margin was greater, but local dynamic stability was lower (higher λs) in backward than in forward walking. CONCLUSIONS: Backward walking is more variable, and less locally stable than forward walking, all in all suggesting reduced control of stability during backward walking. The increased step width and safety margin in BW compared to FW, suggests that participants increased their step width during unstable locomotion to increase the safety margin between the extrapolated center of mass and their base of support.

Table 1: Gait parameters for forward and backward walking. Asterisks indicate significant difference between walking directions ($p<0.05$).

	FW	BW
Step width [m]	0.191 ± 0.023	0.267 ± 0.034*
Step width variability [m]	0.018 ± 0.003	0.028 ± 0.004*
Stride time variability [s]	0.019 ± 0.005	0.034 ± 0.013*
Safety margin [m]	0.074 ± 0.011	0.115 ± 0.016*
λ_s [-]	2.818 ± 0.168	3.349 ± 0.210*

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P2-J-64 Novel system identification method to determine the contribution of the ankle and hip joints to human balance control

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BACKGROUND AND AIM: Bipedal upright human stance is inherently unstable and constantly challenges the central nervous system (CNS). Although balance control is commonly modeled as an inverted pendulum, multiple segments contribute to the stabilization. A more realistic approach is to include the ankle and hip joints resulting in a double inverted pendulum. In order to identify the stabilizing mechanisms of a double inverted pendulum two independent perturbations are required, as mechanical couplings between the two segments arise. Here, we present the first experimental results of a novel non-parametric multiple-input multiple-output (MIMO) closed-loop system identification method that estimates the balance control contribution of the left and right ankle and hip joints seperately in the saggital plane. METHODS: Seven healthy participants were asked to maintain their balance without moving their feet while two mechanical perturbations were applied, using a motion platform and an

actuated backboard. The two independent perturbation signals were continuous pseudo-random periodic signals. Reactive forces and torques of both feet and body movements were measured, to obtain the joint angles, body sway angle and joint torques. Firstly, the ratio between the periodic and the non-periodic part of the participants' responses was expressed by the noise-to-signal ratio (NSRs). Secondly, using MIMO system identification techniques we calculated the frequency response functions (FRFs) of the stabilizing mechanisms, which express the magnitude and timing of the joint torques in response to the joint angles at the specified perturbation frequencies. RESULTS: The average responses of the participants indicated linear, time invariant behaviour and a low presence of noise, shown by low NSR values. They were 0.24 (ankle angle); 0.28 (hip angle); 0.15 (sway angle); 0.56 (ankle torque) and 0.35 (hip torque), respectively. The FRFs of the stabilizing mechanisms showed that the contribution of the hip joint increased above 1Hz, while the contribution of the ankle decreased above 1Hz. Interactions between the segments were expressed by the FRF hip angle to ankle torque which gain remained constant, and the FRF ankle angle to hip torque which gain increased with increasing frequency. Balance control was very symmetrical in our sample. CONCLUSION: We demonstrated that our method provides a reliable estimate (expressed by low NSRs) of the stabilizing mechanisms underlying multi-segmental balance control. We found that mechanical and neural couplings between the ankle and hip exists, suggesting the existence of heterogeneous reflexes. Future applications are the assessment of axial rigidity and balance control asymmetries in patients with e.g. Parkinson's disease.

P2-J-65 Adaptability of intra- and inter-foot coordination to altered footwear and posture conditions in upright stance

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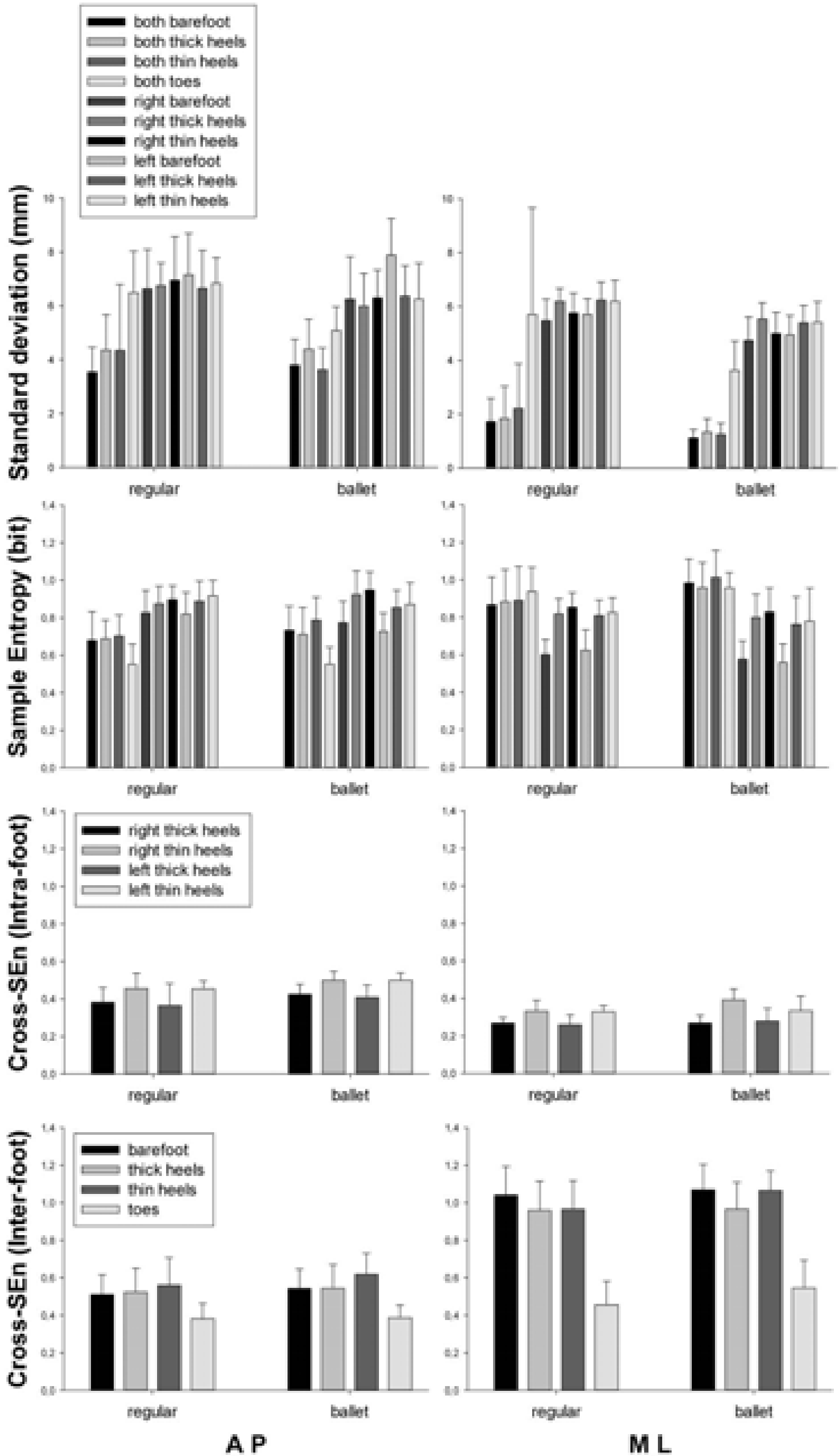
BACKGROUND AND AIM: Intra-foot coordination between center of pressure (COP) of the ball and heel of the foot in single leg standing while wearing a high heel shoe and inter-foot coordination of the right and left foot during bipedal stance was examined as a function of postural stance (two legs, one leg, and toe postures), footwear (barefoot, different area based high heel shoes) and postural training (ballet group and regular exercising group). METHODS: Young adult females performed three 20 s trials in each postural condition. In general, the standard variability measures of postural motion, namely, the mean velocity and standard deviation (SD) of COPnet motion increased under the less stable postural support conditions and ballet dancers had better balance in the posture conditions that are related to the specific ballet postures. In addition, the temporal dynamics of COPnet were examined using Sample Entropy (SEn). RESULTS: We found that SEn either increased or decreased with increased task difficulty. Regularity analysis of foot coordination (Cross-SEn index) revealed a negative relation between the variability of foot coupling (both intra- and inter-foot) and the SD of COPnet that was mediated by the interaction of shoe support and postural stance. CONCLUSION: The findings show that shoe support and postural stance modulate collective postural motion (COPnet) through the adaptability of the coupling of foot dynamics. Our results add to the generality of the commonly proposed assumption that movement variability in postural control increases as the functional degrees of freedom of the system decrease. Finally, this study provides further evidence that the information obtained from two adjacent

force platforms in quiet standing provides the basis for a more complete characterization of the movement dynamics of postural control than the traditional use of one platform and the sole focus on COPnet.


both barefoot
both thick heels
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Standard deviation (mm)
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Cross-SEn (Intra-foot)
barefoot
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regular
ballet
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M L

P2-J-66 Assessment of adaptive walking performance

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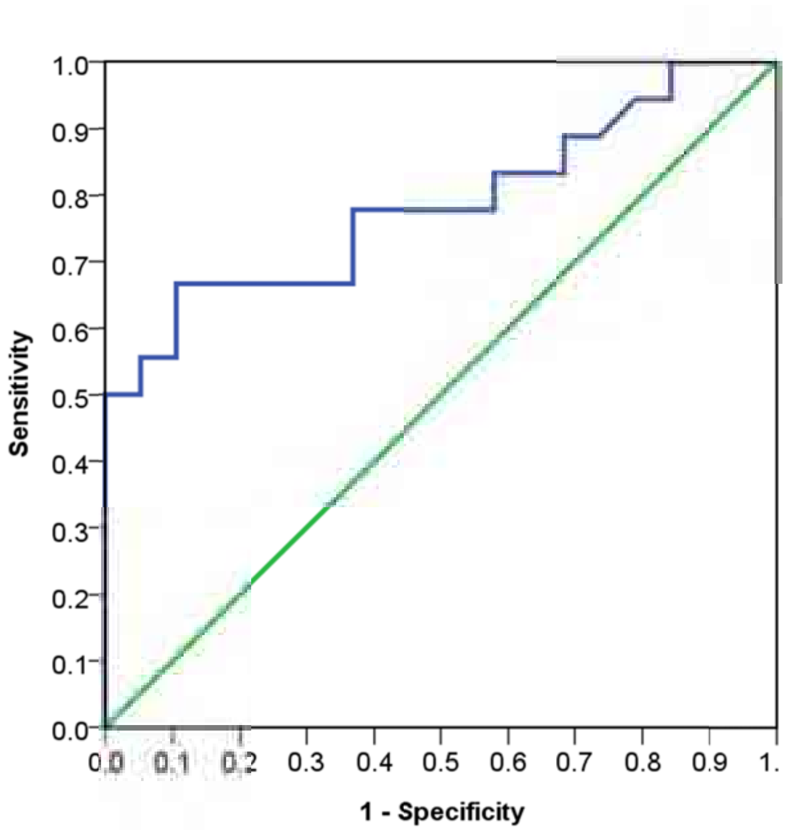
BACKGROUND AND AIM: Although mostly negative aspects, such as fall risk or mobility impairment, are reported to be associated with gait variability, irregular walking is needed when walking performance has to be adapted to specific environmental conditions. The aim of this study was to evaluate test-retest reliability and discriminative ability of a measure to assess adaptive walking performance. METHODS: Eighteen older (median age 77.5 years) and 19 young women (median age 30 years) were instructed to walked the most precisely over a defined course of 26 arbitrarily positioned square boxes fixed on an instrumented walk way with embedded pressure sensors. RESULTS: ICC(1,1) of 0.79 and within subject SD (standard error of measurement) of 0.6 cm demonstrated sufficient reliability in the cohort of older women. Deviation of the foot prints from the marked square boxes was significantly higher in older women than in the group of young subjects (2.9 cm versus 2.3 cm, p=0.003). Gait speed of the older women was higher during the test (0.50 m/s versus 0.40 m/s, p=0.025), whereas during unconstrained walking gait speed was higher in young subjects (1.50 m/s versus 1.15 m/s, p<0.001). The deviation measure classified 78% of the subjects into correct age group using an optimal cut frequency of 2.65 cm (sensitivity 67%, specificity 90%, area under the curve 0.79, p=0.003) identified from ROC analysis, as shown in Figure 1. Figure 1: ROC curve of the adaptive walking performance test on young and old women CONCLUSIONS: This study shows that adaptive walking performance is a reliable measure of irregular walking with ability to discriminate between young and older subjects, and can be used complementarily to walking speed to characterize walking. Our results suggest that older persons might try to camouflage their accuracy of adaptive walking performance by higher gait speed.



P2-J-67 Quantitative description of the lie-to-sit-to-stand-to-walk transfer by body-fixed sensors

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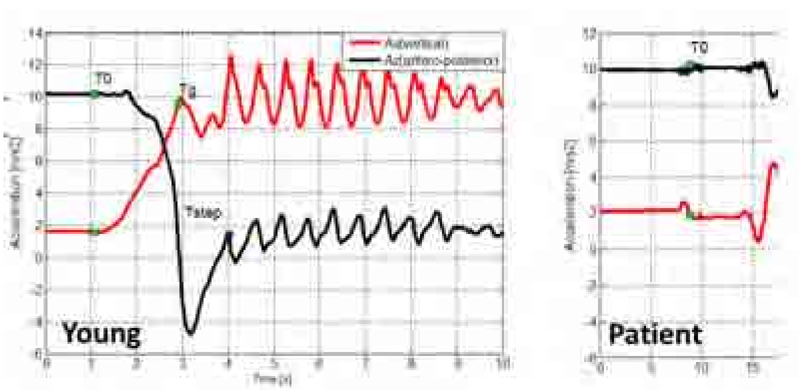
BACKGROUND AND AIM: Sufficient capacity and quality of performance of complex movement patterns during daily activity, such as standing up from a bed or from a chair, are prerequisites for independent living. More than half of all in-patient falls in elderly people in acute care settings occurred at bedside, during transfer or whilst getting up [1-2]. Up to now, the transfer from lying-to-sit-to-stand-to-walk (LSSW) was investigated only by functional testing or subjective rating [3]. The aim of this preliminary study was to describe the complex movement of the LSSW transfer in young and older subjects by kinematic body-fixed sensors. METHODS: Fifteen older patients of a geriatric rehabilitation clinic (median age 81 years, 80% women) and 10 young healthy employees of the same hospital (median age 37 years, 60% women) were recruited for this experimental study. Participants were instructed to stand up in a continuous movement from a lying position on a conventional nursing bed to upright standing and to start walking. In the cohort of older patients the assessment was repeated on the consecutive day for evaluation of test-retest reliability (Intra-Class Correlation coefficient, ICC(3,1). Data acquisition

was performed using a DynaPort® Hybrid (McRoberts, The Hague, NL) data logger including a tri-axial seismic acceleration sensor at the lower back. Since the movement is performed mainly in the anterio-posterior direction, the medio-lateral accelerometer output was not analyzed. Temporal parameters, such as the beginning of the movement (T_0), the first upright position with trunk vertical (T_g) and the end of the movement (T_S) corresponding with the first heel strike, were extracted from the accelerometer outputs. The total time ($TT = T_S - T_0$) was calculated. Jerk and fluency (sum of the residuals with respect to the low-pass filtered signal) of the accelerometer outputs were evaluated as indices of smoothness. Both parameters were normalized to the duration of the movement. RESULTS: TT, jerk, fluency and reliability are reported in Figure1 (left) for both groups. An example of accelerometer outputs for a representative young subject and older patient is reported in Figure1 (right). As shown in Figure1 (left table), the values of the three parameters were higher in the older patients, suggesting that performance of movements was different between groups, although some older patients had low values of TT and jerk, similar to young subjects, indicating good performance. $ICC_{3,1}$ ranged between 0.846 and 0.883 for TT, jerk, and fluency. CONCLUSIONS: Instrumented LSSW test allowed evaluating objectively the performance of younger and older subjects in terms of time spent and fluency of movement. Future developments will regard the integration of gyroscope measurements to describe the bed-rise strategies. The results obtained in this preliminary study suggest the usability of this instrumented test in a broader scenario, possibly involving the ability to evaluate the fall risk during transfer from lying to standing in older subjects.

	Young subjects (n=10, 6 women)			*Older patients (n=15, 12 women)*			
	Median	*1.-3.Q*	*Min-Max*	*Median*	*1.-3.Q*	*Min-Max*	$ICC_{3,1}$
Total time [s]	3.00	2.38-3.55	1.70-4.50	12.10	6.60-17.30	4.70-22.90	0.846
Jerk [m] (log scale)	11.20	10.50-11.75	9.60-12.50	15.40	13.80-16.60	12.10-17.80	0.883
Fluency [m] (log scale)	7.70	7.25-8.18	6.80-8.90	10.60	9.50-11.20	8.30-12.20	0.876

All differences between groups are p<0.0001



P2-J-68 Could face piercing (body art) affect binocular alignment, postural control, and lead to nonspecific back pain?

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BACKGROUND AND AIM: Piercings (body art, i.e. with jewelry) are more and more widespread, and can induce various complications such as infections, allergies, headaches, and various skin, cartilage, or dental problems which will lead to economic effects on health-care systems (e.g. [1]). This study of four cases draws attention to other possible side effects resulting from face piercing complications such as eye misalignment, decreased postural control efficiency, and nonspecific chronic back pain [2]. METHODS: Four subjects wearing jewelry pierced in eyebrow, tragus, upper lip, and nose retained our attention; they suffered from nonspecific chronic back pain with an additional comorbidity such as dizziness, headache or eyestrain known in nonspecific chronic back pain (e.g. [3]). Vertical eye misalignment evaluated with the Maddox rod test was systematically found, but lower than one diopter. Postural control was evaluated through the center of pressure displacements with a force platform while the subjects fixated a target placed at eye level at 200 cm in a straight ahead position: eyes open and eyes closed, with and without piercing. The pain score was evaluated with a subjective visual analogical scale. A check was done on average 3 weeks later. RESULTS: Removing the jewelry: i) restored eye alignment; ii) improved postural stability through the decreasing of the magnitudes of the center of pressure displacements (see Figure 1: example of representative statokinesigrams for one subject); iii) alleviated back pain in a lasting way, i.e. pain evaluation dropped for each subject. CONCLUSIONS: Disturbance of somaesthetic afferences and sensorimotor conflicts here produced by piercings in the trigeminal territory could be at the origin of eye misalignment and postural instability in quiet upright stance. Prolonged disturbance and conflict could lead to pain in line with an experimental study (see [4]). Further studies of a larger group are needed to establish the significance of these data for health care.

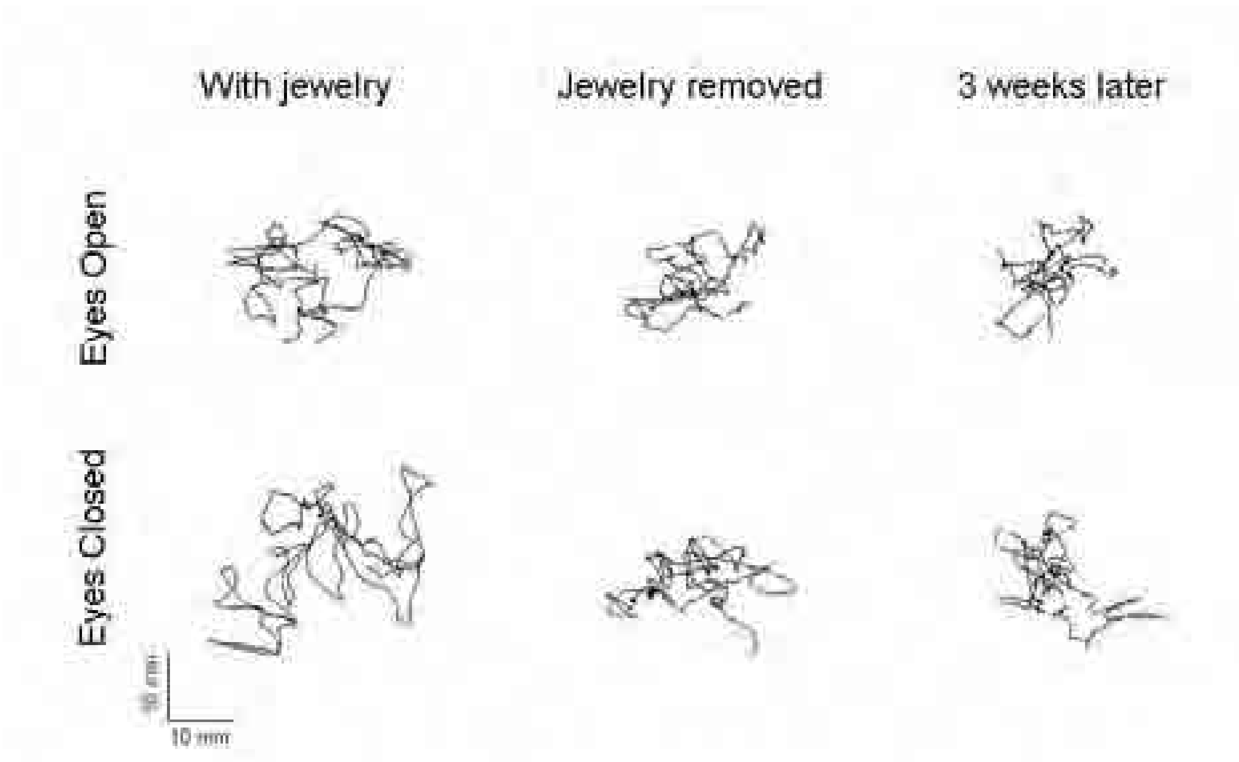

Fig.2 Example of statokinesigrams eyes open and eyes closed, with jewelry, with jewelry removed, and when the check was done, still without jewelry, 3 weeks later.

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K - Neurological Diseases II

P2-K-69 Gait in Parkinson's disease patients treated with subthalamic deep brain stimulation in comparison with a parallel non-DBS group

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BACKROUND AND AIM: Results of studies assessing influence of subthalamic nucleus (STN) deep brain stimulation (DBS) on gait in Parkinson's disease (PD) are inconsistent. The aim of the study was to evaluate gait disorders (GD) in two groups of patients with advanced PD, with and without DBS

treatment and to assess the influence of DBS duration on gait. METHODS: 8-item questionnaire of GD (8-QGD) was mailed to PD patients with and without bilateral STN DBS treatment matched by age and disease duration. 8-QGD included questions (rating in five grades from zero to four) on gait in relation to a global motor impairment, freezing, impact of fear of falling on activities of daily living, falls and injuries. Correlation between 8-QGD score and DBS duration (in days) was assessed by Pearson correlation coefficient. RESULTS: questionnaires from 65 (48 males, 18 females) DBS and 65 (42 males, 21 females) non-DBS patients were evaluated. No significant difference was found in any parameter evaluated (see Table). Slight but significant correlation between 8-QGD score and DBS duration (in days) was found (r=0.26, p=0.038). CONCLUSION: Gait disorders in patients with advanced PD do not significantly differ between DBS and non-DBS population. Correlation between 8-QGD score and DBS duration could be explained by the natural course of disease progression or declined effect of DBS on gait over time.

Patients group	Age *yrs±SD (range)*	Disease duration *yrs±SD (range)*	DBS duration *yrs±SD (range)*	Freezing %	On freezing %	Fear of falling %	Falls %	Injuries %	8-QGD total score *yrs±SD (range)*
DBS (N=65)	62±7.7 (42-81)	17.9±5.2 (9-30)	5.4 ± 2.9 (1-10)	83	72	76	87	67	17.6±6.1 (3-31)
Non DBS (N=65)	63±6.7 (46-81)	16.2±4.5 (10-30)	--	89	80	71	78	58	15.6±7.1 (0-30)

P2-K-70 Risk factors for freezing of gait in Parkinson's disease

Francisco Grandas[1], Ana Contreras[1], Beatriz De la Casa[1], Fernando Alonso[1]

[1]Hospital Universitario Gregorio Marañon

BACKGROUND AND AIM: Freezing of gait (FOG) is an episodic gait disorder that may occur in patients with Parkinson's disease (PD). The risk factors for this disorder are poorly understood. To determine the relevant risk factors for FOG in PD. METHODS: We screened 160 consecutive patients with PD for FOG using the FOG questionnaire (Giladi et al, 2000) , and assessed 36 potentially related variables. Freezers and non-freezers were compared using statistical univariate analysis, followed by bivariate and multivariate logistic regression, receiver operating characteristics curves and Kaplan-Meier estimates. RESULTS: Seventy-one patients (44.4 %) reported FOG. FOG appeared after a mean disease duration of 8.1 ± 6.3 years. Freezers experienced falls more frequently than non-freezers (57.7 % vs 23.6 %, p<0.001). Disease duration was the independent variable most associated with FOG (OR=1.10, 95%CI=1.01-1.19, p=0.020). Its specificity was 77 %, but its sensitivity was low, and Hoehn and Yahr staging and the UPDRS (part III) score showed similar accuracy to that of disease duration in predicting freezers. Previous antiparkinsonian treatments and predominant motor signs (tremor/akinesia-rigidity subtypes) at the onset of PD were not related to FOG. Patients who developed PD before the age of 60 years experienced FOG earlier than older patients (log-rank, p<0.005). CONCLUSIONS: FOG is a common and disabling motor complication of PD that is related to the progression of the disease. It is not

primarily associated with dopamine replacement therapy. FOG may occur early in young patients and may be a specific cause of falls in these patients. FOG could be a clinical hallmark of progression of PD.

P2-K-71 Limb-specific postural dyscontrol in stroke survivors with spasticity

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BACKGROUND AND AIM: Spasticity is defined as a velocity dependent increase in tonic stretch reflexes with exaggerated tendon jerks resulting from hyperexcitability of the stretch reflex [1]. Spasticity in the upper limb can limit function and interfere with one's interaction with objects in the environment and in the lower limb can affect gait and balance control. While there has been extensive study focused on upper limb spasticity and associated control of the upper limb, the influence of lower-limb spasticity on balance control has received less attention. The purpose of this study was to characterize postural control in a group of stroke survivors with lower limb spasticity. METHODS: The data was extracted from a larger database (>300 patients) exploring the longitudinal recovery from stroke. Patients who were able to stand independently and had spasticity at the knee (extensors) and/or ankle (plantarflexors) when assessed 90 days or more after first-ever stroke were identified from the database. Twenty-four patients (60.2 /- 14.2 years) met the initial inclusion criteria. The presence of spasticity was identified using the Modified Ashworth Score (MAS) [2]. Postural control was assessed while standing quietly on two force plates for 30 seconds; one foot was placed on each force plate to examine limb-specific dyscontrol. For this preliminary analysis, the measures chosen to characterize postural control included the root mean square (RMS) of the centre of pressure (COP) in the antero-posterior (AP) and medio-lateral (ML) direction, average COP velocity, COP length, and stance load symmetry ratio (stance load affected/unaffected limb). The data acquired from the force plate under the affected leg was compared to that of a group of 25 randomly-selected stroke survivors without spasticity. RESULTS: Of the participants included in the analysis, 1/24 had spasticity in the knee, 10/25 had ankle spasticity, and the remaining 13 participants had MAS>0 in both knee and ankle. The group with spasticity bore relatively less weight on the affected limb (lower symmetry ratio) as compared to the group without spasticity (0.7 versus 1.0) In addition, the patients with spasticity displayed larger COP sway (7.6 versus 5.5 mm) in the AP direction on the affected limb. CONCLUSIONS: These preliminary results indicate that impaired balance control, as revealed by measures of centre of pressure sway of the stroke-affected limb, is linked to the presence of lower limb spasticity. Further analysis using the dual force platform technique is required to individually assess the contributions of the unaffected limb to balance control in individuals with unilateral lower limb spasticit

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P2-K-72 Loss of balance in patients with Cerebellar Ataxia while standing on a slow inclining surface

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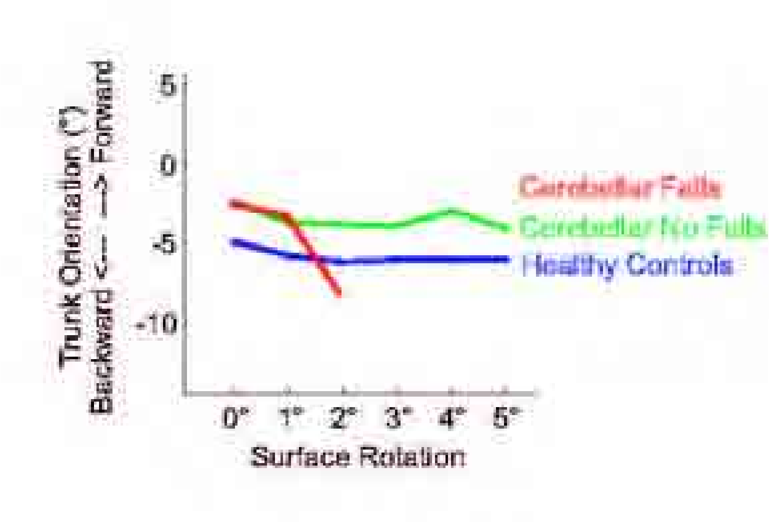
BACKGROUND AND AIM: In the present study, we aimed to determine how patients with cerebellar ataxia adapt their posture to a slowly inclining surface, involving an online update of postural orientation to maintain balance. We hypothesize that the cerebellum significantly contributes in this slow adaptation processes involving a gradual recalibration of sensory information to optimize motor performance. METHODS: Nine subjects with cerebellar ataxia (61±10 yrs) and eight age- and gender-matched healthy control subjects (59±5 yrs) participated in the study. All subjects with cerebellar ataxia were ambulatory and could stand without assistance. Subjects stood eyes closed (blindfolded) on the horizontal force platform for 1 minute after which the surface was tilted 5° toes-up at a ramp velocity of 1°/s. The toes-up position was held for 2.5 minutes after which the surface rotated back down to horizontal with the same tilt characteristics and held for 5 minutes. Two trials were collected for each subject. The trunk, hips, legs, feet and surface motions were computed from marker positions recorded at 60 Hz with an 8-camera video system. RESULTS: Cerebellar patients showed marked difficulty in adapting their posture to a slow up-moving incline. Eight out of 9 cerebellar patients fell backward or took a step during the incline motion in at least one of their trials. Five out of 9 were unable to maintain balance on the up-moving incline in both attempts. The down-rotating surface was not as challenging for cerebellar patients. Only 3/9 subjects fell forward or took a step and only one did not succeed in their 2 attempts. Adapting to a slowly rotating surface was not challenging for control subjects who were able to remain stable in all trials. When the surface began tilting up, all subjects leaned back, orienting their trunks with respected to the tilting surface. However, all control subjects and cerebellar patients who did not fall back, maintained balance by adjusting their posture with trunk flexion. The cerebellar patients who fell or stepped back showed steady backward trunk reorientation beginning within the first second following surface movement onset (see Figure). As a result, cerebellar patients who fell backward showed interrupted and large trunk extension during the surface movement. CONCLUSION: Thus, postural instability associated with cerebllar ataxia derives from an inability to adapt trunk orientation in space while standing on a slowly inclining surface, due to the hypermetric responses to surface incline rather than the inability to accurately time the sensorimotor response to the incline.



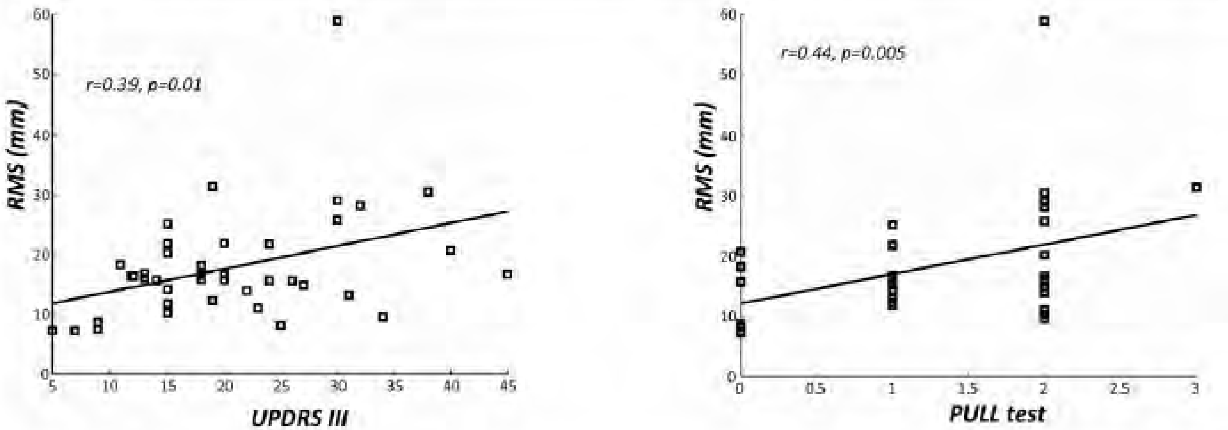
P2-K-73 The relationship between Parkinson's disease severity and posturography

Amie Peterson[1], Martina Mancini[1], Fay Horak[1]

[1]Oregon Health Sciences University

BACKGROUND AND AIM: Postural instability is one of the four cardinal features of Parkinson's disease (PD). Balance problems and falls are a major source of morbidity and mortality late in the disease and are not clearly related to dopamine loss. To determine the relationship between PD severity and balance measures using clinical posturography. METHODS: Forty subjects with PD underwent a battery of 3 computerized balance tests: 1) 6 condition of the Sensory Organization test, 2) Motor Control Test (backward platform translation), and 3) Sit-to-Stand on the Neurocom posture platform in the "on" state. Parkinson's severity (Motor UPDRS), Pull Test, cognitive function (trails A & B, MMSE, verbal fluency, and clock draw), and dyskinesias (mAims) were also measured. The relationship between the balance measures and clinical scales were investigated by Pearson's correlation analysis. RESULTS: There was a significant correlation between the UPDRS motor score and sway measures when subjects stood on a compliant platform with eyes open (condition 4 of the SOT). Specifically, planar RMS (root mean square distance) and planar RANGE (peak to peak sway) were significantly correlated with the Motor UPDRS ($r=0.39$, $p=0.01$ for RMS and $r=0.32$, $p=0.04$ for RANGE) and the Pull test (RMS $p=0.44$, $r=0.005$; RANGE $p=0.37$, $r=0.01$; MV $p=0.38$, $r=0.01$). The postural instability/gait disorder (PIGD) subscore, but not the total UPDRS, was significantly correlated with the weigh transfer time ($r=0.42$, $p=0.01$) and rise index ($r=-0.35$, $p=0.03$) during the neurocom Sit-to-Stand test. CONCLUSIONS: Severity of PD was related specifically to ability to stand without accurate surface orientation information but not with many other measures of postural control. Objective measures of sit to stand may reflect impaired dynamic stability in PD.

Correlation of root mean square (RMS) in SOT 4 and clinical measures



The RMS (a measure of sway) correlated with the motor UPDRS score and Pull test in condition SOT4 (eyes open on a compliant platform).

P2-K-74 Trunk sway in patients with idiopathic normal pressure hydrocephalus compared to healthy elderly - estimation with gyroscope technique

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BACKGROUND AND AIM: Cardinal symptoms in patients with idiopathic normal pressure hydrocephalus (INPH) are deficits in balance and gait. These symptoms are commonly examined using a standardized test battery, and the scoring is visually performed by a physiotherapist. Technical solutions such as electronic walkways and force platforms have been used, but only on small patient materials and not in daily clinical practice. Trunk sway (TS) is a promising measure of postural stability during balance tests. To measure balance and gait continuously on an unlimited area and on different surfaces, as well as to reduce subjectivity, a high resolution gyroscopic technique with the potential to measure balance in a standardized and objective manner was evaluated. The balance behaviour of patients with INPH was compared to the balance of healthy elderly. METHODS: TS was measured in 58 healthy individuals (HI), 71±4 years (mean±SD), and in 21 patients with suspected INPH, 71±9 years, using the gyro-based system SwaystarTM. Patients were included only if they were able to stand without support. Ten standing and walking tasks were evaluated. Combinations were made with eyes open or closed on solid ground, on a foam surface and including obstacles along the walkway. Each test was performed during 30 s. RESULTS: The gyro technique was well suited to measure TS in an elderly population. All HI and 13 patients could perform all tasks, although not always throughout the entire task duration. TS e.g. when standing feet

together eyes open in HI and INPH patients respectively (HI n=58, patients n=16) were: pitch angular amplitude range 1,8±0,7° (mean±SD) and 4,1±2,0° respectively, and pitch angular velocity range 4,8±2,0°/s and 16,4±18,7°/s respectively. The difference in both amplitude and velocity was significant (p<0,05). CONCLUSIONS: The gyro technique was found to be a promising tool to evaluate balance behaviour of INPH patients in daily clinical practice in a standardized and objective way. TS could be measured during simple as well as more challenging tasks such as standing or walking on foam or over hurdles to simulate a rough terrain, this is important since the scales used today are easily saturated. The next step is to include more patients and to evaluate TS before and after predictive tap-test as well as after treatment by liquor shunting.

P2-K-75 Symmetrical dynamic stability in people after stroke after balance perturbations towards the paretic and non-paretic side

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[1]Radboud University Medical Centre

BACKGROUND AND AIM: Impaired balance is a common complaint after stroke. During quiet standing, stroke-related impairments are more pronounced in the frontal than in the sagittal plane [1]. In this study we investigated whether this is also true for the ability to withstand external perturbations. To this aim, we compared the highest perturbation intensity that persons could recover from without stepping (stepping threshold) between patients with stroke and healthy controls. METHODS: Twelve community-dwelling patients with chronic stroke (mean age 59y; Berg Balance scores 33-56; lower extremity Fugl-Meyer scores 18-97% recovery) were included, as well as twelve healthy controls (mean age 63y). They stood on a moveable platform and were instructed to recover balance while keeping their feet in place during perturbations in the forward, backward, leftward and rightward directions. The stepping thresholds were determined for all 4 directions by gradually increasing the platform acceleration until the participant was no longer successful in maintaining the feet in place. In addition, we determined the excursions of the Centre of Mass (CoM) on the basis of full body kinematics. According to the method suggested by Hof et al [2], we calculated the extrapolated CoM (XCoM). The margin of stability was determined (the distance of the XCoM to the borders of the base of support) at the stepping threshold in each direction. RESULTS: The participants with stroke had lower stepping thresholds than controls in all four directions (p values between 0.012 and 0.04). Within the stroke group, there was no difference in stepping thresholds between perturbations towards the paretic versus the non-paretic side. The margins of stability at the stepping threshold were not significantly different between patients with stroke and controls in all four directions. Again, there was no difference between perturbations towards the paretic versus the non-paretic side for patients with stroke. CONCLUSIONS: The lower stepping thresholds for patients with stroke with relatively normal margins of stability show that they are less able to control the CoM and that they are forced to a change -of-support strategy earlier than healthy controls, both in the sagittal and the frontal plane. Remarkably, stepping thresholds were not different for perturbations towards the paretic and non-paretic side. This result may be explained by the fact that patients with stroke usually adopt a weight-bearing asymmetry, leading to greater stability when being

perturbed towards the unloaded leg [3]. Weight-bearing asymmetry after stroke may, therefore, be an adequate compensation to optimally withstand external perturbations.

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3. De Kam et al. Abstract submitted to ISPGR 2012.

P2-K-76 Changes in cyclic movement in standing position at initial stage of Parkinson disease and in patients with essential tremor

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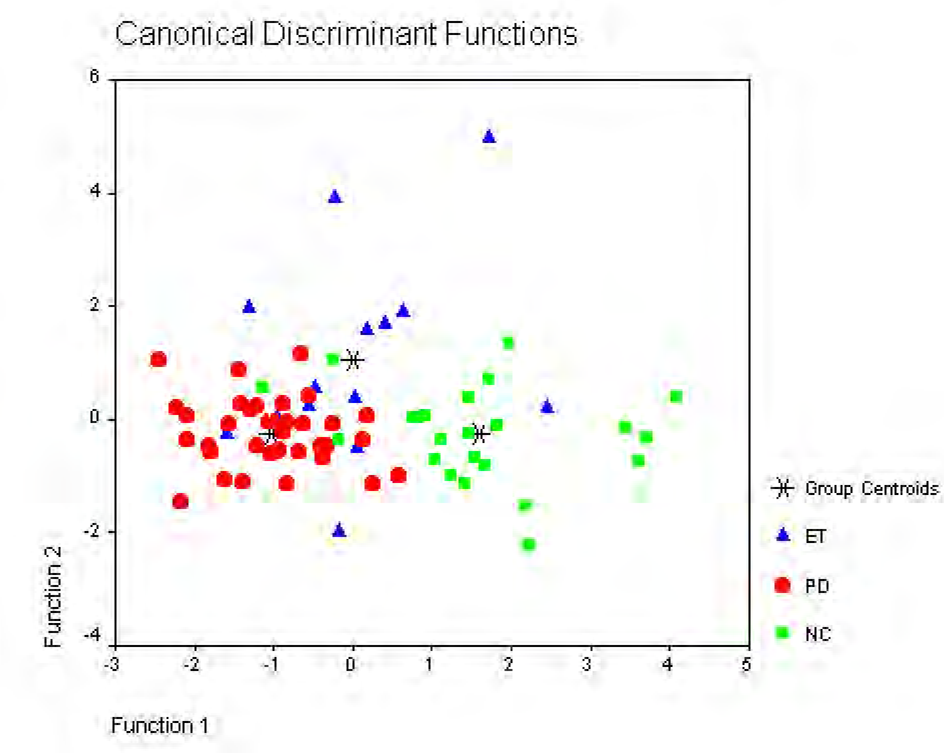
BACKGROUND AND AIM: Early diagnostics of Parkinson's disease is important because by the time patient complains first symptoms degeneration of substantia nigra involves 70% of neurons in substantia nigra [1]. On early stage of Parkinson's disease clinically significant symptoms are absent. Discrimination of Parkinson desease (PD) and essential tremor (ET) from control group of subjects without known neurological pathology (NC) based on some nonclinical markers could be a background for early diagnostics of PD. METHODS: Present study involved 27 PD patients, 10 ET patients and 25 control subjects (NC). Participants executed cyclic body movements in standing position. Repertoire of cyclic movements comprised 6 movement in all three anatomical planes: swinging forward - backward in saggital plan, right-left swing in frontal plane and clockwise - counterclockwise rotation around vertical axis. Amplitudes of angles in the ankle, hip and torso effective pseudo-joint in the plains of cyclical motion were employed as output cinematic parameters - 18 parameters total. We applied discriminant analysis to amplitudes of joint angles. Accuracy of classification was evaluated using the weighted k (kappa) coefficient [2]. RESULTS: Optimal two-dimensional discriminant function classifying 3 groups of subjects employing 8 amplitudes of joint angles is represented in figure 1. Each symbol represents one subject. Green symbols correspond to controls, red в - to PD and blue - to ET patients. Accuracy of classification reaches k = 0.68. At the same time for classification as patients and controls k = 0.85. Components of discriminant function are represented by linear combinations of amplitudes of joint angles: DF1 = -.05*H(sA)-.09*T(sH)-.04*H(sH)+.28*A(sH)+.016*T(fA)+.03*T(hA)+.02*H(hH)+.13*A(hH)-1.4 DF2 = -.23*H(sA)+.01*T(sH)+.02*H(sH)-.1*A(sH)+.23*T(fA)+.02*T(hA)+.004*H(hH)+.02*A(hH)-.9. Analysis of structure of discriminant function have shown that PD patients are characterized by difficulty rotating of hip segment around vertical axis. This is consistent with deficit in proprioceptive-motor integration, since the only adequate control of particular movement is proprioceptive. ET patients demonstrated enlarged torso sway in frontal plane. Bigger than necessary movement can be interpreted as a subtle sign of cerebral dysfunction, in drastic case reflecting in hypermetria. CONCLUSIONS: Changes in body movements in standing position executed by patients with PD and ET can serve as early sub-clinical markers of these diseases and can be used for early diagnostics.



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P2-K-77 Asymmetric standing posture after stroke is related to a biased egocentric coordinate system

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BACKGROUND AND AIM: Weakness and somatosensory deficits have long been known to be involved in the postural instability of subjects with stroke. Recently, it has been shown that impaired representations of the orientation of the longitudinal axis of the body (LBA, egocentric reference) and of verticality (allocentric reference) may also play a role. The objective of the present study was to determine whether these two references were independently linked to postural asymmetry in standing stroke patients. METHODS: Twenty-two subjects were tested after a first hemispheric stroke (13 _ 7.5 weeks). The LBA perception was investigated in the supine position by adjusting the orientation of a luminous rod in the frontal plane to correspond to the subjective LBA. The subjective visual vertical (SVV) was assessed by adjusting the orientation of a luminous line in the frontal plane to correspond to the SVV in upright patients. Weight distribution was measured in the standing position for about 2 minutes and 45 seconds by two separate force platforms under the feet. RESULTS: LBA and SVV were strongly associated (r _ 0.7; p _ 0.001). The estimate of the LBA was a better predictor (r__0.52: p _ 0.02) of weight bearing asymmetry than was SVV (r__0.41; p _ 0.074) when adjusted for motor

weakness and hypoesthesia. CONCLUSION: Contralesional rotation of the longitudinal axis of the body could lead to unequal distribution of loading on the feet. This novel interpretation of weight bearing asymmetry underlines the complexity of control of the erect stance following stroke and brings new perspectives for rehabilitation programs.

P2-K-78 Do the sub-types of Parkinson's disease patients respond differently to challenging walking conditions?

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BACKGROUND AND AIM: Patients with the Postural Instability Gait Difficulty (PIGD) sub-type of Parkinson's disease (PD) generally exhibit more severe deficits in balance and gait, compared to the Tremor Dominant (TD) sub-type. However, the effects of challenging walking conditions on those two sub-types have been never studied. We aim to test whether challenging walking conditions have a greater impact on PIGD and hypothesized that dual task (DT) walking and obstacle negotiation will be more difficult in these patients. METHODS: We examined 19 PIGD patients (mean age: 65.9±7.1 yrs) and 19 TD patients (mean age: 61.8±11.3 ys). Subjects walked with a safety harness under four conditions: usual walking, walking while subtracting 3 (i.e., DT) and walking in an obstacle course with and without DT. A 3D accelerometer (Mcroberts Inc.) worn on the lower back quantified gait. Acceleration-derived measures included average stride duration and variability, step and stride regularity, step symmetry, and frequency-based measures which reflect the average gait cycle (peak frequency), gait variability (width) and consistency. We compared gait measures of PIGD vs. TD including their DT and obstacle cost, which was defined as the difference between the measures of the DT or the obstacle walks versus the usual walk (UW), normalized with respect to UW measures. Cognitive function was evaluated using a computerized neuropsychological battery that generated indices for several cognitive domains. RESULTS: The PIGD group walked significantly slower under UW and DT (e.g., DT gait speed PIGD: 1.04±0.21 m/s; TD: 1.24±0.21 m/s; p=0.01). The PIGD patients had higher gait variability (e.g., UW stride variability: 1.84±0.55 % vs. 1.33±0.30 %; p=0.002) and lower stride regularity (p=0.03). The PIGD patients had higher DT and obstacle costs, which was reflected by the amplitude and width measures (e.g., Obstacle DT cost of the Amplitude: PIGD: 0.33±0.15; TD: 0.19±0.11; p=0.006). The PIGD patients scored lower on the MMSE (27.6±2.52 vs. 29.2±1.1, p=0.014) and the Montreal Cognitive Assessment (23.7±4.5 vs. 26.3±2.7, p=0.04). Higher Amplitude DT costs were related to poorer computerized catch game scores (r=-0.55, p=0.001) and lower global cognitive score (r=-0.36, p=0.03). The DT effects on stride-to stride variability, was correlated with the MoCa (r=-0.42, p=0.01) and with the executive function index (r=-0.42; p=0.01). CONCLUSIONS: Acceleration-derived measures of gait confirm that PD patients with PIGD sub-type have worse walking performance than TD. Moreover, these results demonstrate, for the first time, that PIGD patients apparently have less coping abilities during challenging walking conditions. Associations with the cognitive measures suggest that the exaggerated response to DT and obstacle negotiation may, in part, represent cognitive deterioration, and points to the importance of motor-cognitive interactions in these patients.

P2-K-79 Performance of alternating hand tapping and its relation to gait and postural disturbances in Parkinson's disease

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BACKGROUND AND AIM: Recent studies indicate that bilateral coordination of limb movements during locomotion is impaired in patients with Parkinson's disease (PD). We tested the hypothesis that patients with PD, with higher score on the Postural Instability Gait Difficulty (PIGD) items of the Unified Parkinson's disease rating scale (UPDRS) have a generalized deficiency performing bilateral alternating hand tapping. METHODS: We studied 75 patients with PD (Mean age 63.2±9.2; 21 female; mean disease duration 6.37±4.34 years) during the "OFF" state (i.e., 12 h without antiparkinsonian medication). A PIGD score was calculated (The sum of 5 items of the UPDRS part ii and iii- Jancovik et al. 1990). Based on this score, the patients were stratified into quartiles. Patient characteristics of the upper and lower quartiles (n=19 in higher score; n=18 in lower score) are described in Table 1. Hand tapping was measured while the patients sat in front of a wooden board in which two sensors (one for each hand) were embedded. They were asked to perform left-right alternating and single left/ right tapping on the sensors, for 45 sec at their comfortable pace. Gait was assessed during a 60 m walk performed at a self-selected speed. To determine the timing of the gait cycle and the stride-to-stride variability, subjects walked while wearing force sensitive insoles. Outcome measures were compared between quartiles: Gait variability, single and alternating hand tapping variability (i.e., stride to stride time and inter-tap time fluctuations) and number of errors during alternating hand tapping. RESULTS: Patients with higher PIGD score (H-PIGD) had more errors than patients with lower PIGD score (L-PIGD) in alternating hand tapping pattern (i.e., more disrupted; see table). Alternating hand tapping variability was significantly larger (worse coordination) among H-PIGD compared to the L-PIGD (p=0.012). Single hand tapping variability was also significantly larger in the H-PIGD (p=0.029), only in the more affected side. Hand tapping variability was significantly increased in the alternating condition, compared to the single hand condition, in the H-PIGD (p<0.05), but not in the L-PIGD. In addition, gait variability was higher (worse) in patients with H-PIGD than in L-PIGD (p=0.013). The PIGD score was correlated with gait variability (r=0.62, P<0.001), and with hand variability during alternate tapping (r=0.42, P=0.018). In contrast, the tremor score (i.e., UPDRS items contributing to tremor) was not associated with those variables. CONCLUSIONS: PD patients with PIGD symptoms suffer from dysrhythmicity and unsteadiness, both during gait and hand tapping. Increased difficulties with bi-lateral hand tapping, specifically in the H-PIGD group, suggest that the challenges of left-right coordination may contribute to the gait changes observed in these patients. These findings point to the potential involvement of hemispheric connections in the PIGD sub-type.

Table: Demographic, clinical and bilateral coordination parameters (mean ± SD)

Demographic & Clinical Parameters	H-PIGD (n=19)	L-PIGD (n=18)	P value
Age (y)	64.2 ±9.63	58.8 ± 10.65	0.11
Gender (F/M)	5/14	5/13	

Disease duration (y)	7.65±4.36	5.56±3.55	0.118
UPDRS motor part III	42.68± 8.65	40.72 ± 18.51	0.679
Coordination Parameter			
Errors in hand tapping	0.84±1.26	0.06±0.24	0.013
Single hand tapping variability (%) [affected side]	13.1±6.07	7.44±5.26	0.012
Alternating hand tapping variability (%)	20.32±11.50	12.14±6.69	0.012
Stride time variability (%)	4.99±4.61	1.94±0.48	0.013
H-PIGD and L-PIGD – patients from upper and lower quartiles, respectively, based on PIGD score.			

P2-K-80 Gait and balance impairment in Wolfram syndrome

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BACKGROUND AND AIM: Wolfram syndrome (WFS) is a rare, autosomal recessive, neurodegenerative disorder characterized by early onset insulin-dependent diabetes mellitus, optic atrophy, deafness and diabetes insipidus and neurological abnormalities, including clinically noted ataxia. Neuroimaging and neuropathological studies indicate that the brainstem and cerebellum are particularly vulnerable to WFS. However, gait and balance abnormalities have only been vaguely and qualitatively described. Based on recent reports of cerebellar and brainstem changes evident even in early childhood, we hypothesize that gait and balance impairments may be detectable in childhood. The goals of this investigation were to: 1) compare measures of gait and balance in individuals with WFS to an age-matched cohort and 2) correlate gait and balance measures with a measure of overall neurological impairment. METHODS: 13 individuals with Wolfram syndrome (mean 15.5 /- 5 yrs; range 6.4 - 25.8 yrs) and 30 healthy young age-matched individuals (mean age 13.2 /- 6 yrs; range 5.6 - 28.5 yrs) participated. The Physical and Neurological Examination for Subtle Signs (PANESS) was administered to assess developmentally corrected global neurological function. Balance was assessed using the Mini-Balance Evaluation Systems Test (Mini-BEST). Gait was quantified during forward preferred (FP), forward fast (FF), backward, and dual task (DT) walking on a GAITRite© walkway. A functional ambulation profile (FAP) score was calculated as a measure of overall gait impairment. RESULTS: Significant group differences were present for PANESS, Mini-BEST, and base of support ($p<.05$). No differences were found for velocity or cadence, during FP, FF and DT walking tasks. Leg length normalized velocity and FAP were significantly different between groups during backward walking only. In the healthy individuals, Mini-BEST scores were significantly correlated with age ($p < 0.001$, $r_s = 0.59$) while PANESS scores were not ($p = 0.317$). Within the WFS group, Mini-BEST scores correlated to PANESS scores ($p < 0.032$, $r_s = 0.60$), but did not correlate with age ($p = 0.726$). CONCLUSIONS: Our study quantified gait and balance in relatively young WFS patients and healthy controls, and found that: 1) impairments in gait and balance may occur earlier in the disease process than previously speculated; 2) balance

impairments correlate well with overall neurologic symptoms but not age in WFS, suggesting that disease severity is more relevant than age in determining balance deficits; 3) cadence and velocity were not different between groups during forward walking tasks, but base of support was wider in WFS than controls, suggesting that individuals with WFS may use a wide base of support during gait to compensate for poor balance; and 4) during backward walking, WFS had lower normalized velocity than controls, possibly indicating an inability to compensate for poor balance on a more challenging gait task.

P2-K-81 Knee efforts and weight-bearing asymmetry during sit-to-stand tasks in hemiparetic and healthy individuals

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BACKGROUND AND AIM: Following a stroke, individuals with hemiparesis performing a sit-to-stand (STS) transfer often use an asymmetrical weight-bearing (WB) strategy with more weight supported by the nonparetic foot. However, when asked to perform more symmetrically, these individuals have the capacity to rise with a more symmetrical WB distribution [1,2]. So what other criteria make individuals with hemiparesis decide to spontaneously use this asymmetrical WB strategy during the STS task? The level of efforts to produce at the lower limbs might be among the explanations for the asymmetrical WB. The aim of this study was to determine if hemiparetic individuals have symmetrical levels of effort at the knee during spontaneous sit-to-stand transfers. METHODS: Nineteen individuals with a chronic hemiparesis and 16 healthy controls participated. Their WB distribution during sit-to-stand was assessed with a force platform setup while the knee effort distribution was quantified using electromyographic (EMG) data normalized to maximal EMG values then expressed relative to the sum of the bilateral efforts. Two trials for a spontaneous and a symmetrical condition were executed after practice trials. The knee extensors' maximal static strength was assessed with a Biodex dynamometer which also provided the maximal EMG data. Student t tests and nonparametric statistics allowed to compare groups and subgroups of hemiparetic subjects classified according to their level of strength deficits. RESULTS: In the hemiparetic group, the nonparetic knee extensors were stronger than the on the paretic side ($P<0.001$). Six hemiparetic individuals had less than 10% asymmetry, seven, an asymmetry of 11% - 24% and six, more than 25% asymmetry between sides. Contrary to healthy individuals, the hemiparetic group presented asymmetrical WB and knee effort distributions during the sit-to-stand transfer. However, when subdivided in three groups (mild, moderate and severe) according to their knee extensors' strength asymmetries, the mild group behaved like the controls, the moderate one had similar WB and effort asymmetries and the severe group showed a WB distribution difference between sides but symmetrical knee efforts. These results for the severe group suggest that a control is exerted on the levels of effort when rising from a chair, which might be required when a certain threshold is reached. CONCLUSION: This is the first study to compare the knee effort distribution in a functional task such as the STS in hemiparetic and healthy individuals. Future studies are required to further examine the role of the levels of effort at the hips and knees together during STS tasks in hemiparetic patients.

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P2-K-82 Postural motor learning in Parkinson's disease

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BACKGROUND AND AIM: Parkinson's disease (PD) is known to impair posture control but its impact on motor learning is less conclusive. Postural motor learning has been shown in healthy older adults and appears non-specific to the spatial features of the balance task (Van Ooteghem et al, 2009, 2010). The current study investigated whether postural motor learning is preserved in PD and the type of learning that occurs during balance training. METHODS: 11 participants with mild to moderate PD (ON medication) maintained balance on a continuously translating platform that oscillated with constant frequency (0.5 Hz) and variable amplitude displacement (±2 cm to max 15 cm). Trials contained three repetitions of a 14-s sequence of oscillation amplitudes but participants were not informed of the repetition. Training consisted of six blocks of seven trials. To examine learning, participants performed retention and transfer tests following a 24-h delay. During transfer trials, participants were presented with novel perturbation sequences. Kinematic data were used to derive spatial (gain) and temporal (phase) measures of COM, trunk orientation, and lower limb joint angles. Specificity of learning was examined by comparing retention and transfer trials. Data from healthy, age-matched participants reported previously (Van Ooteghem et al 2010) were used for comparison. RESULTS: As a group, PD participants showed improvements in COM gain ($p<0.001$), COM phase ($p<0.001$), and trunk angle variability ($p<0.001$) during training. Slope analysis revealed however, that three participants failed to show significant improvements in any of these measures. The only significant group effect occurred for COM phase ($p=0.002$). PD participants exhibited greater phase lag than controls across all trials. Trunk flexion decreased with training ($p=0.003$) but there were no changes in lower limb joint angles or joint angle variabilities. Performance levels were maintained during the retention interval and were not disrupted by the transfer task. CONCLUSIONS: Mild to moderate, treated PD does not completely limit postural motor learning or influence the type of learning for balance control. Although some performance deficits were observed relative to control participants, improvements in spatial and temporal COM control and minimization of trunk instability occurred at a comparable rate. Kinematic changes in body segment control were limited to decreases in trunk flexion suggesting that improved COM control might be driven by changes in timing and gain of muscle activity. Positive transfer to new perturbation sequences supports generalized rather than sequence-specific learning and is consistent with the type of learning observed in controls. It remains possible that the capacity for postural motor learning is preserved with levodopa treatment. Future studies will compare OFF and ON levodopa states.

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P2-K-83 High-intensity interval training improves maximum gait speed for patients 3 to 9 months after stroke

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BACKGROUND AND AIM: Motor impairments can be one of the barriers to conduct high-intensity training after stroke. A treadmill with body-weight support (BWS) might help overcome this. The aim of this study was to assess the effect of a six-week high-intensity interval training program on cardiovascular fitness and gait characteristics for patients after stroke. METHODS: Acute stroke patients treated at the stroke unit at Trondheim University Hospital were screened for inclusion 3-9 months after onset. Inclusion criteria were independence in walking with or without walking aid and being able to perform VO2max test. Patients were excluded if they suffered from unstable pulmonary or cardiac disease or severe cognitive impairments. The intervention consisted of 4x4 minutes intervals at 85-95 % of maximum heart rate (Borg Scale=17), interrupted by 3 minutes active breaks at 70% of maximum heart rate (Borg Scale=14). This training protocol was repeated twice a week for six consecutive weeks. The outcome measures assessed before and after the intervention were; VO2max, maximum gait speed, percentage of single support of affected and unaffected leg during the walk cycle and the ratio between these two variables to assess the presence of asymmetry. RESULTS: Ten men and 5 women (mean age; 71, range; 61-85), were included. Mean Scandinavian Stroke Scale score at inclusion was 56.1 (range; 51-58). All patients completed all training sessions. Mean (SD) change from pre-test to post-test was; 28.2 (4.1) to 29.0 (4.1) ml/kg/min (p=0.205) on VO2max and 1.58 (0.33) to 1.71 (0.29) meter per second (p=0.003) on maximum gait speed. The percentage of single support during the walk cycle was 37.26 (2.44) versus 38.37 (1.89) % at pre-test and 37.93 (2.07) versus 38.99 (1.70) % at post-test for the affected and unaffected leg respectively. The ratio between the affected and unaffected leg changed from 0.972 (0.057) to 0.974 (0.062), p=0.878 from pre-test to post-test. CONCLUSIONS: This study, including patients with mainly minor hemiparesis, showed no significant improvement in cardiovascular fitness despite a highly significant improvement in maximum gait speed after six weeks of high-intensity body weight supported treadmill training. The ratio between affected and unaffected leg revealed a slight asymmetry which remained unchanged after the intervention. This protocol should be tested out in a randomized controlled trial.

P2-K-84 Visual cues from ice skating can enhance parkinson?s disease patient motor performance: A case study

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BACKGROUND AND AIM: The marked preservation of specific motor skills such as cycling, dancing or ice skating has been reported amongst some people living with Parkinson's disease (PD) despite these

individuals demonstrating disability in a number of functional movements including walking. Skills from a sport or exercise context with relatively rapid visual flow and a well-learnt behaviour seem to be common across cases of this paradoxical preservation, and may provide potential for enhanced exercise therapy. Ice skating is a biomechanically efficient form of exercise which provides the potential for skill transfer to posture and gait and moreover could provide an enjoyable form of exercise therapy amongst previous ice skaters with PD. The identification of cues that encourage paradoxical kinesia for ice skating amongst certain PD patients may allow for future development of a new 'safe' mode of exercise that capitalises on pertinent skating visuomotor cues to produce neuromuscular responses but does not require physical skating. Our purpose with this case study was to examine the effects of different dynamic visual stimuli on postural control in a person with PD and a preserved capacity for ice skating. METHODS: Postural control was assessed for one 38 year old male PD patient and one age- and sex-matched control subject (CTRL) using a modified Sensory Organisation Test (SOT) protocol. Subjects completed two trials of each of the four 'eyes open' SOT conditions whilst viewing one of four visual conditions for a total of 32 trials. Visual conditions consisted of a blank screen (BASE), 1st person walking (SW1), 1st person ice skating (SK1), and 1st person ice skating fast (SK1F). Centre of pressure data were collected using a computerised dynamic posturography unit. Both subjects were self-identified competent recreational skaters. RESULTS: The CTRL maintained postural sway across all postural and visual feedback conditions. In contrast, in the least challenging postural condition (SOT 1) the PD patient demonstrated increased postural sway when presented with skating visual imagery. When challenged by more demanding postural conditions (SOT 4 and 6) however, the PD patient demonstrated improved postural control when viewing 1st person skating imagery (SK1). Moreover, postural sway was comparable between subjects in these visual feedback/postural challenge combinations (Fig 1.). CONCLUSIONS: The improved postural control demonstrated by the PD patient when presented with ice skating visual imagery in challenging postural conditions suggests that the motor imagery of skating activates postural control responses beyond that of static or non-skating visual feedback. This finding presents the possibility that the visuomotor cues contained in the ice skating imagery in combination with aerobic or resistive exercise, may be appropriate for use in an exercise training protocol amongst some PD patients, this possibility requires further investigation.

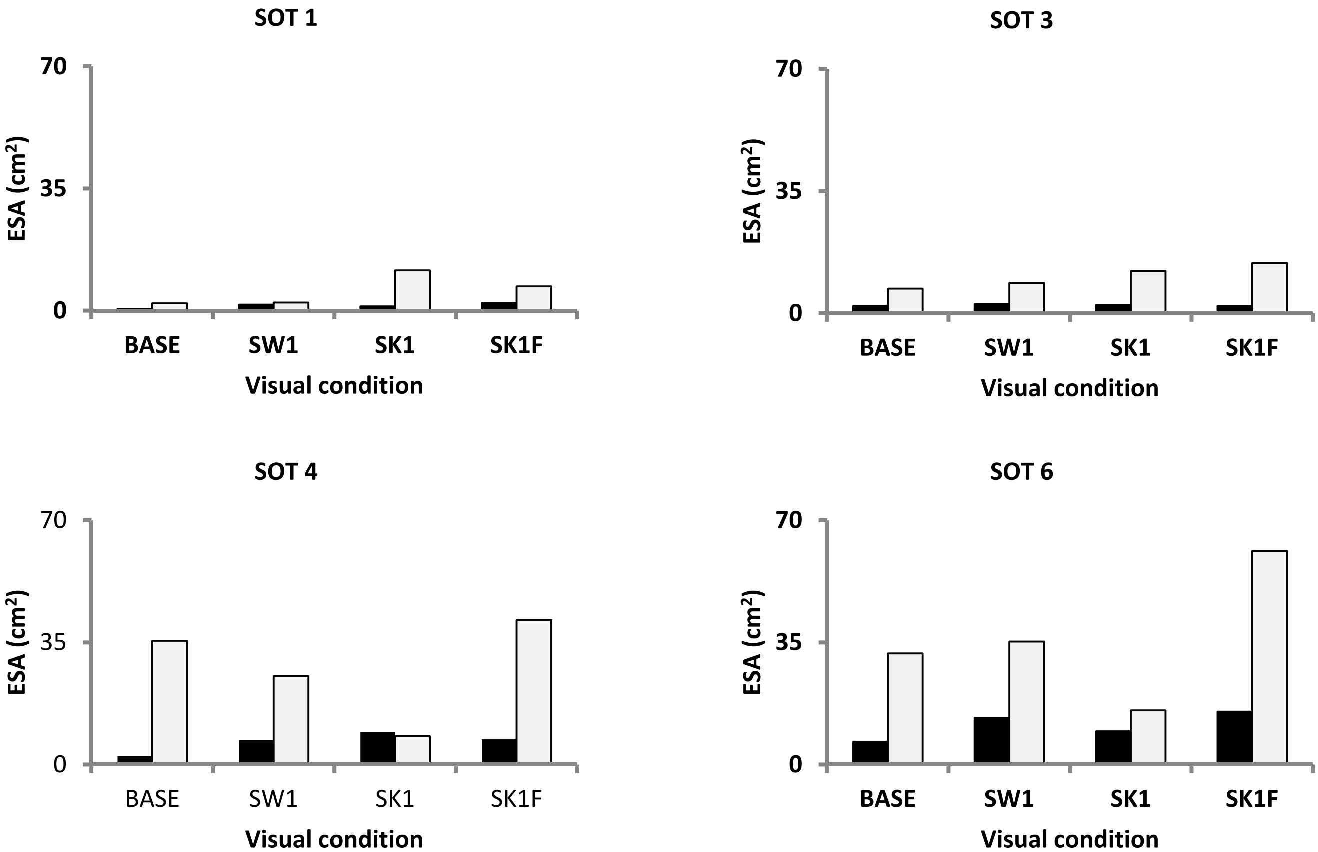

Fig 1. Effects of visual condition on 95% confidence elliptical sway area (ESA). Dark bars represent the data for the CTRL, whilst light bars represent the data for the PD patient.

P2-K-85 Ice skating as exercise therapy amongst Parkinson's disease patients: Pilot evidence of kinematic potential

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BACKGROUND AND AIM: Exercise is proving a strong complement, if not primary approach, in the management of Parkinson's disease (PD) symptoms. Recent research suggests that non-traditional exercises may be most effective, both encouraging and forcing PD patients through more stimulating activities at greater rates and regularity. One promising non-traditional exercise neurotherapy may be ice skating - skating can confer aerobic benefits, generate motor skill transfer, and promote social inclusion. The skill of ice skating perseveres amongst certain PD patients. The purpose of the current project is to provide preliminary evidence of motor improvements amongst ice skating Parkinson's disease patients. METHODS: Five mild to moderate PD patients and five age gender matched controls

completed ten trials of walking and ten trials of ice skating, each 12 m in length at self-selected rate. Trials were captured in sagittal plane video, and muscle activation in lower extremity agonists and antagonists was collected through electromyography. The central 4 m of walking and skating trials were hand-digitized, providing coordinate data for critical anatomical landmarks in each video frame. Kinematic parameters were compared between groups (PD, CTRL) and conditions (SKATE, WALK), including arm swing - maximum resultant displacement vector between hip and hand), step length - maximum resultant displacement vector between left and right heel, and velocity - horizontal velocity of hip in the sagittal plane. RESULTS: PD patients had significant increases in velocity during skating trials, accompanied by increases in arm swing, but decreases in step length (Figure 1). No PD patients fell in the course of the skating trials. CONCLUSIONS: PD patients can ice skate, and skating was capable and confident amongst this group. Ice skating might be facilitated by the visual and/or psychomotor stimulation of the activity, in addition to the biomechanical efficiency. This facilitation, and subsequent increased movement velocities, could make ice skating a robust exercise paradigm of aerobic and neurotherapeutic benefit to Parkinson's disease patients.

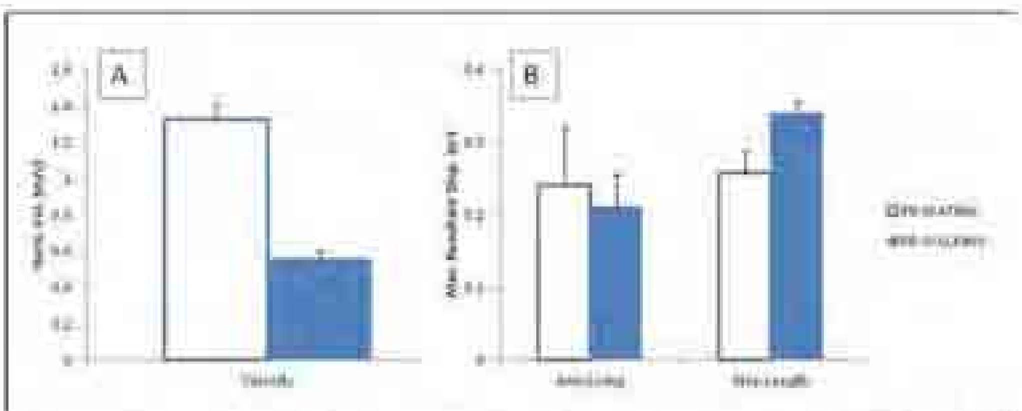

Figure 1. PD patients were able to generate greater horizontal velocities during skating (A), though other benefits were not consistently observed (B). Greater activity rates do present potential for increased aerobic and neurotherapeutic exercise benefits amongst PD patients (Alberts et al., 2011).

P2-K-86 Muscle endurance, activation and fatigue during sub-maximal contraction in children with cerebral palsy

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BACKGROUND AND AIMS: Cerebral palsy (CP) may lead to muscle weakness, spasticity, decreased control and functional impairments, like gait (1). Muscle weakness is largely explained by reduced neuromuscular activation, preventing all motor units (MU) from being recruited voluntarily (1). However, motor unit recruitment during contractions up to 25% of maximal voluntary contraction (MVC) in CP and healthy controls (HC) are similar (1). The aim of this study was to evaluate whether MU recruitment to compensate for muscle fatigue is also normal during a sustained contraction at a low

force level. METHODS: Twelve children with CP and seventeen healthy-controls (HC) of similar age participated in this study. Participants performed isometric MVCs in elbow flexion and extension, and a submaximal isometric contraction until exhaustion at about 20% MVC. Surface electromyography (EMG) of biceps brachii (BB), triceps longus (MTB) and triceps lateralis (LTB) were collected. Data from accelerometer were recorded to measure vertical variations of accelerations of the elbow flexion/extension. RESULTS: The average flexion and extension peak torques during the MVCs were lower in the CP group than the HC group. Time to exhaustion in the endurance task was similar in both groups. The CP group experienced less acceleration fluctuations and a lower increase in this variable from start to end than the control group (p=0.007). The change of EMG amplitude of BB (p=0.017), MTB (p=0.001) and LTB (p=0.021) was significantly greater during the task in the HC group than in the CP group (see Figure 1). The median frequency of the MTB had a larger decrease from start to end in the HC group (p=0.002). CONCLUSION: The lack of EMG amplitude increase in CP subjects shows that even at a contraction level as low as 20%MVC, CP subjects were not able to recruit additional motor units to compensate muscle fatigue. Therefore CP subjects truncated their task at a lower level of muscle fatigue, indicated by the lower change in median frequency EMG and acceleration fluctuations from start to exhaustion. The similar endurance time in CP can be explained by the fact that the external load was determined as a percentage of MVC, which is a relatively lower load of their maximal muscle capacity (1), also supported by the lower amount of acceleration fluctuations at the start of the contraction.

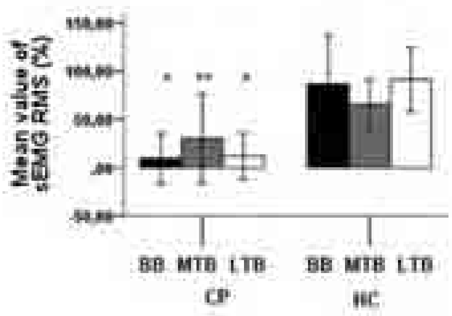

Figure 1. Mean (bar) and 95% confidence interval (errorbar) of percentage change during the fatiguing task of EMG amplitude in the biceps brachii (BB), in the triceps longus (MTB) and in the triceps lateralis (LTB) in the CP and in the HC group. *;** Significant differences between both groups p < 0.05 and p < 0.01.

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P2-K-87 Effects of 8 months of exercise in the adaptive gait of Parkinson disease patients

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BACKGROUND AND AIM: Exercise interventions can improve gait parameters of Parkinson disease (PD) patients as revealed by Goodwin et al. (2008). However, most studies analyzed the effects of short duration exercise programs in the mobility (Gobbi et al., 2009) and the effects of a long-term exercise intervention in the adaptive gait are few studied. The aim of the study was to analyze the effects of 8

months of a Multimodal Exercise Program in the adaptive gait of PD patients. METHODS: Eleven PD patients (UPDRS motor=26.91±11.74 pts; age=67.45±6.84 years; disease duration=5.18±1.84 years) participated in the study. Participants walked on an 8 m pathway in their preferred speed and stepped over an obstacle. The patients performed 3 trials crossing a low obstacle (ankle height=5-10 cm) and 3 trials crossing a high obstacle (half of the knee height=20-25 cm). The trials order was randomized. All trials were recorded by means of a digital camcorder, capturing the markers viewed on the participant's right sagittal plane. Software Dvideow was used for the photogrammetric procedure and an algorithm was created in MatLab to calculate the dependent variables (horizontal and vertical distance between foot and obstacle for leading and trailing limbs). The assessments were performed in pre-test, after 4 months (post-test 1) and after 8 months (post-test 2). The aim of the exercise program was to develop the patients' components of the functional capacity. To compare the conditions, a MANOVA 3 (evaluation period) by 2 (obstacle height) with repeated measures for both factors was performed. RESULTS: Adaptive gait was affected by evaluation period (Wilks' Lambda=0.33, $F_{10,28}=4.58$, $p<0.001$) and obstacle height (Wilks' Lambda=0.57, $F_{5,28}=4.09$, $p<0.006$), without interaction between factors (Table 1). For evaluation period, regardless obstacle height, the variance analyses indicated close leading foot placement before obstacle ($F_{2,64}=18.63$, $p<0.0001$) for post-test 1 in comparison of pre-test and post-test 2; close trailing foot placement before obstacle ($F_{2,64}=14.64$, $p<0.0001$) and leading foot placement in front of the obstacle ($F_{2,64}=6.02$, $p<0.008$) for pre-test and post-test 1 in comparison of post-test 2. For obstacle height, regardless evaluation period, the variance analyses indicated short trailing toe clearance ($F_{1,32}=6.74$, $p<0.01$) for low in relation of high obstacle. CONCLUSION: PD patients were able to modulate gait parameters according to obstacle height. The long duration Multimodal Exercise Program was effective to improve adaptive gait parameters in people with PD.

Table 1. Means and standard deviations of spatial parameters of adaptive gait.

	Pre-test	**Post-test 1**	**Post-test 2**
Low obstacle (cm)			
leading toe clearance	11.29±3.30	10.91±2.83	9.85±3.75
leading foot placement before obstacle	79.75±16.05	72.15±14.01	83.72±13.87
leading foot placement in front of the obstacle	32.94±6.56	33.47±7.41	30.02±4.86
trailing toe clearance	15.20±4.13	14.94±2.41	15.26±3.03
trailing foot placement in front of the obstacle	23.23±6.94	20.88±6.35	26.22±7.36
High obstacle (cm)			
leading toe clearance	11.14±3.67	11.22±4.19	10.38±3.99
leading foot placement before obstacle	80.45±15.36	74.69±13.92	84.24±13.51
leading foot placement in front of the obstacle	33.10±5.10	33.33±6.58	30.35±4.45
trailing toe clearance	16.73±3.71	17.63±5.88	16.80±4.01
trailing foot placement in front of the obstacle	22.65±7.23	21.88±6.41	25.87±6.91

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P2-K-88 Plasticity within the locomotor-balance control system: Perturbation induced adaptations to reduce fall-risk in chronic stroke survivors

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BACKGROUND AND AIM: Up to 70% of community Stroke survivors experience an annual fall resulting from balance and gait impairments. Despite this, interventions aimed at improving locomotor-balance control post-Stroke have demonstrated limited translation of such improvements on fall risk. Previous work has established the significance of adaptive perturbation training in reducing fall-risk in healthy adults. In this study we aimed to determine the extent to which people with hemiparetic Stroke can adapt to reduce the risk of balance loss and falls with a single session of repeated-slip training, compared their healthy counterparts. METHODS: Initial perturbation training while walking in a safety harness was applied to the Stroke participants after inclusion screening (n=10). Low-friction platforms were used to induced, two blocks of repeated slips to the uninvolved side (5 slips/block), separated by non-slips and followed by a mixed block (slips interspersed with nonslips). The same protocol was repeated with slips applied to the involved side after a rest period. Slip outcome (including the incidence of falls and balance loss), dynamic stability (based on the center-of-mass position and velocity) and vertical limb support (based on hip height) were obtained along with other spatial and temporal gait parameters. The trial-to-trial changes in the measured variables were compared within the Stroke subjects and between the Stroke group and healthy adults (n=10), a population at a similar risk of falls. Pre- and post-perturbation training changes in over ground locomotion (kinematic and kinetic gait parameters) were also examined for the Stroke group. RESULTS: Although on the first slip, performance of the Stroke subjects was poor compared to healthy controls (greater fall and balance loss incidence, lower stability, limb support and delayed protective stepping), Stroke subjects were able to exhibit adaptive improvements in proactive and reactive control of their stability and limb support, at a rate similar to that observed in healthy controls when exposed to slips under the uninvolved side. Thus, Stroke subjects had a lower fall and balance loss incidence on the last slip than on their own first slip, and similar to that seen on the last slip of healthy adults. Findings on the involved side were similar to the uninvolved side with the only difference being, a significantly slower rate of adaptation during the initial blocked training. Post training Stroke subjects demonstrated improvements in toe clearance and stance limb loading during over ground locomotion. CONCLUSION: Perturbation-training conducted in a safe-environment can induce plastic changes within the locomotor-balance control system for reducing fall-risk and improving ambulation skills in Chronic Stroke survivors - benefits that would be significant in increasing community participation and reintegration within the Society.

P2-K-89 Consensus-based clinical practice protocol for the prevention of falls in Parkinson's disease

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BACKGROUND AND AIM: Falls in patients with Parkinson's disease (PD) are common and often devastating. Therefore, prevention of falls is an urgent priority. There is currently no accepted falls prevention program that specifically addresses the risk profile encountered in individual patients with PD. We aimed to create a consensus-based clinical practice protocol that systematically addresses all potential risk factors for falls in PD patients. METHODS: First, we developed a concept protocol, including both generic (age-related) and PD-specific risk factors for falling. For each identified risk factor, we specified the following: method of ascertainment; which disciplines should be involved in its assessment and treatment; and which interventions could be used. Second, 27 professionals from multiple relevant disciplines evaluated this protocol and provided feedback. Third, the revised protocol was reviewed by 12 experts. Risk factors and associated interventions were included in the final protocol when a minimum of two-thirds of the reviewing experts reached agreement. RESULTS: Based on agreement, 20 risk factors for falls in PD were included in the protocol. The protocol included the following possible generic risk factors: sedative medication, polypharmacy, orthostatic syncope, cardiac arrhytmia, arthrosis, use of an assistive device, posture, anxiety, weakness due to inactivity, visual impairment, alcohol use, and environmental hazards. PD specific fall risk factors were shuffling and small scaled gait, freezing of gait and festination, postural instability, transfers, cognitive impairment, axial rigidity, dyskinesia and response fluctuations, and long-term adverse effect of subthalamic stimulation. Almost all risk factors required a multidisciplinary team approach. Generic risk factors should mainly be managed by the general practitioner, geriatrician, neurologist and PD nurse specialist. The neurologist, PD nurse specialist and physiotherapist were considered as the main disciplines to address PD-specific risk factors. In addition to health care professionals, caregivers were allocated a key role in falls prevention. Rather than evaluating all risk factors in each patient, the expert panel preferred to first identify the specific fall types (e.g., falls caused by freezing of gait, or falls preceded by syncope). CONCLUSIONS: A clinical practice protocol including both generic and disease-specific risk factors for the management of falls in PD is provided.

P2-K-90 Quantitative analysis of gait and balance does not help to predict future falls in Parkinson´s disease patients

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BACKGROUND AND AIM: Postural instability and falls belong to the most disabling features of advanced Parkinson´s disease (PD). The aim of the present study was to verify the value of routine clinical tests and computerized assessments of gait and balance in predicting future falls in PD patients. METHODS: We examined 45 patients with PD [11 F, 34 M; age mean 67.2±7; PD duration 9.9±3 years; H&Y 2.2±0.5]. At baseline, all subjects were investigated using the Falls Efficacy Scale (FES), the Frontal assessment

battery (FAB), the Montreal Cognitive Assessment (MoCA) and Non-motor symptom scale (NMS-30). In addition, accelerometric parameters (average turning velocity and stride time variability) in Timed Up and Go test (TUG) and computer dynamic posturography (Sensory organization Falls severity scale-SOTFSS and Rhythmic weight shift-RWS in anterioposterior-AP and mediolateral-ML direction) were performed, in both "OFF" and "ON" medication states within one examination day. The patients were then followed for 6 months, using fall diaries and regular monthly phone calls to detect falls, to define fallers (≥ 2 falls) and non-fallers (≤ 1 fall). The predictive value of eight baseline tests [UPDRS-PIGD (postural instability gait disorder subscore), Pull test, Push&release test, SOTFSS, RWS-AP, RWS-ML and two parameters in TUG test] was calculated using binomial logistic regression with hierarchical switching. RESULTS: At the end of the follow-up period, 23 fallers (16 M; mean age 65±8.2, PD duration 10±3.9) and 22 non-fallers (18 M; mean age 69±6.2, PD duration 9.8±2.8) were identified. In return to baseline, the fallers had significantly higher UPDRS III OFF score (31±9.4 vs. 25±8.2; p=0.02), UPDRS-PIGD OFF subscore (6±2.6 vs. 4±2.5; p=0.03), NMS-30 score (10±3.9 vs. 7±3.7; p<0.01) and greater fear of falling according FES (13±3.2 vs. 11±3.5; p=0.01) than the non-fallers. MoCA and FAB scale did not reveal any meaningful differences between both groups. Predictive value of both single tests and subset of the best single tests was insignificant, only UPDRS-PIGD subscore in ON medication state and RW-AP in OFF medication state showed within the subsets the significant regression coefficients (p<0.05). CONCLUSIONS: None of the routine clinical tests or computerized measures of gait and balance showed sufficient value to predict future falls in PD. Of our eight tests there seem to be no single test or small subset of tests that would predict prospective falls well. Prospectively identified fallers showed increased fear of falling and worse UPDRS motor and postural instability and gait disorder subscores as well as non-motor symptoms compared with non-fallers.

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P2-K-91 Performance of a secondary motor task reveals altered gait patterns in future Parkinson’s fallers.

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BACKGROUND AND AIM: People with Parkinson's disease (PD) who fall demonstrate alterations in temporospatial, segmental and kinematic parameters of gait. Performance of dual tasks while walking results in decreased performance in people with PD. The aim of this study was to determine how gait patterns were altered when performing a secondary motor task. Given that PD fallers have been shown to have poorer segmental control during controlled walking tasks, their risk of falling could be exacerbated under conditions that challenge postural stability. METHODS: PD patients (n=44) and healthy age-matched controls (n=32) were assessed using three-dimensional motion analysis while walking at a self-selected pace during normal walking and while carrying a glass of water. Falls were recorded prospectively over 12 months using daily falls calendars. RESULTS: Based on the prospective falls data, participants were divided into four groups; PD Fallers (n=29); PD Non-Fallers (n=15); Control Fallers (n=17); and Control Non-Fallers (n=17). PD fallers and non-fallers had similar disease severity

based on the UPDRS and Hoehn &Yahr scores. PD fallers had significantly greater disease duration, Freezing of Gait score and increased fear of falling than non-fallers. Average daily Levodopa dose was not different between the PD fallers and non-fallers. The secondary task resulted in a decrease in walking velocity, cadence, stride length and toe clearance. Stance and double support time were increased. Trunk flexion, mediolateral pelvis motion and knee flexion/extension range were increased. PD fallers were characterised by slower walking velocity, decreased toe clearance, reduced arm swing, increased trunk flexion and mediolateral motion of the head and pelvis, and increased knee flexion. Performance of the secondary task by PD fallers exaggerated differences in mediolateral pelvis motion and knee flexion angle. CONCLUSIONS: Postural control deficits in PD fallers may impair their capacity to adapt to different task constraints. In an everyday activity, carrying a glass of water, PD fallers had increased segmental instability and altered kinematics. The risk of falling for people with PD may be increased when performing secondary tasks.

P2-K-92 Incidence and prediction of falls in patients with Parkinson disease: An 8-month prospective study.

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BACKGROUND AND AIM: Incidence and prediction of falls in patients with Parkinson's disease are not fully understood. The primary aim of current study was to assess the incidence of falls in a cohort of community dwelling Brazilian patients with Parkinson's disease prospectively over an 8-month period. We also aimed to i) determine the effectiveness of different functional tests and disease-specific clinical assessments at the baseline in predicting fallers and ii) compare the baseline characteristics of fallers and non-fallers. METHODS: Forty-eight patients with idiopathic Parkinson's disease undertook a baseline battery of demographic, functional, and disease-specific clinical tests in the ''on medication'' state. The tests included disease duration, history of previous falls, Hoehn and Yahr Rating Scale, Unified Parkinson's Disease Rating Scale (UPDRS), Mini Exam of Mental Status, Schwab and England Activities of Daily Living Scale, Clock Drawing Test, Falls Efficacy Scale - International (FES-I), Berg Balance Scale, Timed Up and Go, Dynamic Gait Index, Sit to Stand Up Test (30 seconds), Six-Minute Walk Test, and Balance Evaluation - Systems Test. Falls were recorded prospectively over eight months. RESULTS: Forty-one percent of participants reported a fall and 29% more than 1 fall. Receiver operating characteristic analyses demonstrated Six-Minute Walk Test (sensitivity 80% , specificity 85%), Timed Up and Go (sensitivity 76% , specificity 71%), and FES-I (sensitivity 75% , specificity 71%) to produce the best sensitivity and specificity in predicting fallers. Non-fallers showed better performance than fallers on UPDRS, FES-I, Berg Balance Scale, Sit to Stand Up Test, and Six-Minute Walk Test. CONCLUSIONS: A high incidence of falls was found in Brazilians patients with Parkinson's disease. Both functional and disease-specific clinical tests are important measures for predicting falls and distinguishing fallers and non-fallers.

P2-K-93 Do measures of reactive balance control predict falls in individuals with stroke returning to the community?

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BACKGROUND AND AIM: Individuals with stroke have an increased falls risk, which is highest soon after discharge from rehabilitation [1]. This suggests that those at risk are not identified or prepared during in-patient rehabilitation for the challenges they will face in their everyday environment. Studies of falls risk factors in community-dwelling stroke survivors are inconclusive. A key factor that determines whether an individual will fall is the ability to recover from a loss of balance. Compensatory stepping responses are particularly important as individuals with stroke appear to have difficulty executing these responses to prevent a fall following a loss of balance [2]. This study aims to determine if indices of reactive balance control are related falls following discharge from stroke rehabilitation. METHODS: Subjects with stroke were recruited at discharge from in-patient rehabilitation. Only those discharged home were included. Subjects completed an assessment of compensatory stepping prior to discharge using a release-from-lean postural perturbation system. The following outcome measures were obtained: frequency of trials requiring external assistance to prevent a fall; frequency of trials in which an attempted reach-to-grasp response was observed; frequency of trials with a multi-step response; time to foot-off; and time to foot-contact. Participants reported falls experienced for up to six months post-discharge. Poisson regression was used to determine which outcomes were related to increased falls frequency relative to the duration of the monitoring period. RESULTS: Preliminary results from 39 subjects who have completed either all (n=23) or part (n=16) of the monitoring period are presented; a larger dataset will be presented at the conference. Sixteen subjects experienced 28 falls during the monitoring period; five subjects fell more than once. Poisson regression revealed that reduced frequency of attempted reach-to-grasp responses (relative risk (RR)=0.98 [0.96-0.99]; p=0.0077), increased frequency of multi-step responses (RR=1.01 [1.00-1.03]; p=0.055) and reduced time to foot-off (RR=0.99 [0.99-1.00]; p=0.0003) were related to an increased falls frequency post-discharge. CONCLUSIONS: Reduced foot-off times might indicate that fallers responded too early without having processed enough information about the perturbation to select an appropriate response. Increased frequency of multi-step reactions indicate that the first step was not sufficient to regain stability following the perturbation. Initiating a reach-to-grasp reaction might be a way to compensate for impaired stepping responses and reduce the risk for falls. Analysis of the full data set will provide a more complete picture of reactive balance control and falls risk post-stroke.

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P2-K-94 Perception of balance impairments and frequency of falls in people with Charcot-Marie-Tooth disease

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BACKGROUND AND AIMS: Falls are anecdotally reported by people with Charcot-Marie-Tooth disease (CMT) but to date there has been little formal investigation of this problem. Frequent falling increases risk of injury and impairs mobility through avoidance of activities perceived to threaten stability. To successfully manage the problem of falls there needs to be a greater understanding of why they occur. This abstract outlines two studies: (1) a focus group study exploring the experience of balance and falls in people with CMT, (2) a survey of people with CMT to ascertain how often they fall, nearly fall and the circumstances that may have contributed. METHODS AND RESULTS: Study 1: Three focus groups were run for a total of 25 participants. Group interviews were audio-taped and transcribed. Scripts were coded independently by two researchers and themes were negotiated. Six themes relating to balance and falls were identified. Cognitive burden of walking: people described having to think about every step to avoid trip hazards. Environmental issues: participants described difficulties on uneven, rough terrain, slippery surfaces and slopes. External support: people describe their reliance on external support, such as walking aids and orthotic devices. Frequent falling: There was a general perception amongst participants that they fell more frequently than people who didn't have CMT. Difficulties once fallen: Participants described the ordeal of being on the floor with difficulty getting up or reliance on others to assist them. Perceptions of others: Many participants expressed concerns about how their balance difficulties were perceived by others. Study 2: A postal survey was administered to 222 people with CMT under the care of the MRC Centre for Neuromuscular Diseases. Ninety four questionnaires were returned. In total, 89.4% of respondents reported falls, most occurring at least once a month (29.8%), 19% fell more than once a month and 33% less than once a month. Near falls in the previous six months were reported by 89.4% of respondents. The majority of falls happened indoors (47.8%) either at home (34.8%) or in a public place (12.9%). Most falls occurred during walking (52.2%) with participants reporting ankles or knees giving way (25.8%), tripping (20.8%), slippery or uneven surfaces (20.4%) and loss of balance (15.8%). The majority of falls resulted in no or minor injuries (61.2%), but moderate injuries, such as sprains were experienced in 14.8% of falls and 2.8% sustained serious injuries such as fractures. Near falls were attributed to most often to knees or ankles giving way (35.4%) then loss of balance (25.6%), trips (17.5%) and slippery or uneven surfaces (16.6%). CONCLUSIONS: Falls and near falls are regular events for many people with CMT. Despite the concern about falling on uneven surfaces outdoors, the high number of falls indoors is an important consideration. Peoples' mobility at home would require further investigation by clinicians to reduce the risk of future falls.

P2-K-95 Functional gait training using an instrumented treadmill with visual context improves gait adaptability in the chronic phase after stroke: a proof of concept

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BACKGROUND AND AIM: After stroke, the ability to make step adjustments during walking, i.e. gait adaptability, is often reduced [1, 2], which contributes to increased risk of falling and elevated fall incidence [3]. The C-Mill is a novel instrumented treadmill with visual context presented by a projector [4], specifically designed to train this aspect of walking ability in a safe and controlled environment (Figure 1A). In this proof-of-concept study we examined the effect of C-Mill training on gait adaptability, as assessed with laboratory-based obstacle-avoidance tests under time pressure, as well as clinical indicators of walking ability. The former test was performed with and without a concurrent attention-demanding cognitive task to examine potential changes in attentional demands of gait adjustments. METHODS: Sixteen community-dwelling persons in the chronic phase after stroke (54±11 yrs; time after stroke: 17±11 months) participated in the study. Participants underwent 10 1-hr C-Mill training sessions in 5-6 weeks. Pre and post intervention, instrumented obstacle-avoidance tests with and without a concurrent auditory Stroop task [5] were conducted to examine the effect of C-Mill training on gait adaptability (i.e. obstacle-avoidance success rates) and the associated attentional demands. In addition, Berg Balance Scale (BBS), 10m walking test (10MWT), Timed Up and Go test (TUG) and the subtask obstacle course of the Emory Functional Ambulation Profile (EFAP) were assessed. RESULTS: The ability to avoid obstacles under time pressure improved after C-Mill training, as evidenced by an increase in obstacle-avoidance success rates (from 57±18% pre intervention to 80±18% post intervention; $p<0.001$). Also, BBS, 10MWT, TUG and EFAP all improved significantly ($p<0.05$) (Figure 1B). CONCLUSIONS: C-Mill therapy fully complies with evidence-based ingredients for effective gait training in that it allows for task-specific, repetitive, intensive gait training with feedback on performance (e.g. [6]). The results of this study indicate that C-Mill training is a promising therapeutic means for improving gait adaptability and clinical indicators of walking ability in the chronic phase after stroke. We currently examine whether or not these improvements are accompanied by meaningful changes in the attentional demands of gait adjustments.

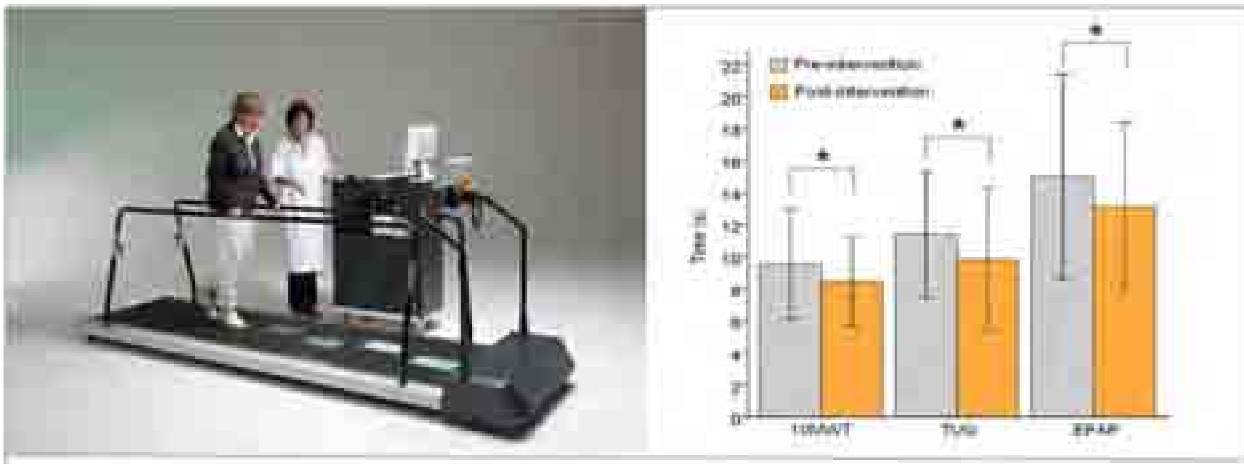

Figure 1. (A) Functional C-Mill training with visual context, e.g. stepping targets, presented by a projector
(B) Timed walking test, i.e. 10MWT (10 meter walking test), TUG (Timed up and Go) and EFAP (Emory Functional Ambulation Profile – Obstacle course) before ( ) and after ( ) C-Mill training.
Error bars: ± 2 SD
* Significant difference, p<0.05

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P2-K-96 Balance rehabilitation therapy by tongue electrotactile biofeedback in patients with degenerative cerebellar disease

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BACKGROUND AND AIM: Cerebellar damage typically results in ataxia and can be caused by stroke, tumor, or some degenerative diseases. Since few pharmacological options are available, most treatments rely heavily on rehabilitation therapy [1]. A possible way to improve balance is the use of a biofeedback system in balance prosthesis. Tyler et al. [2] developed a head position-based, tongue-placed biofeedback system whose underlying principle is to transmit artificially sensed head orientation/motion with respect to gravitational vertical along anteroposterior and mediolateral axes through electrotactile stimulation of the tongue. The aim of present study was assessing the effectiveness of a balance rehabilitation program using this biofeedback system in patients suffering from progressive ataxia due to cerebellar degeneration. METHODS: Five patients (age 55.6 ± 11.6, mean ± SD) voluntarily took part in a balance rehabilitation program consisting of postural exercises executed

with the biofeedback system for 10 to 20 minutes, twice a day over a 2-week period. Bipedal postural control was assessed with a force platform before rehabilitation and on the day of discharge in four sensory conditions: (1) eyes open (EO)/Firm support, (2) eyes closed (EC)/Firm support, (3) EO/Foam support, (4) EC)/Foam support,. The standard deviation of the centre of foor pressure (CoP SD) in the mediolateral (ML) and anteroposterior (AP) axes (measures of the variability of postural sway) was used to assess postural behaviour. An analysis of variance (ANOVA) was applied to the CoP SD. Post-hoc analyses (Newman-Keuls test) were performed whenever necessary. Level of significance was set at 0.05. RESULTS: Analysis of the CoP SD showed significant main effects of Support ($p<0.01$) and Vision ($p<0.01$), a significant interaction Support x Vision ($p<0.01$), and a significant triple interaction Session × Support × Vision ($p<0.05$). As illustrated in Figure 1, post-hoc analyses further showed decreased CoP SD in the Post relative to the Pre-session in the EC-Firm, EO-Foam and EC-Foam conditions, whereas no significant difference was observed in the EO-Firm condition ($p>0.05$). CONCLUSIONS: These preliminary results suggest that a balance rehabilitation program with postural exercise performed with a head position-based tongue-placed biofeedback system could significantly improve bipedal postural control in patients suffering from ataxia due to cerebellar degeneration. Further comparative studies are needed to determine the clinical validity and outcome of balance rehabilitation therapy. Fig.1 Mean and standard error of standard deviation of the CoP (NS: P>0.05; *: P < 0.05; **: P < 0.01).

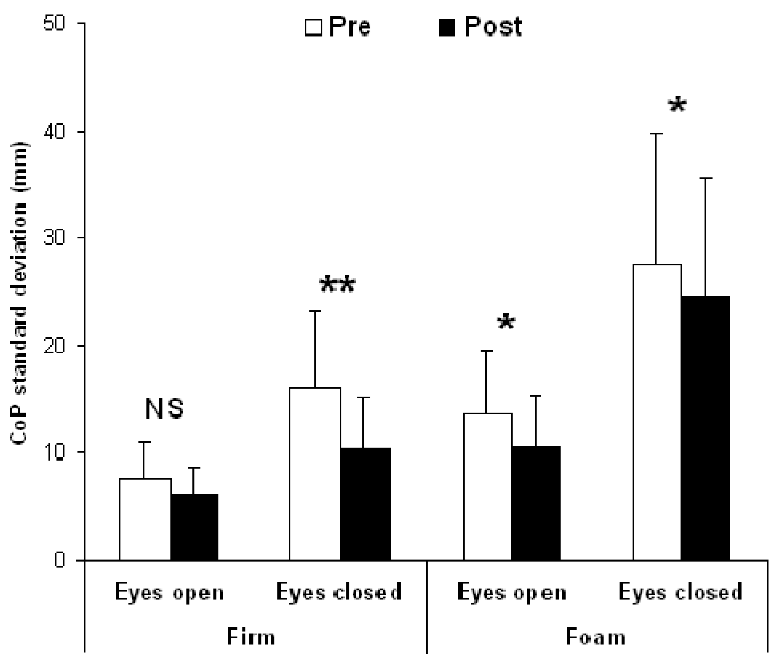

Fig.1 Mean and standard error of standard deviation of the CoP (NS: P>0.05; *: P < 0.05; **: P < 0.01).

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P2-K-97 How might visual cues help turn initiation following stroke?

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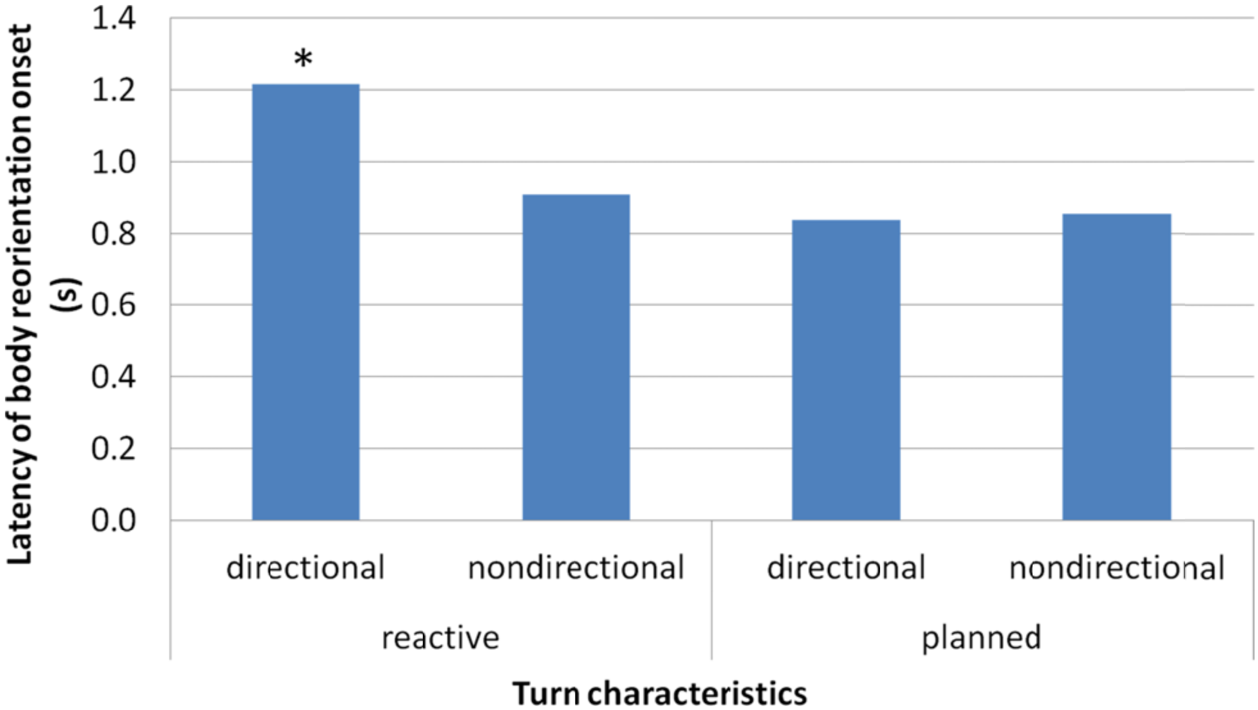
BACKGROUND AND AIM: A recent study showed that stroke patients were slower to initiate turns than control counterparts and this was improved when turns were made reactively to visual cues [1]. We previously hypothesized that the coordination of axial body segments during turning represents a robust pre-programmed postural synergy that is dependent on, and triggered by, eye and head rotation in a new direction [2]. In order to explore the role of eye and head reorientation in controlling the initiation of the turning "synergy", and a possible mechanism for why visual cues may have previously improved turn initiation, this study contrasted stroke patients turning performance under conditions when the signal to turn required a eye and head rotation to view the turn signal and when the turn signal was in view without eye and head rotation. METHODS: Participants who had suffered a stroke (> 6 months prior to participating), able to walk 10m without assistance were included (n=9). Participants were asked to change walking direction by 90°, either left or right, at the midpoint of a 6m path. Conditions (5 trials each) were: 1) planned turns in which the cue to turn was provided at the start of the walk, 2) reactive turns in which the cue to turn was provided one stride prior to the required turn, 3) directional cues in which the signals to turn were in line with the target travel path and 4) non-directional cues in which the signals to turn were in line with the straight path. Full body and eye kinematics were measured using a Vicon MX motion analysis system and a Bluegain EOG system respectively. RESULTS: Preliminary results (n=9) indicate participants with stroke fail to initiate anticipatory head reorientation to the new travel direction in the same manner as previously seen in healthy participants [1]. Repeated measures ANOVA demonstrate a significant interaction between visual cue type (directional vs non-directional) and timing (planned vs reactive) of cue delivery ($F(1,16) = 10.1$, $P<0.05$). Post-hoc analysis revealed that the latency of turns to non-directional visual cues was significantly shorter than those to directional visual cues but only in the reactive cue condition (figure 1) CONCLUSIONS: Providing a cue to turn which elicits an eye and head rotation did not improve timing of head reorientation in these participants; indicating that the turning "synergy" may not be triggered by or dependent on gaze reorientation as previously hypothesized [2].



ACKNOWLEDGEMENTS:
Stroke Association Fig.1 Onset latency of head reorientation in the new direction

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P2-K-98 Effect of transcranial Direct Current Stimulation (tDCS) on the protective stepping response in Parkinson's disease patients

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BACKGROUND AND AIM: Falling is a major issue in Parkinson's disease (PD) patients, which responds less to medication. As transcranial direct current stimulation (tDCS) has shown positive results on motor recovery in stroke patients we examine here whether tDCS improves motor performance in PD patients as well. The purpose of the study is to examine the effect of tDCS, combined with exercise training, on protective stepping response in PD patients. METHODS: Twelve moderate to severe PD patients (mean age 66 years, Hoehn-Yahr scale 2-3) were recruited in the study. tDCS was applied on the primary motor cortex for 15 minutes during exercise training. All participants received exercise training and both real and sham tDCS conditions on separate days (at least five days apart to avoid carry-over effects). Before and after the tDCS plus exercise training, subjects were instructed to stand on a platform which moves randomly forwards and backwards, thus requiring a protective step in order to maintain balance. Reaction time, step length, angular velocity of the protective step, and trunk displacement before taking the protective step were then measured. Number of steps taken during the perturbation was also

recorded. RESULTS: Forwards and backwards step length significantly increased after exercise training in both real and sham tDCS conditions (p=0.015). There was a trend to decreasing the number of steps taken during the perturbation in the real tDCS condition, although the improvement was not statistically significant (p=0.069). Step reaction time and velocity were unchanged. No consistent difference was found in trunk displacement before taking the protective step. CONCLUSIONS: tDCS of the motor cortex might have therapeutic effect on protective stepping response in PD, although only forwards and backwards step length showed significant improvement after the exercise training plus stimulation. However, as the stimulation was applied for 15 minutes only, the effect of longer duration stimulation or repetitive sessions may need further investigation.

P2-K-99 Ambulatory activity but not sedentary behavior discriminates early Parkinson's disease and controls

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BACKGROUND AND AIM: Measures of physical activity and sedentary behavior reflect distinct characteristics of habitual function and present as independent risk factors for health outcomes in older adults. Recent research suggests that people with advanced Parkinson's disease (PD) demonstrate altered patterns of sedentary behavior even though total sedentary time is comparable to controls. Early identification of subtle changes in PD behavior may help identify optimal management strategies. We aimed to examine differences in physical activity and sedentary behavior in early PD and controls METHODS: Fifty nine people (mean (SD) 69.3 (8.5) years) with PD and 58 controls (mean (SD) 66.8 (10.2) years) were recruited. Participants wore an activity monitor (activPAL) for seven days which recorded the sequence and period of time of individual bouts of ambulatory and sedentary behaviour. Preferred gait speed was assessed using a 7m instrumented walkway (GAITRite). Outcomes included: accumulation of bout time, bout time variability, total step count, and number of stepping bouts greater than 2 minutes all reported per day. Differences in sedentary outcomes were examined with Students t-test and univariate analysis for activity outcomes, controlling for gait speed. RESULTS: There were no differences in sedentary outcomes for PD and controls. All activity outcomes were significantly different. People with PD were unable to sustain walking bouts of 2 minutes and over (mean (SD) 29.1 (21.7) compared with controls (mean (SD) 53.4 (31.7), p = .000. Gait speed contributed significantly to total step count (p = .003), but not to number of stepping bouts greater than 2 minutes (p = .136). CONCLUSIONS: Despite significant differences in ambulatory activity in early PD and controls, sedentary behavior was no different which highlights the independence of these characteristics. Subtle changes in ambulatory activity were evident in newly diagnosed PD which may reflect an early compensatory strategy for energy conservation.

P2-K-100 Gait features of progressive supranuclear palsy revealed by stride length cadence analysis

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BACKGROUND AND AIM: People with Progressive Supranuclear Palsy (PSP) present clinically with similar gait characteristics to people with Parkinson's disease (PD), making it difficult to clinically identify PSP from PD in the early stages of the disorder. Identifying the distinguishing features of the footstep patterns of people with PSP may assist in the diagnosis of this disorder. Aim: To describe the spatiotemporal gait characteristics of participants with PSP and to compare these results to people with PD and healthy older adults (HOA). METHODS: The footstep patterns of 19 people with PSP, 20 people with PD and 20 HOA were measured on an electronic walkway system. Participants performed 3 walking trials at 5 differing speeds – preferred, slow and very slow, fast and very fast. Primary outcome measure was the relationship between stride length and cadence (SLCrel) (R2). Secondary outcome measures included stride length, cadence, double support (%), and step width. Linear regression analyses determined slope, intercept and R2 values. Comparison of gait parameters between groups at preferred speed and matched stride length was done using one-way ANOVA tests. RESULTS: All groups demonstrated a strong linear relationship between stride length and cadence with no difference between groups ($p>0.05$). The intercept was lowest in the PSP group and highest in the HOA group ($p<0.001$). At matched stride length, the PSP group had a higher cadence than HOA ($p>0.05$) and greater step width and greater double support (%) compared to the other two groups ($p<0.05$). CONCLUSION: The relationship between stride length and cadence remains intact in PSP and PD. Like PD, PSP results in lower stride length for their cadences suggesting that PSP also results in a defective scaling of stride length. The longer double support time may be compensation for greater postural instability in PSP.

P2-K-101 Sensitivity, validity and reliability of a novel method to detect apas prior to gait initiation

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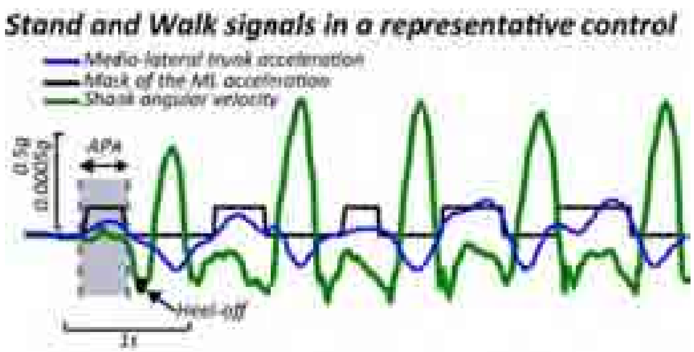
BACKGROUND AND AIM: Anticipatory postural adjustments (APAs) precede the onset of voluntary movements such as step initiation. Reduced size of APAs is a specific, primary symptom of Parkinson's disease (PD), responsible for severe balance and mobility problems. The main objectives of this study were: 1) to develop an algorithm to automatically detect and characterize APAs using inertial sensors and 2) to measure test-retest reliability and clinical validity of the new algorithm. METHODS: Study I: Validity of the algorithm was determined by comparing 1) APAs detected from inertial sensors on the trunk with force-plate center of pressure and 2) first step length and velocity from inertial sensors on ankles with kinematics (34 Motion Analysis reflective markers). Twelve subjects with PD (ON medication) and 17 age-matched controls were asked to voluntary initiate gait (5 repetitions at a comfortable pace) from a consistent initial foot position. Proposed algorithm: Our algorithm was "trained" based on comparison of the maximum lateral acceleration during gait with the lateral peak during APA and calculating a percentage, both for controls and PD. At this point, the "training" was finished and the algorithm automatically (see Figure 1): 1) identified the maximum peak of the lateral

acceleration and build up a mask of the signal that is 1 when the acceleration was bigger than the percentage calculated in the training , 2) identified the APA onset and offset within the mask of the ML acceleration (APA was identified when the value in the mask goes the first time to 1), 3) make sure that the detected APA is the right one (immediately before heel-off). Study II: For reliability, after finishing the 3 sway trials, the sensor was removed, subjects rested for 30 min, and the protocol was repeated. A different set of 17 early-to-moderate, treated PD (tested ON medication), and 17 age-matched CTR were tested in the clinic. Differences between untreated PD and CTR were determined with a Paired t-test. Pearson product moment correlation was used to assess the relationship between APA peak ACC ML and the Posture Instability and Gait Disability (PIGD) score. Intra-Class Correlation (ICC(1,1)) evaluated test-retest reliability. RESULTS: After training the algorithm, duration of APAs detected using inertial sensors was not sigificantly different than the APAs detected using the force-plates (p>.05). APA peak ACC ML was smaller in subjects with PD compared to control subjects (p=.02). ICC(1,1) for APA peak ACC ML was .75 (LB=.56, UB=.87) in control and .87 (LB=.65, UB=.96) in PD subjects. APA peak ACC ML was significantly correlated with the PIGD score, r=-.52, p=.0001. CONCLUSIONS: These results suggest the feasibility of our novel approach to automatically detect and evaluate APA in both controls and PD subjects. The results presented may potentially be useful for monitoring patients in the home environment to detect and measure postural preparation.



P2-K-102 New tools for estimation of time-varying neural and non-neural properties underlying ankle joint impedance

Carel G Meskers[1], *Erwin De Vlugt,* Karin L De Gooijer[1], Sloot Lizeth[2], Jaap Harlaar[2]

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BACKGROUND AND AIM: Ankle joint impedance (dynamic relationship between joint angle and torque) is important for the control of gait and posture as it largely determines the amount of dissipation and storage of mechanical energy. Joint impedance is determined by intrinsic viscoelasticity (connective, muscular and tendinous tissues) and by continuous neural control from supraspinal and spinal activation of the muscles. For clinical application, quantitative measures of the non-neural and neural components to joint impedance is crucial for therapy, in particular the changes of these components over time during movement. METHODS: We developed new system identification and parameter estimation (SIPE) tools for the quantification of neural and non-neural components underlying ankle joint impedance during ankle movement. The basic idea is to perturb the ankle by either angular or torque pulses and estimate the neural and non-neural properties from the corresponding mechanical and EMG responses. RESULTS: In a first clinical study, ramp and hold angular rotations at different speed were imposed to the ankle joint by an electrically driven manipulator in stroke (n=19) and CP (n=23) patients(de Groot -van de Groep et al., 2012; de Vlugt et al., 2010). Patients were seated on a chair and instructed not to react to the rotations. Neural and non-neural components were quantified using a nonlinear ankle model including EMG driven muscles. Results showed reliable estimates of both components. Both in stroke and CP, neural and non-neural components were larger compared to a control group. However, in stroke tissue stiffness was dominant while in CP also the stretch reflexes contributed substantially to ankle impedance. These findings may have important implications for treatment. Also, the observed variations in the ratio between tissue stiffness and reflex torque over patients having the same diagnosis are a base for goal directed therapy. CONCLUSIONS: We are now extending the aforementioned SIPE technique for application during voluntary induced movements, both during single joint rotations (in seated position) and also during walking using an instrumented high performance treadmill. In the latter case, we will apply small angular rotations to the ankle joint by means of brief changes in treadmill speed during walking. We will compare existing model based SIPE techniques to recently developed open-structured models that rely on varying state space models(van Wingerden and Verhaegen, 2009). Our future aim is to quantify changes in neural and non-neural components of ankle impedance in high temporal resolution (milliseconds) during various loading conditions, which is paramount for understanding neuromuscular control of movement.

L - Aging

P2-L-103 Age-related differences in harmonic ratios during narrow base walking

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BACKGROUND AND AIM: Age-related declines in control of mediolateral motion during walking are a risk factor for falls in older adults. Harmonic ratios (HRs), determined from proxy center of mass accelerations in mediolateral (ML), anteroposterior (AP) and vertical (VT) directions, have been used as a global measure of walking skill, with higher HRs indicative of greater control. We challenged ML control via narrow base walking and examined age-related differences in HRs during usual versus narrow base walking. METHODS: Young adults (YA, 21.5 ± 1.9 yrs, n=20) and healthy older adults (OA, 70.7 ± 4.2 yrs, n=19) performed 5 trials of usual and narrow base walking (9m). In narrow, participants walked between taped lines that were standardized to 50% of the distance between the participant's anterior superior iliac spines. Both conditions were paced by a metronome set at the subject's usual cadence. A lower trunk triaxial accelerometer recorded proxy COM accelerations to derive HRs, and mean gait characteristics and variability (within-subject standard deviations) were recorded by an instrumented walkway. We used mixed linear models to compare HRs across age groups and conditions, with and

without adjusting for differences in each of the spatiotemporal variables. RESULTS: HRs were reduced from usual to narrow in all directions of motion for both YAs and OAs (p<.001). While reductions in HRs were similar for both groups in the ML and VT directions, OAs exhibited a greater reduction in the AP direction (interaction p=.02) which was partially explained by differences in step length. For YAs, changes in step width explained 39% of the reduction in the ML HR from usual to narrow, 37% of the reduction in the AP HR, and 27% of the reduction in the VT HR. For OAs, changes in step width explained 21% of the reduction in the ML HR, only 11% of the reduction in the AP HR and 22% of the reduction in the VT HR. Reductions in mean step length, and increased step time- and step length variability contributed more to reductions in HRs for OAs. CONCLUSIONS: HRs were reduced in narrow walking for both young and older adults, but the changes in stepping strategies related to the decline in HRs differed. The finding that older adults adopted a different strategy than young adults to deal with a walking challenge may potentially inform interventions to improve motor skill in walking.

ACKNOWLEDGEMENTS:
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P2-L-104 Approximate entropy indicates that visual surround oscillation alters sway pattern regularity in elderly individuals

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BACKGROUND AND AIM: Age-associated decrements in sensory reweighting occur when visual surround information is made unreliable during quiet stance [1]. As evidence, linear sway variability of the rate of the Centre of Pressure (CoP) displacement increases when the visual surround oscillates periodically at a slow frequency (0.3 Hz). Currently, it is not known how the temporal structure of the postural sway patterns is affected by visual reweighing induced in the quiet stance condition. Using approximate entropy (ApEn), a measure of regularity, the current study explored the effect of a periodically oscillating virtual environment on temporal structure of postural sway variability in healthy young and elderly adults. METHODS: Sixteen healthy young (age: 22.4±2.7yrs; height: 174.4±10.7cm; mass: 70.1±13.9kg) and 10 healthy elderly (age: 72.7± 4.0yrs; height: 159.3±6.6cm; mass: 73.3±3.3kg) participants stood quietly on a force platform (Bertec BP6501; 105Hz) adopting a natural bipedal stance position under two 60s conditions: a 3D stationary virtual scene (SVS) and a 3D periodically oscillating (0.3 Hz) virtual scene (OVS). ApEn values were calculated from anterior-posterior CoP component time series [2]. A mixed 2 (Group) x 2 (scene condition) ANOVA was performed to compare ApEn during quiet standing in the SVS and OVS conditions and between the two age groups. RESULTS: ApEn was significantly lower in the young compared to the old group participants ($F(1,24)=28.54$, $p<0.001$). In addition, a significant Group x Condition interaction was noted ($F(1,24)=4.34$, $p=0.048$) resulting in further post-hoc analysis. For the young, there was no significant difference in ApEn between the SVS and OVS conditions [$t(15)=1.058$, $p=0.307$]. However, for the elderly, there was a significant decrease in ApEn when standing in the OVS relative to the SVS condition [$t(9)=3.084$, $p=0.013$]. CONCLUSIONS: These results suggest that manipulating visual surround information significantly affects the temporal structure of postural sway variability in the elderly participants. Specifically, the elderly seem to become more entrained to the periodically oscillating virtual room, demonstrating more regular and repeatable sway patterns, as evident by the decreased ApEn values in the OVS condition. Young participants on the other hand, were not affected by the room oscillation. This lack of difference in the ApEn values between the two conditions suggests a rapid downscaling of the visual channel in the young. Further, our results demonstrate that elderly are more dependent on visual surround information to control postural sway variability during quiet stance as compared to their young counterparts.

ACKNOWLEDGEMENTS:
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P2-L-105 Obesity affects postural stability in community-dwelling older women

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BACKGROUND AND AIM: Older individuals have impaired balance control, particularly those that are frail and/or have sensory deprivations. Younger but obese individuals show faster body sway during upright stance than normal weight individuals, suggesting that they also have difficulty controlling balance even if they do not have the same sensory issues as older people. Therefore, the objective of this study was to assess if obesity negatively affects balance control in older female individuals. METHODS: Postural sway of normal weight (n=15, Age = 70.8±5.5 years; BMI = 22.2±1.9kg/m²), overweight (n=15, Age = 71.7±4.3 years; BMI = 27.3±1.3kg/m²) and obese (n=15, Age = 71.1±4.3 years; BMI = 33.1±3.4kg/m²) women was measured with a force platform for normal quiet stance lasting 30s in opened and closed eyes conditions. RESULTS: The obese group oscillated at a faster speed than the normal weight group (vision: 0.99 cm/s vs. 0.70 cm/s, P<0.01; no vision: 1.43 cm/s vs. 0.87 cm/s). The obese group exhibited greater range in both axes without vision compared to the normal weight group (P<0.05). When observing sway density parameters, obese group also spent less time in stability zones (2mm radius area in which the center of pressure is relatively stable) and the distance between these stability zones were greater than normal weight group in both visual conditions (P<0.01 and P<0.05, respectively). CONCLUSIONS: Obesity clearly affects postural control in older women. As postural instability or balance control deficits are identified as a risk factor for falling, our results also suggest that obesity in older women could be considered as another contributing factor for falling.

P2-L-106 Do changes in physiological functions in healthy elderly people predict deterioration of gait speed and functional muscle strength over a one-year period?

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BACKGROUND AND AIM: Physiological functions as well as the ability of performing functional tasks like gait and rising from a chair are reported to change with increasing age. However the associations between changes in such functions are not well known. Therefore, the study aimed to determine whether physiological function, gait speed and functional muscle strength declined over a year in healthy elderly people and to investigate how changes in physiological functions could predict deteriorating gait speed and functional muscle strength. METHODS: Ninety healthy elderly persons (mean age 77.1, ±4.1 years) drawn from the Norwegian National Register participated. Participants were assessed at baseline and at one-year follow-up. Physiological functions (vision, peripheral sensation, muscle force, reaction time and postural sway) were assessed by the Physiological Profile Assessment (PPA) long form. Gait speed was assessed by an electronic gait mat (GaitRite) and functional muscle strength by a 5 repetitions Sit-to-Stand (STS) test at fast speed measured by a linear encoder. RESULTS: During the one-year follow-up period isometric-quadriceps muscle strength ($p \leq 0.001$), high and low contrast visual acuity ($p \leq 0.001$) and visual contrast sensitivity ($p=0.001$) decreased (Table1). Other physiological functions did not change. Fast gait speed ($p \leq 0.001$) and performance on STS test (average velocity, $p=0.019$, peak velocity, $p=0.012$) decreased. In a multiple regression model, participants' age at baseline was significantly associated with decreased average velocity on the STS test (Beta=-0.252, $p=0.005$). Decline in peak velocity of the STS test could be predicted by changes in high contrast visual acuity (Beta=-0.199, $p=0.02$) and foot reaction time (Beta=0.172, $p=0.04$). None of the physiological changes predicted decline in gait speed. CONCLUSIONS: This study demonstrated an age-related decline in physiological functions as well as in gait speed and functional muscle strength. Over the one year follow-up few of the changes in physiological function could alone predict decline in functional tasks. It is suggested that change in functional performance may be explained by a complexity of physiological functions.

Table1: Characteristics of Physiological Profile Assessment (PPA) variables, gait speed, Sit-to-Stand (STS) at baseline and one year follow-up (n=90).

		baseline	One year follow-up	P values
PPA variables	Quadriceps Strength[a] (kg)	30.34(10.54)	27.48(8.67)	≤0.001*
	Hamstring Strength[a] (kg)	16.02(6.06)	16.22(6.38)	0.579
	Ankel Dorsalflex Strength[a] (kg)	10.84(3.83)	10.79(3.70)	0.800
	Vision Edge Contrast Sensitivity[b] (dB)	22.31(1.98)	21.54(2.16)	0.001*
	Vision Depth Perception[b] (cm)	1.64(1.42)	1.77(1.55)	0.502
	Visual Acuity			
	High contrast	4.51(1.09)	5.23(1.24)	≤0.001*
	Low contrast	13.77(5.67)	17.62(5.49)	≤0.001*
	Proprioception[b] (degree)	1.95(1.61)	2.01(1.46)	0.659
	Tactile Sensitivity[b]			
	Simple test	2.00(0.92)	1.95(0.42)	0.624
	A-B test	2.24(0.87)	2.12(0.58)	0.211
	Coordinated Balance Stability	15.52(11.16)	15.46(11.83)	0.502
	Maximal Balance Stability[a] (cm)	16.27(3.92)	16.89(4.06)	0.104
	Quiet Postural Sway(mm)[a]			
	Eyes open flat	4.45(3.61)	4.07(4.10)	0.201
	Eyes open mat	8.09(6.12)	7.92(6.50)	0.569
	Eyes close flat	7.31(8.49)	8.31(7.91)	0.183
	Eyes close mat	19.26(15.48)	18.34(13.97)	0.89
	Reaction time(ms)[b]			
	Hand	0.32(0.09)	0.31(0.08)	0.092
	Foot	0.36(0.11)	0.35(0.09)	0.226
Sit-to-Stand test (STS)[a]	Average velocity(m/s)	0.32(0.09)	0.3(0.08)	0.019*
	Peak velocity(m/s)	0.76(0.18)	0.72(0.17)	0.012*
Gait speed[a]	Fast speed (m/s)	1.46(0.28)	1.42(0.28)	≤0.001*
	Preferred speed (m/s)	1.06(0.21)	1.05(0.2)	0.511

[a]Non-parametric data evaluated using the Wilcoxon Signed-Rank Test;

[b]Parametric data evaluated using the paired t-test;

Significant differences: $p < 0.05$

P2-L-107 Trunk and step characteristics during normal and narrow-based walking under deteriorated sensory conditions: effects of aging

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BACKGROUND AND AIM: Navigating through complex environments relies on sensory inputs to assist in the control and adaptation of gait. Particularly, narrow-based walking is often used to examine postural control in older persons as it provides a greater challenge to medio-lateral(ML) stability. Age-related deterioration in both sensory inputs and the integrative ability of CNS has been reported. Therefore, the role of sensory inputs and sensory integration during challenging walking conditions requires further investigation. The trunk has a large body mass that requires a precise control for maintaining body stability while walking. Also, step width variability is more strongly associated with falls in the elderly compared to variability in step length and cadence. Therefore, the purpose of this study was to investigate the impact of age and sensory deterioration on gait velocity, trunk stability and step width variability during normal and narrow based walking. METHODS: Thirteen young(age 20 to 30) and thirteen older adults(age¡Ý65 years) were asked to walk under normal condition and between lines of tape placed 25 cm apart(narrow-based walking), at their usual pace with and without sensory manipulation. The vision and vestibular input were manipulated by blurring goggles and bipolar galvanic vestibular stimulation(GVS), respectively; either individually or concurrently. Average gait velocity, peak trunk roll, peak trunk pitch and step width variability were calculated. Mixed factor ANOVA was used to test the effects of walking conditions, sensory manipulations and age on the variables(age groups x walking conditions x vision conditions x GVS conditions). RESULTS: Gait velocity was significantly higher in normal walking vs narrow-based walking condition(p=0.01). Further, gait velocity increased with GVS in both normal(p=0.05) and blurred vision condition(p<0.01). However, this increase was much less in blurred vision condition(3%) compared to normal vision(10%). Peak trunk roll was marginally higher in narrow-based walking vs normal walking condition(p=0.09). GVS significantly increased peak trunk pitch in older participants by 12%(p=0.02); however, in young participants the increase was less(5%) and not significant. Additionally, step width variability was significantly higher in blurred vision condition vs normal vision condition(p=0.05). CONCLUSION: The increased gait velocity with GVS perhaps was a way to compensate for ML instability usually induced by GVS. Further, it is possible that compared with young people, declined ability to keep trunk stability in older adults resulted in larger peak trunk pitch with increased gait velocity in GVS condition. Normal vision showed a compensatory effect on gait velocity when vestibular inputs were manipulated. Also, vision may play an important role in foot placement reflected by increased step width variability with blurring goggles. Blurred vision had no impact on trunk stability.

Acknowledgement:
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P2-L-108 Age dependent modulation of multisensory reweighting during visual- and vestibular-evoked postural perturbations

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BACKGROUND AND AIM: Sensory reweighting is the process by which sensory information required for posture control is integrated, depending on each input's reliability. In a previous study we showed that young and elderly adults are similarly affected by the degradation of visual information when standing in a dynamic environment during visual anticipation [1]. The current study extends this research to investigate aging effects on multisensory reweighting in anticipatory conditions induced by different sensory events. METHODS: Twelve young (age 24.9±6.4) and 12 elderly adults (age 74.8±6.4) stood upright in a virtual room for 360s. During standing, vision (VRO: Virtual Room Oscillation, 0.3Hz) and proprioception (ATV: Achilles Tendon Vibration, 80Hz) were individually or simultaneously attenuated for 60s periods. In addition to a Quiet Standing (QS) trial, two trials were performed during which visual and vestibular anticipation was induced by collision Avoidance (AV) and Galvanic Vestibular Stimulus (GVS) events respectively. Performance was quantified by the SD of Centre of Pressure velocity. Mixed model RM ANOVAs were used to analyze differences between groups across conditions and over time. RESULTS: In all tasks, elderly adults displayed greater postural sway compared to the young when either vision, proprioception or both were attenuated (QS: $F(1,22)=10.28, p<0.01$; AV: $F(1,22)=4.59, p<0.001$; GVS: $F(1,21)=21.96, p<0.001$). In QS, a 3-way interaction revealed that only the old and not the young group showed adaptation across the sensory conditions since the elderly's posture was initially more affected by both VRO and ATV and required a reduction of sway to maintain stability ($F(16,352)=2.27, p<0.05$). In the two anticipation trials, young participants managed to reduce the destabilizing effects of VRO and ATV on sway variability whereas elderly participants were less able to do so (AV: $F(4,88)=3.25, p<0.05$; GVS: $F(4,84)=11.1, p<0.001$). Vestibular anticipation was more effective in down-weighting of the less reliable modalities compared to visual anticipation ($F(4,172)=6.5, p<0.05$). CONCLUSIONS: The results suggest that regardless of the presence and type of anticipation, elderly adults display less efficient multisensory reweighting compared to the young. The elderly's greater visual dependence possibly related to postural trait anxiety (fear of falling) may alleviate the age constraint in conditions of visual anticipation when the reweighting process is limited to the visual modality [1]. This trait anxiety characteristic results in a system that is less flexible in inhibiting unreliable modalities. Thus multisensory reweighting appears to be primarily mediated by attentional shifts. Age related impairments in shifting lead to reduced postural performance.

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P2-L-109 Deficits in movement velocity and control, gait, functional performance, and falls in older adults

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BACKGROUND AND AIMS: Older adults experience increasing challenges and difficulties engaging in voluntary weight shifting and/or transitioning of body mass over different bases of support. Little is known, however, about how movement velocity and control of center of gravity are associated with gait and other physical outcomes in the elderly population. The purposes of this analysis were to examine the extent to which older adults' movement velocity and control in performing rhythmical weight shift tasks are related to gait-related characteristics (stride length, walking velocity and speed), functional task of timed Up&Go, and incidence of falls. METHODS: This study used a cross-sectional design in which a sample of 121 older adult patients (mean age = 75±9 years) were recruited from local healthcare providers in Lane County, Oregon, U.S.A. Participants' ability to rhythmically move their center of gravity in both anterior-posterior and lateral (left-right) directions was assessed via computerized dynamic posturography (Balance Master� System). During the test, participants' velocity of center of gravity movement (degrees per second) in an intended direction and a comparison of the amount of movement in the intended direction to the amount of extraneous movement, expressed as a percentage, were recorded. Dependent measures included stride length and walking velocity assessed using a computerized 14-foot walkway (GAITRite, CIR Systems Inc.), walking speed assessed using a 50-walk test, and functional performance assessed using Timed Up&Go, and self-reported falls in the past 3 months. For analysis purposes, scores on movement velocity and control performed in the two cardinal directions were dichotomized, on the basis of their median scores, resulting in two functional groups: impaired vs. unimpaired. RESULTS: In performing the anterior-posterior weight shifts, participants in the impaired group showed significantly worse performance scores on stride length, walking velocity and speed, and Timed Up&Go, compared to those of unimpaired patients. In the lateral direction, participants in the impaired group showed poor performance scores in walking velocity, speed, and Timed Up&Go. Regardless of movement directions, functionally impaired participants were likely to be fallers with more frequent falls compared with those in the unimpaired group. Table 1 presents the performance results between the two groups. CONCLUSIONS. Older adults with decreased movement velocity and control in the displacement of the center of gravity over the base of support are associated with poor performance in locomotion, functional performance, and high incidence of falls. Exercise interventions aimed at training reciprocal weight-shifting movements around ankle joints may help older adults to increase their ability to engage in spatial- and temporal-based functional tasks of daily living.

Table 1. Between-Group Differences in Study Outcomes

	Anterior-Posterior Direction		
Measures	Unimpaired	Impaired	P value
Stride length, cm	114.03	101.089	0.01
Walking velocity, cm/s	99.67	88.49	0.01
50-foot walk test, s	14.26	17.06	0.007
Timed Up&Go, s	9.26	11.30	0.01
Number of falls, mean	0.8	1.29	0.02
	Lateral Direction		
Stride length, cm	111.09	104.63	0.06
Walking velocity, cm/s	98.04	87.80	0.02
50-foot walk test, s	14.82	17.01	0.04
Timed Up&Go, s	9.46	11.19	0.03
Number of falls, mean	0.89	1.33	0.05

P2-L-110 Development of the Height Stance Ratio (HSR) test

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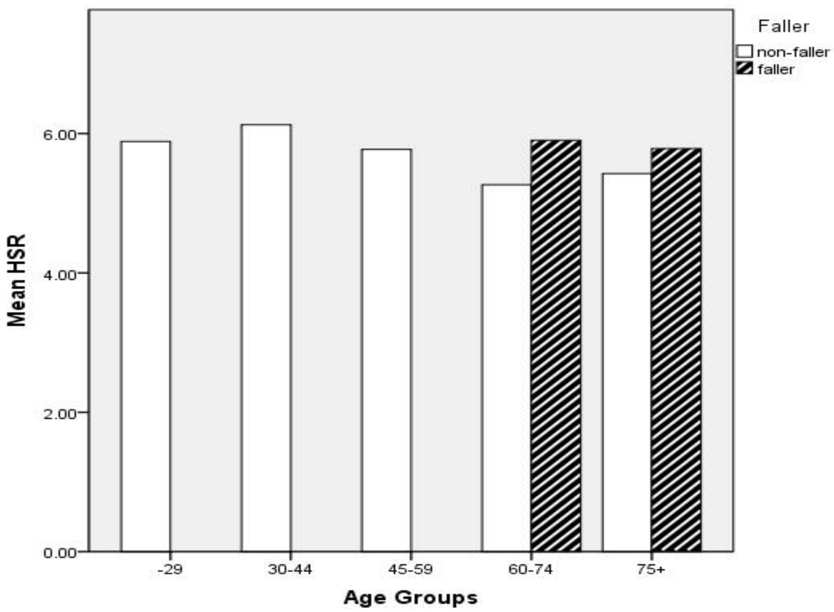
BACKGROUND AND AIM: Simple and low cost fall risk assessment tools are needed. Identification of all fall risk factors is essential for the prevention of falls in the elderly. The aim of this study was to evaluate the reliability and validity of the Height Stance Ratio (HSR). Additionally, we determined whether the HSR differs between elderly fallers and non-fallers. METHODS: A total of 55 community dwellers (age: 72±8SD years), 14 living in residential care facilities (age: 84±6SD years) and 40 healthy adults (age: 31±10SD years) participated. They were recruited in two different regions. Region A=62 and region B=47 participants. The participants were instructed to take a comfortable stance. The maximal width of the base of support (BOS width) was assessed with an anthropometric calliper. Falls were assessed retrospectively. Age subgroups were formed (-29yrs/30-44yrs/45-59yrs/60-74yrs/75yrs). The HSR was calculated by dividing the body height with BOS width. The reliability was analysed with intraclass correlation coefficient ICC, smallest detectable differences (SDD) and Bland-Altman plots. A one way ANOVA was selected to analyse the difference between the test regions. A univariate analysis of variance (1x3) was used for the difference between the living conditions. A univariate analysis of variance (2x5) was selected as well to determine the difference between fallers and non-fallers and between age subgroups. The Bonferroni analysis was used to analyse the differences between the age subgroups. RESULTS: Forty-one elderly participated in the test-retest and interrater reliability. The ICC's for the HSR revealed 0.87/0.95. The SDD was 0.03. The Bland-Altman plots showed no systematic error. There was no difference between the test regions (F(1/108), 0.405, p=0.526). There was a significant main effect between the different living conditions (F(3/106)=7.404, p=0.001). The Tamhane T2 shows only a significant difference between the community dwellers and the healthy adults (0.001). The univariate analysis of variance revealed significant effects between fallers and non-fallers (F(1/102) =6.722, p = 0.011) and between the age subgroups (F(4/102)=5.159, p=0.001). The Bonferroni showed significant difference between age subgroups (-29yrs and 60-74yrs=0 0.008). Levene's test was for both

calculations not significant (0.110/0.182).The mean HSR change splits in fallers and non-fallers and age subgroups are shown in Figure 1. CONCLUSIONS: The HSR is a reliable and valid method. The HSR score changes with normal ageing but somehow fallers do not show that change in score. It can discriminate between fallers and non-fallers. The predictive value of the HSR for subsequent falls is open until prospective studies confirm our assumption.

Figure 1 The mean HSR change split in fallers and non-fallers and age subgroups



P2-L-111 Efficacy of computer-based 'visual-training' programs in improving reach-to-grasp balance-recovery reactions in older adults

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BACKGROUND AND AIM: Visuospatial information (VSI) about the surroundings is required for the control of balance-recovery reactions that involve rapid limb movements toward handholds or step locations; however, older adults often have difficulty in performing tasks that rely on rapid processing of VSI. The potential for computer-based "visual training" programs to improve VSI processing has been demonstrated, both in younger adults (playing first-person-shooter video games; VG) [1] and older adults ("Useful Field of View" training; UFOV) [2]. The objective of the present study was to determine whether improvements in visual processing due to VG or UFOV training can also increase ability to execute effective reach-to-grasp balance-recovery reactions, in older adults with moderately-impaired VSI processing. METHODS: Subjects (66-80yrs), with UFOV selective-attention score >200ms and <500ms, were randomly assigned to one of three computer-based training conditions: 1) UFOV; 2) VG (first-person-shooter game identified in pilot tests to be enjoyable for older persons [3]); or 3) control

group (non-spatial word puzzles). Training comprised ten 45-minute sessions (2 per week for 5 weeks) of increasing difficulty. Visual processing (enumeration and UFOV tests) and reach-to-grasp reactions were assessed pre- and post-training. Reach-to-grasp reactions were evoked via sudden unpredictable platform translation. Prior to each perturbation, a small handhold located to the front and right of the subject was moved unpredictably and intermittently along a transverse axis by a motor-driven system [4] before stopping at one of three final positions (visual angles of 20, 30 and 40 deg relative to straight-ahead gaze, which was maintained by requiring subjects to fixate on a target directly in front of them). The perturbation was then delivered after a random delay (1-3s). Surface EMG and motion analysis were used to assess the speed and accuracy of the grasping reactions. RESULTS: To date, all 33 subjects have completed the training and testing protocol. Preliminary analysis of the first five subjects suggests that VG and UFOV training both improve visual processing (selective attention), reduce reach-to-grasp errors and increase grasp accuracy. Complete analysis pertaining to the effectiveness of the training intervention will be presented at the meeting. CONCLUSIONS: This study will provide new information about the role of visual processing in the control of balance reactions, and effects of age-related visual-processing deficits. Positive results will support clinical use of the new "visual training" interventions to improve ability to recover balance and thereby reduce risk of falling.

ACKNOWLEDGEMENTS:
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P2-L-112 Forwards and backwards protective stepping response in young and elderly subjects

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BACKGROUND AND AIM: The protective stepping response is an essential postural reaction for fall avoidance. Most previous studies examined this response in a single direction, usually forwards thus making the postural perturbation unnaturally predictable. Here we characterize the forwards and backwards stepping response in young and elderly participants when facing an unpredictable perturbation. METHODS: 17 healthy young (mean age 26 years) and 17 healthy elderly volunteers (mean age 67 years) were instructed to stand on a motorised platform, which moved unpredictably forwards or backwards, thus perturbing balance and requiring a protective step. Stepping responses, including reaction time, length and angular velocity of the first protective step, number of steps taken, total trunk displacement and trunk displacement before taking the protective step, were measured. RESULTS: Both groups showed significantly shorter reaction time, slower and more protective steps, smaller total trunk displacement and smaller trunk displacement before taking the protective step when stepping backwards than when stepping forwards. Comparing the two subject groups, the elderly, unlike the

young subjects, produced shorter backwards than forwards steps. Step velocity in both directions was also slower in the elderly. CONCLUSIONS: There are significant differences between the protective step response in the backwards and forwards directions. Backwards protective steps are earlier but slower than forwards steps and there is more 'tolerance' to forwards trunk displacement before a protective step is generated. These differences are likely related to bio-mechanical features that provide smaller stability margins in the backwards direction. The elderly had slightly slower protective steps which were also smaller backwards. Given that our elderly group had an average age below 70 years, these findings are likely to represent the first sign of deterioration in this rescue postural response, thus contributing to the elevated risk of falling in the elderly.

P2-L-113 Does aging impair ability to use peripheral vision to guide perturbation-evoked reach-to-grasp balance-recovery reactions?

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BACKGROUND AND AIM: For a reach-to-grasp reaction to prevent a fall, it must be executed very rapidly, but with sufficient accuracy to achieve a functional grip. Recent studies [1-3] suggest that the CNS may avoid potential time delays associated with saccade-guided arm movements by instead relying on peripheral vision (PV). This study aimed to determine whether age-related slowing of PV processing affects ability to use PV to guide effective reach-to-grasp balance-recovery reactions. METHODS: Twenty-four healthy community-dwelling older adults (65-80yrs) were compared to 12 young adults (22-29yrs) tested previously [3]. Twelve older adults had moderate visual-processing impairment (selective-attention "Useful Field of View", UFOV, score >200ms but <500ms) and 12 had normal visual processing (selective-attention UFOV score <200ms). Reach-to-grasp reactions were evoked via sudden unpredictable platform translation. Prior to each perturbation, a small handhold located to the front and right of the subject was moved unpredictably and intermittently along a transverse axis by a motor-driven system [4] before stopping at one of three final positions (visual angles of 20, 30 and 40 deg relative to straight-ahead gaze). The perturbation was then delivered after a random delay (1-3s). Subjects were required to guide the reach-to-grasp reaction using either central vision (fixated directly on the handhold) or PV (fixated on a computer screen directly in front of them), and performed a concurrent visuo-cognitive task in half of the PV trials. An eye-tracker verified that central fixation of the computer screen was maintained. Surface EMG and motion analysis were used to assess the speed and accuracy of the grasping reactions. RESULTS: In the young adults, forced reliance on PV led to slower and less direct arm movements at the larger visual angles, but did not compromise ability to achieve a functional grasp and recover equilibrium [3]. Processing of the data from the 24 older adults is in progress. Full results will be presented at the meeting. CONCLUSIONS: This study will provide new information about the role of visual processing in the control of balance reactions, and effects of age-related deficits in visual processing. The results could contribute to the development of new "visual training" interventions to improve ability to recover balance and thereby reduce the risk of falling.

ACKNOWLEDGEMENTS:
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P2-L-114 Postural balance in adult patients with low back pain and elderly: Stabilometric assessment

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BACKGROUND AND AIM: Low back pain (LBP) is a common condition impairing significantly quality of life [1]. Elderly people have fears for falling and fall more often than adults. The aim of this study was to evaluate postural stability in in-patients at neurology ward whose major problem was LBP and to compare the data with the postural balance in the elderly. METHODS: For assessment of postural stability we used Romberg test at stabilometric force plate (manufacturer - "MBN", Moscow, Russia) in all patients who consented to participate in this study. All the patients were asked to stand for 60 seconds in a standardized "European position" with the opening angle between the feet with eyes fixed on a point (EO), and then with eyes closed (EC). Statokinesigrams areas (mm2) that measure degree of sway of the gravity center were calculated with EO and EC by computer software. Intensity of pain was self-assessed by patients using 0-10 numeric scale. RESULTS: We evaluated 8 men and 14 women (mean age 55.05 years, SD - 13,7 years) with moderate LBP (mean - 5.9/10, SD - 1.8) and compared their statokinesigrams areas to the same parameters from healthy controls [2] and from the elderly patients from the same department. Patients with LBP had much bigger areas of statokinesigrams than healthy controls: EO - 230.2 vs 39.7 mm2 (p=0.00008); EC - 323.0 vs 142.8 mm2 (p=0.003), but no correlation with the severity of LBP, age of gender was found. The results from the elderly will be analyzed and presented. CONCLUSIONS: Patients with LBP and elderly have postural balance problems which do not depend on the severity of pain.

ACKNOWLEDGEMENTS:
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P2-L-115Improving walking balance in unilateral vestibular loss individuals using the Nintendo® Wii.

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BACKGROUND AND AIM: A major issue that plagues adults >65 years of age is poor balance control during locomotion and frequent falls [1]. Balance control is further compromised in individuals with vestibular loss making them more likely to experience falls [2]. The objective of this study was to determine if training using the Nintendo® Wii could improve balance during locomotion in unilateral vestibular loss (UVL) individuals. METHODS: Individuals with peripheral UVL (N=11, mean age: 62 years) participated in this study. Participants were randomly assigned to one of two training groups (visual or balance). Each participant performed 6 45-minute training sessions over a 6-week period using the Nintendo® Wii. Prior to and following the training, a physiotherapist (blind to participant group assignment) evaluated each participant on three standard clinical tests: Dynamic Gait Index (DGI), Timed-Up and Go (TUG), and the Activities-specific Balance Confidence (ABC) scale. RESULTS: There was no main effect of training on the ABC scale values (p>0.05). Both groups had an average score of approximately 70 before and after training. The results from the TUG test also revealed no significant main effect of training (F=0.17, p>0.05). Both groups had an average score of 10s before and after training. The DGI scores revealed a significant main effect of training (F=25.6, p<0.001) and the group by training interaction showed a trend (F=3.8, p=0.08). Both groups began with an average score of approximately 17, the balance training group improved to an average of 20.5 and the visual training group only improved to approximately 19.2. CONCLUSIONS: Initial findings suggest that DGI may be a sensitive enough measure to quantify changes in dynamic balance control following training. DGI scores revealed that both forms of training using the Nintendo Wii improved dynamic balance in a UVL population after only 6 training sessions. However, with larger numbers in each group, the separation in DGI scores between the groups following training will most likely increase due to the nature of the training. Training using similar mechanics to those needed to control dynamic balance (i.e., loading and unloading limbs) is more beneficial than simply using visual training. Nintendo® Wii balance board facilitates the improvement of balance control because it provides instant feedback about an individual's ability to control posture against gravity.

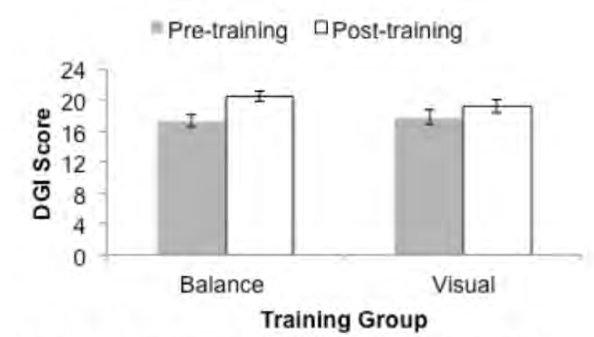

Figure 1- DGI scores before and after training using the Nintendo Wii. A higher DGI score reveals an improvement in balance control. The balance group had slightly better (p=0.08) balance following training than the visual group.

ACKNOWLEDGEMENTS:
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P2-L-116 The mid-Norway in-hospital fall project

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BACKGROUND AND AIM: In-hospital falls are the most commonly adverse event reported to the Norwegian Board of Health Supervision. In 2008, 28 % of the adverse events reported in the health-region of Mid-Norway were related to in-hospital falls. This project aims to identify risk factors for, and consequences of in-hospital falls in older persons in acute hospitals. METHODS: The project was conducted as a retrospective descriptive study, with review of patient records of elderly aged 75 years and older, all with an in-hospital fall accident reported as an adverse event in 2009. RESULTS: A total of 290 fall accidents in 234 patients (55 % women) were analyzed. Mean age was 85 ±5 years. A total of 73 % had mild cognitive impairments, delirium or dementia diagnoses prior to hospital admission; for 30 % delirium were reported during the hospital stay. The proportion of patients who walked independently dropped from 25 to 8 % from hospital admission to discharge. At the day of the fall accident 43 % of the patients needed personal support during walking. The proportion of patients living in their own home dropped from 70 to 17 % before hospital admission to discharge, and the proportion of patients living in nursing homes increased at the same time from 16 to 55 %. Within the first year after the fall accident 47 % of the patients had died; 7 % died during their index hospitalization. CONCLUSIONS: The results indicate that older persons experiencing falls in hospital settings are frail and have poor prognosis. Studies on falls preventive interventions are warranted.

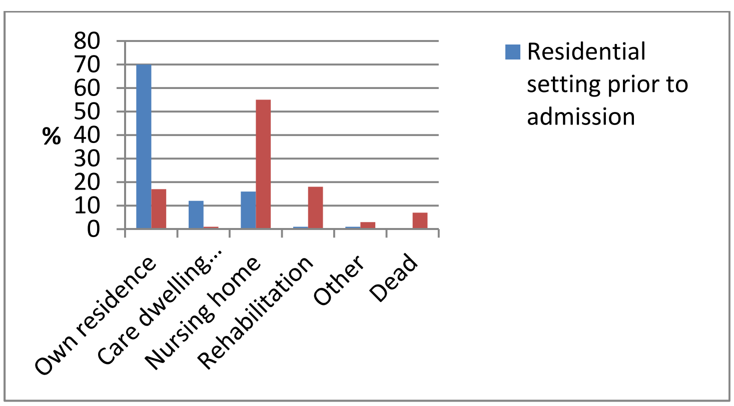

Fig.1: Changes in the patients residential settings from hospital admission to discharge.

P2-L-117 May rehabilitation of elderly patients with gait and balance deficits improve gait and mental functions? Results of geriatric day hospital

Dominique Champon[1], Stéphane Noyon[1], Valérie Azarian[1]

[1]HGMS PLAISIR

BACKGROUND AND AIM: The objective is to determine if rehabilitation of gait and balance in our geriatric Day Hospital (GDH) is efficient. Candidates for our rehabilitation program are not selected. They consult for gait and balance deficits, have falls and various pathologies including : Parkinson's disease, Alzheimer's disease, stroke-related disability, vestibular deficits. The team of GDH is composed of nurses, geriatric physicians, physical therapists, occupational therapists, nutritionists, psychologist, neuropsychologist, chiropodist and posturologist. METHODS: This study is a retrospective cohort analysis of patients admitted to the rehabilitation program of our GDH in Plaisir - France, over a five year period. An assessment of our outpatients (mean age 80.5 ± 9.4 women 67 %) is being made at the beginning and the end of rehabilitation. This rehabilitation is lasting two months, two days a week. The measures considered are : fast walking speed (s/10 m) MMSE, Tinetti Poma assessment scores (Balance and gait), Timed up and Go. RESULTS: Changes in gait an cognitvie performances are in the attached table. After our rehabiliation program, most elderly patients improved fast gait speed time. Patients with MMSE < 24 improved MMSE score. Walking speed is associated with physical and fragility status, MMSE score with cognitive status. Our GDH ambulatory rehabilitation program had positive effects on these measures. CONCLUSION: A prospective study is necessary to know if these gains are maintained after 6 months.

CHANGES IN TEST PERFORMANCES

	n	Admission mean SD	Discharge mean SD	Differences	Improvment (%)
Tinetti score	78	16.99 SD 3,51	19.21 SD 2,92	22.22 SD 2,5 P < 0.05	74 %
Tinetti gait score	80	6.07 SD 1.80	7.41 SD 1.60	1.33 SD 1.41 P < 0.05	70 %
Tinetti balance score	80	10.71 SD 1.94	11.59 SD 1.79	1.33 SD 1.41 P < 0.05	57 %
Timed up and go (s)	80	21.11 SD 16.33	7.08 SD 12.09	- 4.04 SD 9.74 NS	68 %
Fast gait speed time / 10 m (s)	188	17.04 SD 12.44	13.93 SD 11.77	- 3.11 SD 6.90 P < 0.05	67 %
Fast gait speed with MMSE < 24	55	22.73 SD 24.72	19.05 SD 24.23	- 3.22 SD 8.95 NS	63 %
Fast gait speed with MMSE > 24	133	15.51 SD 9.53	12.57 SD 6.97	- 2.93 SD 4.93 P < 0.05	69 %
MMSE Score	80	24.98 SD 4.6	26.41 SD 3.6	1.44 SD 2.47 P < 0.05	61 %
MMSE Score < 24	53	27.36	28.09	0.74 SD 2.18	62 %

		SD 2.02	SD 1.83	P < 0.05	
MMSE Score > 24	27	20.30 SD 2.76	23.11 SD 3.95	2.81 SD 2.48 P < 0.05	74 %

P2-L-118 The discrepancy between actual & perceived gait abilities among non demented older adults

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BACKGROUND AND AIM: Multiple factors have been associated with fall risk among older adults including both performance-based measures of gait and balance and self-efficacy. We speculated that a mismatch between perceived and actual abilities may also increase the risk of falls. For example, persons with poor actual abilities who view themselves as having good balance and gait might take inappropriate risks, thereby further increasing their risk of falls. We examined: a) the factors that contribute to self-perceptions about gait quality and b) the divergence between actual and perceived performance among non-demented older adults. METHODS: 221 community-living healthy older adults (age: 76.3±4.2 yrs; 62% women; MMSE: 28.7±1.3, range: 25-30) were studied. Self-perception of gait quality was determined using a visual analog scale (VAS-gait: 0-worst and 10-best). Other measures included gait speed during usual-walking and dual-tasking, performance-based measures of mobility, cognitive function (e.g., Trails Making Test A and B), and affect (Geriatric Depression Scale, Spielberger anxiety state and trait). The mis-match between perceptions and ability was determined by calculating differences between z-scored VAS-gait and usual-walking gait speed and other performance-based measures such as the Timed Up and Go (TUG) and Dynamic Gait Index (DGI). RESULTS: VAS-gait was 8.2±1.8 and usual-walking gait speed was 127±22 cm/sec. 51% of the subjects reported very good gait (VAS-gait>9). Subjects with low VAS-gait performed worse on the TUG, DGI, usual-walking gait speed, and DT gait speed, compared to subjects with high VAS-gait. TMT A and B, depressive symptoms and anxiety were also related to VAS-gait scores. In multivariate analyses, those with VAS-gait>9 had higher usual walking gait speed, higher dual-tasking gait speed, better DGI & TUG scores, and less depressed. Subjects who's abilities and self-perceived gait diverged tended to be slightly younger and more anxious, compared to those who showed better convergence. Surprisingly, fall history was not related to VAS-gait. CONCLUSIONS: Among non-demented community-living older adults, self-perception of walking quality is generally related to performance-based measures of mobility and anxiety. Most subjects (67%) did not over-estimate their gait quality. Nonetheless, fall risk may not be appropriately viewed by a subset of older adults. We should account for these associations and differences when tailoring interventions and evaluating the gait of older adults.

P2-L-119 Real and imagined walking and walking and walking while talking: Evidence from older adults

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BACKGROUND AND AIM: Motor imagery involves asking individuals to envision themselves executing motor actions, and may be an effective rehabilitative tool to improve walking in individuals with Parkinson's disease (Yágüez et al., 1999), or post stroke (Braun et al., 2008), because it activates the same neural systems as the actual execution of motor actions (Anderson & Lenz, 2011). Current study examined the relationship between real and imagined walking tasks in 82 older adults (M Age in years = 80.45, 55% female). METHODS: Age-related decline in gait performance is often observed when individuals are asked to walk, while performing a cognitive task such as reciting alternate letters of the alphabet - an ecologically valid dual-task situation that reliably predicts falls in older adults (Verghese et al., 2002) and engage executive control processes (Holtzer et al., 2006). Participants were timed while they walked a 14 feet course at their normal pace, following which time estimated to imagine walking the same course was recorded. Participants were also timed walking the course while reciting alternate letters of the alphabet and estimating the time taken to imagine this complex task. The real and imagined walking times ($r = .61$, $p<001$) were correlated. RESULTS: A stronger correlation was seen for the real and imagined walking while reciting alternate letters of the alphabet times ($r = .87$, $p<001$). CONCLUSION: The close temporal correspondence between intra-individual real and imagined walking tasks is particularly encouraging for the development of this paradigm as a rehabilitative tool, and for examining the neural systems underlying complex gait performance with neuroimaging.

P2-L-120 Dual-task interference and short-term decay of visuospatial memory: Effects on perturbation-evoked reach-to-grasp reactions in young and older adults

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BACKGROUND AND AIM: Visuospatial information (VSI) about the location of graspable objects is essential for successful execution of reach-to-grasp balance-recovery reactions [1]. Previous results indicate that the CNS is well able to use VSI stored immediately prior to perturbation onset (PO) to guide these reactions [2-3]; however, the situation where accurate VSI must be retained in working memory for an interval of time prior to PO has not been studied. In this study, we examined the effect of memory decay on the speed and accuracy of perturbation-evoked reach-to-grasp reactions, as well as effects of concurrent cognitive tasks performed during VSI storage. Since aging impairs working memory [4], we compared findings in young and older adults. METHODS: Reach-to-grasp reactions were evoked via sudden unpredictable platform translation in healthy young (age 20-30; N=10) and older (age 60-70; N=10) adults (foam barriers deterred step reactions). At the start of each trial, a small handhold was moved to one of four locations in front of the subject, who was then allowed to view the handhold for 2s before vision was occluded by liquid-crystal goggles for the remainder of the trial. The 'recall delay' between visual-occlusion onset (VO) and platform perturbation-onset (PO) was randomly varied (0, 2, 5 or 10s). A non-spatial- or spatial-memory task was performed during the VO-PO interval, in a subset of trials. RESULTS: Both age groups were able to recover balance by grasping the handhold and exhibited similar reach accuracy; however, the older adults were slower in initiating and completing the reach

reactions. For both age groups, increase in recall delay led to greater lateral endpoint error but reaction timing was not compromised, whereas performing spatial and non-spatial cognitive tasks adversely affected both timing and accuracy. Although most effects of recall delay and cognitive task were similar in both age groups, reduction in spatial-task performance (dual- vs single-task) occurred only in the older adults. CONCLUSIONS: As in studies of volitional reaching, recall delay reduced reach accuracy, but unlike those studies, did not lead to slowing of the reach. Presumably, the CNS acts to preserve speed of response to prevent falls. Findings that spatial and non-spatial cognitive tasks had similar effects on the reach reactions suggest an influence due to generic attentional demands. The dual-task-related reduction in spatial-task performance in the older adults indicates that there were also competing demands for specific resources related to spatial working memory (which exceeded the resource capacity of the older adults).

ACKNOWLEDGMENTS:
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P2-L-121 Age-related differences in the visual control of reach-to-grasp reactions evoked by unpredictable balance perturbation

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BACKGROUND AND AIM: Rapid reach-to-grasp reactions are a prevalent response to sudden loss of balance and play an important role in preventing falls. A previous study indicated young adults are able to guide functionally effective grasping reactions using visuospatial information (VSI) stored in working memory [1,2]. This study addressed whether older adults are also able to use 'stored' VSI in this manner, or are more dependent on 'online' visual control. METHODS: Liquid-crystal goggles were used to force reliance on either stored or online VSI, while subjects reached to grasp a small handhold in response to unpredictable forward and backward platform-translation perturbations. Foam barriers deterred step reactions. In each trial, a motor-driven device moved the handhold, in an unpredictable manner, to one of four locations in front of the subject, prior to perturbation onset. Twelve healthy older adults (65-79 years) were compared to 12 young adults (19-29 years) tested in a previous study [1,2]. RESULTS: Similar to young adults, older participants were almost always able to recover balance by grasping the handhold. However, the older adults were slower in initiating and completing the reaching reactions, reach accuracy was more variable, and collisions between the hand and handhold occurred more frequently. Both age groups showed a reduction in reach accuracy when forced to rely on stored-VSI; however, a tendency to undershoot the rail in stored-VSI trials was exacerbated in the older adults. Forced-reliance on online-VSI led to similar delays in response initiation and execution in both age

groups; however, the older adults were more likely to reach with the "wrong" limb (contralateral to the handhold location) and/or adopt a strategy of raising both arms initially (which presumably served to allow more time to decide which limb to use). CONCLUSIONS: Reach-to-grasp balance-recovery reactions are slower and less accurate in older adults, regardless of the nature of the available VSI. Situations that force the CNS to rely entirely on either stored or online VSI tend to exacerbate these age-related changes. Although the older subjects were able to recover balance successfully despite these age-related changes, these changes may impair the ability to respond to larger perturbations without falling. Further work is needed to examine this, and to determine the effects of concurrent cognitive tasks and tasks that require stored VSI to be retained in spatial memory for various lengths of time prior to the onset of the balance perturbation.

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P2-L-122 Age-related differences in neural activity while dual-task walking: A fNIRS study

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BACKGROUND AND AIM: Several studies have shown that the gait, especially that of older persons, is degraded in dual-task conditions only when the additional task had high visual-processing requirements. A common interpretation of this outcome names differences in cognitive capacities and neural activities in young and elderly people. METHODS: The current study was designed to evaluate whether increased activations in the prefrontal cortex (PFC) were detected in walking while checking boxes on a sheet of paper (CHECK) compared with unperturbed walking (SINGLE) in 16 young (mean age: 24.8 ± 3.3 years) and 15 older (mean age: 70.3 ± 4.1 years) participants using functional near-infrared spectroscopy (NIRx Dynot232, Fa. NIRx Medical Solution, Berlin). In a separate session on the same day, subjects completed a battery of cognitive tests assessing planning (HOTAP test), attention (d2-test) and executive functions (Stroop test). RESULTS: We found that locomotion of young subjects showed better performances in most of the walking measures (i.e. walking speed, temporal-spatial orientation). Neural activity showed an age-related increase in HbO2 levels in CHECK compared to SINGLE in several channels, indicating a higher PFC activation in the elderly than in young subjects when walking in dual-task condition. CONCLUSIONS: The presented study provides a first assumption that oxygenation levels diverge in the PFC during dual-task walking compared to single-task in young and older subjects. This outcome diversified by age suggesting that older adults may increase PFC activation in visually demanding locomotion tasks.

P2-L-123 Older adults´ cognitive function and gait: Effect of covariables

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BACKGROUND AND AIM: Older adults' cognitive function and gait: Effect of covariables Bertha Cecilia Salazar, Yolanda Iveth Reyes, Raquel A. Benavides, Esther C. Gallegos Back ground and Aim of the Study: Depression and some chronic diseases affect gait speed particularly in older women. The aim was to explore the effects of depressive symptoms, chronic diseases and demographic data among cognitive function and gait speed of 185 older adults from Monterrey Mexico. METHODS: Descriptive correlational design. Three cognitive function tests were applied; the Mini Mental State Examination test Spanish version, the Clock Drawing test, and the Stroop interference test. Demographic information was collected including if a major life event had happened to him/her family during the past year and also if they suffered chronic diseases. The Center for Epidemiologic Studies Depression Scale was used for depression symptoms. Gait was measured by the GAITRite walkway system. To determine percentages of older adults with cognitive decline and symptoms of depression, established cutoff points were used. Data analysis was done through descriptive statistics, correlation coefficients and multiple regression models. RESULTS: Hypertension and diabetes were the most prevalent chronic diseases reported by older adults. Using a cutoff of 16 points, 109 participants (58.9%) have at least four symptoms of depression but only 40 (21.6%) of them reported a medical diagnosis of depression. Some differences according to sex were: women showed worse cognitive performance on all three cognitive tests, more symptoms of depression, more chronic diseases and slower gait speed than men. Significant relations were found between cognitive performance and gait speed; between depression symptoms and cognitive performance, chronic diseases and gait speed. Results on the Mini Mental State Examination are influenced by age, and years of schooling; explained variance = 28%. The clock drawing test is affected by age, sex and years of schooling; explained variance = 18%. The Stroop interference was not related to any of the studied variables. Finally age, depression symptoms and use of a walking device showed an effect on gait speed; explained variance = 17.8%. All p values were < .001. CONCLUSIONS: Depression symptoms, age, sex, and years of schooling affect both cognitive performance and gait in older adults. It is important to acknowledge and treat beginning symptoms of depression before they evolve into a major depression and even worse to death.

P2-L-124 The effect of walking while talking on balance in community dwelling older adults

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BACKGROUND AND AIM: Balance is affected by simultaneous performance of a secondary cognitive task among older adults. However, majority of previous studies are limited to assessing static balance during standing. The aim of this study was to investigate the effect of dual-tasking (walking while talking; WWT) on balance during walking measured by trunk sway compared to usual walking among older adults and the correlates of dual-task associated changes in trunk sway. METHODS: This study was nested in the Central Control of Motor Aging Study. Eligibility criteria for the study included individuals aged 65 and older, living in lower Westchester County, New York. Exclusion criteria included severe auditory or visual loss, institutionalization, dementia (Mini-Mental State Examination score ≤24), or inability to ambulate independently. Demographic information, falls during past year, fear of falling, clinical gait abnormalities, and executive attention (Trail Making Test A & B) were collected. Trunk sway in roll (medio-lateral) and pitch (antero-posterior) directions were measured using an angular velocity sensor (SwayStar) strapped to the lower back. Trunk sway was measured during two conditions, usual pace walking and walking while talking (WWT). WWT, a dual task paradigm which is previously validated in predicting falls in elderly, requires individuals to recite alternate letters of the alphabet while walking. Dual-task cost on trunk sway was calculated as percent change of trunk sway during WWT relative to usual walking in both roll and pitch directions. Linear regression analysis was used to identify the clinical correlates of dual-task cost on balance. RESULTS: The data from 124 participants (mean age±standard deviation (SD), 75.8±6.9; 54.0% women) were analyzed. 20.9% of participants demontrated clinical gait abnormalities. Means (±SD) of maximum ranges of roll and pitch angles during WWT were significantly larger compared to usual walking (7.3±3.8 versus 5.9±2.3 for roll angle, p<0. 001 in paired t-test; 8.2±4.1 versus 6.8±2.7 for pitch angle, p<0. 001). Participants with clinical gait abnormality had significantly increased dual-task cost on roll angle (β, 20.15%; 95% confidence interval (CI), 0.32-39.97; p=0.046) compared to those without gait abnormality after adjusting for age and gender. However, there was no significant association between gait abnormality and dual-task cost on pitch angle (p=0.744). Falls during past year, presence of fear of falling, and poor performance on Trail making were not associated with the dual-task cost on either roll or pitch angle. CONCLUSIONS: Simultaneous performance of a cognitive task may worsen balance control during walking in older adults and poor balance control is associated with the presence of clinical gait abnormality. This knowledge will aid clinicians in stratification of older adults for fall risk.

P2-L-125 Declining physical capacity, but maintained health promoting aerobic activity in early Alzheimer's disease. A two-year longitudinal study

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BACKGROUND AND AIMS: Higher-level cognitive functions are important for the ability to move safely and efficiently in real life situations. In early stages of Alzheimer's disease (AD), cognitive and gait dysfunctions are present. However, the longitudinal effects on physical capacity and aerobic activity level are unclear. Therefore, changes in physical capacity and aerobic activity in early stages of AD were evaluated during a 2-year follow-up period. METHODS: Twenty-five people with early AD (Mini Mental State Examination 21-30 p, Md 25 p), aged 55-79 (Md 73), were assessed at baseline, and at 1- and at 2-year follow-up by the following physical capacity tests: 10-meter walk (10MWT), 6-minute walk (6MWT) and Timed Up-and-Go (TUG) single and dual tasks, respectively. In the two types of TUG dual tasks, the participant simultaneously recited names or animals. Aerobic activity was assessed by diary registrations made by a cohabitant. At baseline, the AD group was compared with healthy controls. Twenty-two participants with AD completed the 2-year follow-up. Differences between baseline and 1- and 2-year follow-ups were calculated by Friedman's test. Post hoc pair wise differences were calculated by Wilcoxon signed ranks test. The level of significance was set at p<0.05, except for post hoc pair wise comparisons, where significance was p<0.025. RESULTS: At baseline, the AD group had a significantly

(p<0.001) lower physical capacity than the control group, but comparable levels of aerobic activity. In both groups, 83% reached public health recommendations of aerobic activity, i.e. moderate intensity ¡Ý30 minutes, five days each week. Twelve participants with AD needed verbal cueing to perform the TUG dual tasks at baseline, but none in the control group. The dual tasks costs (percentage difference dual task - single task) were high among participants with AD even at baseline: names 46%, animals 89 %, compared to controls: names 7%, animals 11%. During the follow-up period, physical capacity declined significantly in the AD group as assessed by 10MWT, 6MWT, and TUG single task, but there were no significant changes in TUG dual tasks or aerobic activity level (Table 1). Nevertheless, five of the 22 remaining participants with AD were unable to perform the TUG tests at the 2-year follow-up, regardless of verbal cueing. More than two-thirds of those who did complete TUG tests, required verbal cueing. CONCLUSION: Our results indicate that, despite a declining course of physical capacity, people in early stages of AD can maintain a health promoting aerobic activity level if support is provided. Additionally, it appears that cognitive dysfunction contributes to impaired physical capacity. Therefore, TUG tests may be useful for detecting early signs of cognitive impairment.

Table 1. Differences between baseline, and 1- and 2-year follow-ups for 10-m comfortable walk speed, 6-minute walk test, Timed Up-and-Go single/dual tasks, and aerobic activity in participants with Alzheimer's disease. Significant values in bold types.

Outcome measures	***Baseline Md (M) (range)***	***1-yr follow-up Md (M) (range)***	***2-yr follow-up Md (M) (range)***	***p-value***
10 m comfortable walk speed, m/s, (n=22)	1.11 (1.15) (0.83-2.0)	1.11 (1.13) (0.50-1.43)	1.08 (1.04) (0.48-1.43)	**0.022**
6-minute walk test, m, (n=22)	494 (495) (344-712)	445 (458) (174-703)	430 (418) (160-616)	**<0.001**[a, b]
Timed Up-and-Go				
single task, s, (n=21)	11 (11.2) (8-14)	12 (13.4) (9-30)	12.5 (14.5) (9-27)	**0.020**[a, b]
dual task, names, s, (n=17)	15 (17.6) (11-36)	19 (22.6) (11-54)	17 (20.5) (12-35)	0.391
dual task, animals, s, (n=17)	17 (20.2) (12-39)	17 (23.5) (12-70)	22 (27.6) (12-83)	0.137
Aerobic activity, (n=21)				
minutes/week	332 (337) (8-945)	285 (316) (10-670)	270 (263) (10-600)	0.711
days/week with aerobic activity ≥30 minutes	5 (4.8) (0-7)	4.5 (4.5) (0-7)	4.0 (3.9) (0-6.5)	0.308
Mini Mental State Examination, 0-30 p, (n=21)	25 (25)	22 (22)	20 (19)	**<0.001**[a, b]

	(21-30)	(16-29)	(9-28)

Values denote medians with means and ranges in parenthesis. [a] significant differences between baseline and 1-year follow-up. [b] significant differences between baseline and 2-year follow-up.

P2-L-126 Comparisons between simple and complex gait tasks across different executive function groups and tertiles - cross sectional data from The Irish Longitudinal Study on Aging (TILDA)

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BACKGROUND AND AIM: It is suspected that Executive function (EF) contributes to disruptions of gait and balance, however a detailed relationship has not yet been solved. Understanding this relationship would have far reaching clinical benefits. This study aims to explore associations in an ageing Irish population between performance in EF together with a single and a dual gait task. METHODS: This study used baseline cross sectional data (5947 healthy adults, 56% women, age = 61.1 +/- 8.8yrs) from The Irish Longitudinal Study on Aging (TILDA). TILDA's target population are Irish residents aged 50 plus. This report examines gait parameters recorded with a GaitRite pressure sensing mat and neuropsychological data of EF as assessed using the colour trails test (CTT). Subjects completed a walk defined as a single gait task and also dual gait tasks (gait and manual/cognitive task). Gait velocity percent decline was investigated using the single gait task as a baseline value. Subjects were divided into EF groups based on differences in time to complete CTT A and B (ΔCTT <70s, 70-156s and >156s representing good, intermediate and poor EF respectively) and EF tertiles (ΔCTT: <40s, 40-59s and >59s) and compared to ascertain if differences exist in gait velocity and dual task effect between subjects with different EF test scores. Single and dual gait task velocities and percent decrements were compared across EF groups and tertiles using Analysis of covariance after adjusting for age, gender, years of education and depression. Contrast coding and regression was used to compare good EF group with poor and intermediate EF groups. RESULTS: Gait velocities and percent decrements were significantly different over the three EF groups and tertiles for cognitive dual task (17 to 26%) and motor dual tasks (2-9%), ($p<0.05$), see Table 1. Both the poor and intermediate EF groups walked slower and had greater speed decrements than the good EF group in both dual tasks ($p<0.001$). In the single walk, the difference was only observed for the poor versus good EF group ($p=0.01$). This relationship was also seen within EF tertiles but only for the cognitive dual task. CONCLUSION: The results demonstrate a strong relationship between EF and gait performance. Furthermore, the addition of a dual task, in particular a cognitive task, was shown to reduce self selected gait velocity. This velocity reduction, which differs by EF test score, may be due to reallocation of attentional resources from the gait task. These results indicate, either similar neural mechanisms are used for dual gait tasks and EF task (colour trails task), or dual tasking requires EF. We hypothesize that maintaining gait performance during a complex dual task requires EF of a certain level to compensate for the addition of a cognitive task to a gait task. This indicates that there is indeed a quantifiable link between neural processes involved in movement and cognition.

Table 1: Gait Velocity [cm/s] and % Decline by Delta Colour Trials Task groups (ΔCTT)

TASK	Good ΔCTT n=4466 75.1% <70s	Intermediate ΔCTT n= 1421 23.9% 70-156s	Poor ΔCTT n=60 1.0% >156s	Overall comparison between 3 Groups P
Single Task				
Motor: 9m Walk	135.88 [a]	134.61	126.77	0.0075
Dual Task				
Motor + Cognitive (Alternate letters)	112.50 [ab]	107.44	96.19	0.0000
Motor + Motor (Carry glass)	133.82 [ab]	130.96	117.88	0.0000
Percent Decline [%]				
Cognitive	17.41 [ab]	20.39	26.19	0.0000
Motor	1.57 [ab]	2.68	8.88	0.0000

Adjusted for age, gender, years of education and depression.
CTT is calculated by subtracting time taken to complete Trail B from Trial A.
[a] Poor versus Good Executive Function Groups significantly different for Motor, Cognitive dual task and single gait velocity (p=0.001, 0.000 and 0.010 respectively)
[b] Intermediate versus Good Executive Function Group significantly different for cognitive and motor dual task (both p=0.000 and 0.000) but not significant for single task (p=0.055)

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P2-L-127 The association between consistency of gait variability and executive function in older adults

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BACKGROUND AND AIM: Test-retest reliability of gait variability is less than ideal, i.e. ICC <0.70.[1] Like fluctuations in cognitive function over trials,[2] inconsistency of gait variability in a person from week to week may be an indicator of impaired functioning. Our purpose was to examine the association of consistency of gait variability to executive function in older adults. METHODS: Participants included 32 community-dwelling older adults who could ambulate independently (mean age= 77.7 years, SD= 5.9). Gait characteristics were measured twice using a computerized walkway with one week between testing sessions. At each session, subjects completed 4 passes on the 4 m long walkway and the standard deviation of the stance times for all steps recorded during the 4 passes was used as the measure of stance time variability (STV). Executive function was measured during the first testing session using

Trails A and B and the Digit Symbol Substitution Test (DSST). Using the average and the difference of the STV measures from sessions 1 and 2 we created three groups: 1) consistently not variable (CNV, n=14), mean STV was <0.035s and STV from session to session differed by < .01s, 2) inconsistent (IN, n=14), STV from session 1 differed from session 2 by >.01s, and 3) consistently variable (CV, n=5), mean STV was > 0.35s and STV from session to session differed by < .01s. Analysis of variance with test for linear trend was used to examine executive function across groups. RESULTS: The CNV group performed the best and the CV group performed the worst on Trails B and DSST; whereas the IN group performed in the middle (Trails B: CNV 90.0±28.6, IN 113.4±46.7, CV 169.7±83.5, Ptrend=0.003; DSST: CNV 49.3±7.8, IN 43.0±9.7, CV 37.8±9.4, Ptrend=0.02). Trails A was similar across groups. CONCLUSION: Fluctuations in gait variability from week to week in a person may not be due to measurement error but may be an informative characteristic of the individual.

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P2-L-128 Grey matter atrophy and gait in older people - a voxel-based morphometric study

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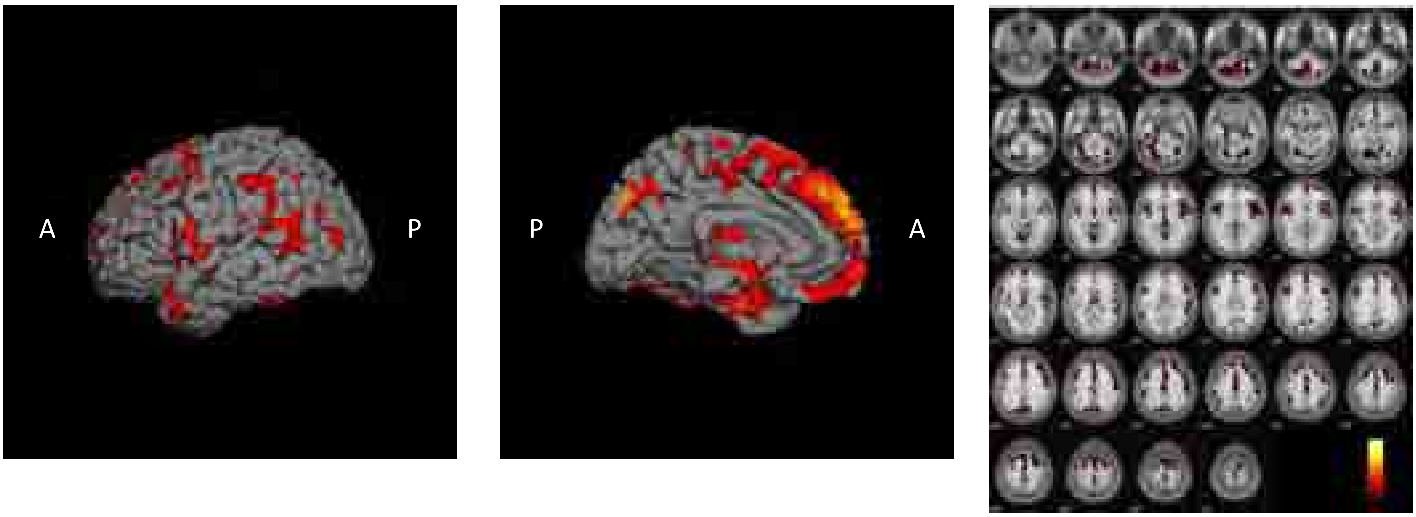
BACKGROUND AND AIM: Walking impairments are common in older people. The aim of this study was to investigate the global and spatial relationships between grey matter atrophy and gait in older people. METHODS: Participants aged 60-86 years in a population-based study underwent high resolution magnetic resonance imaging (MRI) on a 1.5T scanner. Those with Parkinson's disease or MRI infarcts were excluded. Gait variables (speed, step length, cadence, double support phase (DSP), step width) were measured using a GAITRite computerized walkway. Statistical parametric mapping (SPM5) software was used to classify grey matter voxels after accounting for white matter hyperintensities. Linear regression was used to estimate the effect of total grey matter volume on gait. Voxel-based morphometry (VBM) was used to identify regional associations of grey matter loss with gait. Age, sex and total intracranial volume were used as covariates. RESULTS: There were 305 participants, mean age 71.4 (6.9) years, 54% male, and mean gait speed 1.16 (0.22) m/s. Lower total grey matter volume was associated with poorer gait speed (p = 0.002) due to its effect on step length (p<0.001), with a trend towards an association with double support phase (DSP, p = 0.07). Bilateral regional grey matter reductions in several cortical regions (frontal, parietal and occipital), subcortical nuclei (thalamus, caudate, putamen) and cerebellum were associated with poorer gait speed (figure 1), step length and DSP. No global or regional associations were seen for cadence or step width. CONCLUSIONS: After accounting for cerebrovascular lesions, lesser grey matter in bilateral structures involved in motor control, as well as those serving visual, perceptual and memory functions was associated with poorer

gait speed, step length and double support phase in older people. No relationship was demonstrated between grey matter atrophy and cadence or step width.

Figure 1 Associations between grey matter atrophy and gait speed (A=anterior P=posterior)



Left lateral sagittal view Left medial sagittal view Axial view

P2-L-129 Patterns of focal gray matter atrophy are associated with bradykinesia and gait disturbances in older adults.

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BACKGROUND AND AIM: Older adults living in the community commonly experience generalized slowing of movements and gait/balance disturbances. These motor disturbances can occur in the absence of Parkinson's disease or other neurological conditions(1) and they are more common with older age. While their prevalence is at least 15% in adults older than 65 years, it can be as high as 50% among adults older than 80 years(2-4). The aim of this work is to identify the neuroimaging correlates of parkinsonian signs in older adults free from Parkinson's Disease. METHODS: Magnetic Resonance Imaging (MRI) was obtained in 307 adults (82.9 years, 55%women, 39%blacks) concurrently with the Unified Parkinson Disease Rating Scale-motor part. MRI measures included white matter hyperintensities volume (WMHv) for the whole brain and gray matter volume (GMv) for: primary sensorimotor, supplementary motor and medial temporal areas, cerebellum, prefronto-parietal cortex, basal ganglia. RESULTS: In this cohort, 25% of the participants had bradykinesia, 26% had gait disturbances and 12% had tremor. Compared to those without, adults with any one of these signs were older, walked more slowly, had worse scores on tests of cognition, mood and processing speed, and higher WMHv (all $p<0.002$). GMv of primary sensorimotor area was associated with bradykinesia (standardized odds ratio [95% confidence interval]: 0.46, (0.31, 0.68), $p<0.0001$), and GMv of medial

temporal area was associated with gait disturbances (0.56 [0.42, 0.83], p<0.0001), independent of WMHv and age. In these models, the associations of WMH with bradykinesia or gait disturbances were not significant. Further adjustment for measures of muscle strength, cardiovascular health factors, cognition, processing speed and mood or for gait speed did not substantially change these results. CONCLUSIONS: Atrophy localized within the primary sensorimotor and medial temporal areas in adults who are free from overt neurological disease might be important for development of bradykinesia and of gait disturbances. The pathways underlying these associations do not appear to include changes in WMH, cognition, information processing speed, mood or gait speed.

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P2-L-130 The effects of disease severity on obstacle crossing in people with Parkinson's disease

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BACKGROUND AND AIM: As level-ground walking, obstacle crossing is known to be impaired in people with Parkinson's disease (PD), but none has addressed the obstacle avoidance behavior of patients in different stages of PD. The aim of current study was to verify the effects of disease severity in the control of obstacle crossing in people with idiopathic PD. METHODS: Thirty-six subjects volunteered to participate in the study, including 12 patients with unilateral PD (classified in 1 to 1.5 stage of the Hoehn and Yahr Rating Scale), 12 patients with bilateral PD (classified in 2 to 3 stage of the Hoehn and Yahr Rating Scale), and 12 neurologically healthy individuals. Groups were matched by sex, age, body mass, and body height. The obstacle crossing task required participants to walk along a pathway (8 m long by 1.4 m wide) and step over an obstacle (half of the knee height x 600 mm x 30 mm). The obstacle was positioned in the middle of the pathway. Patients were tested in the ''on medication'' state, one hour after taking the dose of Levodopa. Kinematic data were recorded using an optoelectronic tridimensional system. Outcome measures included spatiotemporal parameters of obstacle avoidance. RESULTS: There were no significant difference between patients with unilateral PD and the control group. Patients with bilateral PD showed smaller leading toe clearance and leading foot placement after the obstacle values than the control group. Also, patients with bilateral PD showed lower horizontal mean velocity values during obstacle crossing than controls. CONCLUSIONS: These findings suggest that obstacle avoidance behavior was not affected in the early stage of PD. Conversely, bradykinesia and hypometria influenced obstacle crossing in patients with bilateral PD. Future studies should take the disease severity into account when addressing the obstacle crossing behavior of PD patients.

P2-L-131 Visual-vestibular interaction for maintaining stability while standing up from a sitting position - Effects of aging: A pilot study

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BACKGROUND AND AIM: When standing from a seated position, the vestibular system may be highly stimulated due to linear head acceleration, first horizontally and then vertically. Brown et al. (2006) reported only 18% of their subjects with vestibular dysfunction could perform sit-to-stand (STS) but inefficiently. However, the sensory factors that contribute to postural control during STS have not been investigated in-depth. Preliminary findings showed older subjects were unable to optimally compensate for inadequate visual and somatosensory inputs during STS. However, when vestibular information is integrated during STS for maintaining stability is unknown. The aim of this study was to compare preliminary data to get an insight in the role of vestibular input when STS is performed with eyes open and closed between one old and one young participant. METHODS: One young (YP, age: 23yrs) and one healthy old (OP, age:75yrs) participant were asked to stand up from a standard chair as quickly as possible without the use of arms. On randomly selected trials, transmastoidal galvanic vestibular stimulation (GVS) was used throughout STS at twice the threshold intensity, to manipulate vestibular information. The anode was placed on the left. STS was performed with eyes open or closed in random order. Mediolateral (ML) trunk center of mass (Tr-COM) excursion, Tr-COM velocity in the anteroposterior (AP) and vertical direction and the transition phase (T-phase) duration were measured. Peak Tr-COM velocity in AP and vertical direction delineated T-phase. RESULTS: OP showed greater Tr-COM ML movement than YP either with eyes open or closed indicating weaker stability control. YP showed minimal effects of GVS on ML Tr-COM excursion (Figure 1A and C) whereas, OP showed greater ML Tr-COM movement (Figure 1B and D) with GVS either with eyes open or closed through all 3 phases of STS. This indicates that OP was unable to compensate for vestibular perturbation. With eyes open (Figure 1B) the OP initially moved towards the left (positive value) and then overcompensated towards the right (negative values) and then back towards the left. With eyes closed (Figure 1D), OP was unable to compensate. The CNS, possibly, tried to down-regulate the inaccurate vestibular information during T-phase (Figure 1C and D) and was successful in YP but not in OP when eyes were closed. With eyes open, the duration of T-phase was not affected by GVS for both subjects. With eyes closed, possibly, T-phase and peak Tr-COM vertical velocity of YP was not affected by GVS, however, the OP displayed a longer T-phase and slower peak vertical velocity with GVS. CONCLUSION: OP had poorer trunk stability, longer T-phase and slower peak vertical velocity with GVS when eyes were closed. OP could compensate inaccurate vestibular input when vision was available. However, perhaps this ability was also weakened in OP. This is an ongoing study and more participants will be recruited for further investigation.

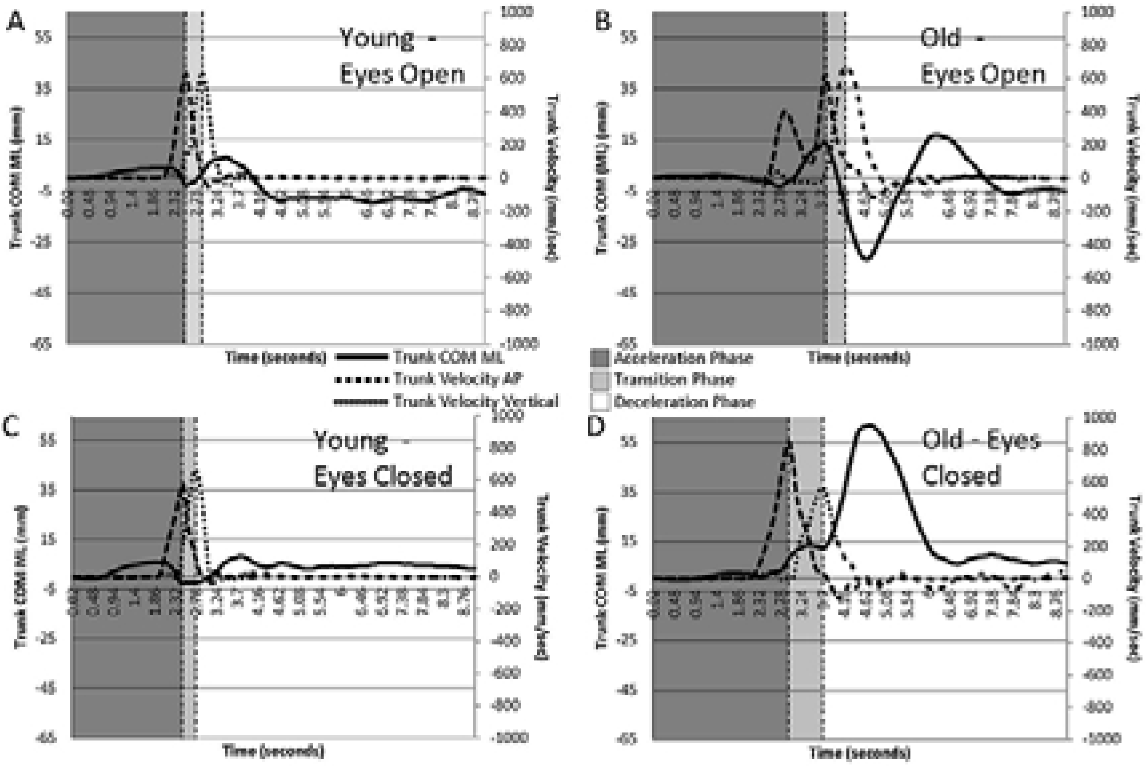

Figure 1. Trunk center of mass (mediolateral) in relation to trunk velocity (horizontal (AP) and vertical direction) over 9 seconds when GVS was applied at an intensity of 2 times threshold intensity of the participant under the following conditions: (a) Young, Eyes Open (b) Old, Eyes Open (c) Young, Eyes Closed (d) Old, Eyes Closed. The dotted vertical lines delineate the transition phase (peak horizontal (AP) trunk velocity to peak vertical trunk velocity).

P2-L-132 Gait kinematics in old adults are instable during weight transfer

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BACKGROUND AND AIM: A large portion of falls occurs during walking and falls are the primary cause of injuries and sedentary lifestyle for older persons. Recent studies have reported that the major portion of falls in community-dwelling older persons occurs during weight transfer. This study investigated whether the gait kinematics of healthy old persons exhibit larger local dynamical instabilities during weight transfer as compared to younger persons. We employed a newly developed outcome to define the intra-stride change in local dynamical stability of the gait kinematics (Ihlen et al., submitted). METHODS: Ten healthy old persons and ten younger persons walked 10 minutes each on a treadmill at 3 different gait speeds. Gait kinematics were measured by a Vicon® 3D motion capture system. Sixteen retro-reflective makers were placed on bony landmarks on the lower extremities according to the conventional gait model. The intra-stride change in the local divergence exponent ë(t) of the state space dynamics was calculated by a newly developed method (Ihlen et al., submitted). The intra-stride

changes in ë(t) were compared to changes in the variation of the gait kinematics. RESULTS: Although preferred gait speed was not significantly different in healthy old as compared to healthy younger persons (Young: 1.14 m/s; Old: 1.17 m/s, p = 0.41), the older persons were more local dynamical instable during weight transfer at the initiation of the double support phase for all gait speeds (see heel-strike (OL) in Fig. 1). Furthermore, this difference between healthy younger and older persons was not present at other events within the stride cycle, such as toe off. A strong relationship was found between the state space divergence and intra-stride changes in variation of the gait kinematics, especially at the distal segments. This strong relationship was reflected in high correlation (R = 0.67 - 0.90, p < 0.01) between the state space divergence during weight transfer and step length and step width variability for both younger and older persons. The significant larger step length and step width standard deviation (p < 0.01) for the older persons were explained by the larger local dynamical instability during weight transfer. CONCLUSION: The present results indicate that gait kinematics of older persons are less stable than the gait kinematics of younger persons during the transitions between single and double support phase only (i.e., weight transfer). Further studies in frail and fall prone persons should investigate whether the increased local dynamical instability during weight transfer in older person's gait might be a precursor of ongoing decline in gait function and thereby increasing the risk of falling.

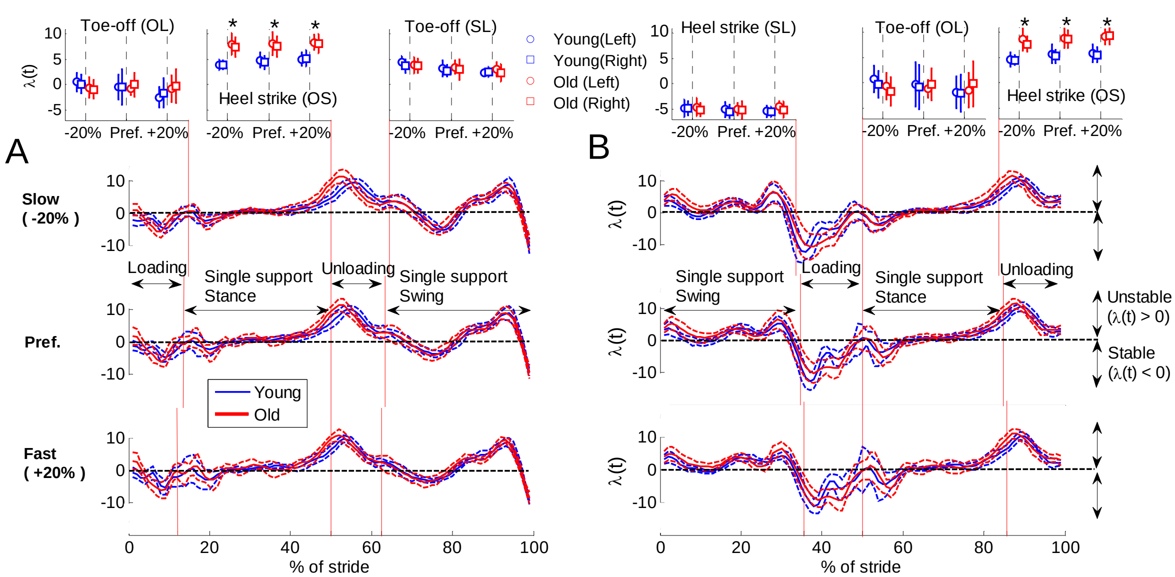

Figure captions

Figure 1: The mean (*solid lines*) and ±1 SD (*dashed lines*) of the intra-stride change in local dynamical stability, $\lambda(t)$, for a group of healthy older persons (*red lines*) and younger persons (*blue lines*) for slow (-20%), preferred, and fast (+20%) gait speed. The upper panels represent the cross-section at heel strike and toe off on the same (SL) and opposite leg (OL). The small panels are corrected for inter-individual variation in the relative time of these events (i.e., phase distortion seen in the $\lambda(t)$ curves). * = significantly larger $\lambda(t)$ for older persons (independent samples t-test; $p < 0.001$).

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P2-L-133 Center of pressure velocity during quiet standing reflects body acceleration rather than body velocity

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BACKGROUND AND AIM: The center of pressure (COP) velocity has been used as one of the most sensitive posturographic measures to detect changes in balance abilities due to aging and/or neurological diseases. Since the COP trajectory matches very well with the center of mass (COM) trajectory due to the body dynamics, the COP velocity has been believed to represent the COM velocity in most of these studies. However, there is no study to date that has investigated the physical and physiological meaning of the COP velocity. Therefore, the purpose of this study was to investigate the meaning of the COP velocity during quiet standing. METHODS: Twenty-seven young (27.2±4.5 yrs) and twenty-three elderly (66.2±5.0 yrs) subjects participated in this study. Each subject was requested to stand quietly on a force plate for five trials of 90 sec each. The body kinematics at the third lumbar vertebra were measured using a laser displacement sensor. The COP displacement (COPdis) and COP velocity (COPvel) were calculated using the force plate outputs. The COM displacement and COM velocity were estimated in two ways: (1) using the laser sensor output (COMdis_l) and its derivative (COMvel_l); and (2) using the force plates outputs with a zero-point-to-zero-point double integration technique (COMdis_f and COMvel_f). The COM acceleration was estimated in two ways: (1) using the horizontal force component based on COMacc1 = Fx / m, where Fx and m describe the horizontal contact force component and the body mass, respectively (COMacc_f); and (2) as the derivative of COMvel_l (COMacc_l). The amount of fluctuation of each variable was quantified using the root mean square, mean amplitude, range, centroid frequency, and frequency distribution. Following, a simulation study was executed to complement the experimental findings. RESULTS: The experimental results show that COPvel was correlated with COMvel_f and COMvel_l for all parameters (r = 0.507 to 0.735), but more highly correlated with COMacc_f and COMacc_l (r = 0.808 to 0.900). The motion equation of the inverted pendulum model, however, accounts only for the correlation between COPvel and COMvel. CONCLUSION: While a correlation between COPvel and COMacc could be expected (since a higher COMvel generally implies a higher COMacc), it is an important finding that this correlation is higher than the one between COPvel and COMvel. Our experimental results can be meaningfully explained by the fact that the neural motor command presumably contains a significant portion that is proportional to body velocity. This interpretation is also supported by the obtained simulation results. In conclusion, the COP velocity fluctuation better captures the COM acceleration fluctuation than the COM velocity fluctuation, providing further experimental evidence that the neural motor command controlling quiet standing posture contains a significant portion that is proportional to body velocity.

P2-L-134 The influence of wearing a portable metabolic measurement system on gait of older adults

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BACKGROUND AND AIM: Oxygen consumption is frequently used to assess aerobic capacity and to derive the energy cost of walking in older adults. Traditionally researchers have used large, stationary metabolic carts which confined assessment to only laboratory settings and novel activities (treadmills and cycle ergometers). Recent advancements in portable systems have enabled researchers to measure oxygen consumption in more usual performance settings, and across more natural walking conditions. It is not known whether wearing the portable system (weight, fit, and masking) alters other concurrent measures, such as gait, especially in older adults with gait dysfunction. Purpose: To investigate differences in gait characteristics of older adults during walking with and without wearing a portable metabolic measurement system. METHODS: Forty community-dwelling older adults [mean age 76.9 (6.8) years] with slow gait (0.8-1.0 m/s) completed walking conditions with and without a portable system (Megraphics VO2000). Each walk consisted of 8 passes over a 4 meter computerized walkway at a self-selected pace. Gait characteristics (gait speed, step length, step width, step time, stance time, single-support time, and double-support time) were recorded for each pass; mean and variability (standard deviation) were calculated by incorporating all steps of all passes for each condition. Intra-class correlation coefficient (ICC) was used to assess consistency and agreement between the two conditions. RESULTS: Mean gait characteristics were similar between the two walking conditions ($p>0.05$), except step width differed by -0.003 meter ($p=0.006$). ICCs for mean gait characteristics were excellent (0.94-0.98), while those for gait variability were slightly lower (0.56-0.79). CONCLUSION: Gait characteristics while wearing a portable metabolic system remained consistent with usual, non-instrumented gait among older adults with slow gait. Additional research is recommended to assess the impact of using alternate brands of portable metabolic systems across other relevant populations.

M - Falls and Falls Prevention

P2-M-135 The Senior Step Study: Maximum step length, gait speed and chair test as a potential self test for individual fall risk in community dwelling elderly

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BACKGROUND AND AIM: Falling is a common problem in the elderly population with a negative impact on social functioning, wellbeing, autonomy and quality of life. Identification of those at risk for falling, preferably before the first fall occurs, may be possible for elderly using a self test to measure their own fall risk at home. The current study explored the feasibility of three possible candidate tests as tools for

self management of fall risk. METHODS: Fifty elderly living at home (age ¡Ý70) and their informal caregivers were included in this cross-sectional study. Three possible self tests, i.e. Maximum Step Length (MSL), Gait Speed (GS) and Chair Test (CT), were performed weekly by the elderly and their caregiver. MSL and GS consisted of several trials and therefore both mean and maximum values were calculated. CT was performed in two ways, use of the arms (A) and the arms folded across the chest (B). After one month a professional also performed these tests in the home setting. Bland-Altman plots were used to compare 1. measurements by elderly with those by professionals and 2. measurements in the presence or absence of a professional. Errors during the tests likely to affect the results were considered as missings. RESULTS: 49 elderly (mean (sd) age: 75.7 (4.0), 22 female) participated in the study. All tests showed a high error rate during performance by the elderly and their caregivers, with 63%, 69%, 69% and 67% for MSL, LS, CTA and CTB, respectively. The errors were mainly due to not following test instructions,. Fair to good agreement was found between the performance by the elderly and professional for all three tests, with the MSL and CTA having the best agreement. CONCLUSIONS: Self management of fall risk by elderly is feasible using MSL, GS and the CT, with results comparable to those of a professional. However, improvement of the test instruction and support of an automatic measurement system may reduce the error rate of these tests.

Table 1 Agreement between different methods of performance of the candidate tests

			n	Outliers (n)[1]	Mean difference compared to line of equality[2] (cm/cm)	Limits of agreement[3] (cm/cm)	Agreement[4] (good/fair/poor)
MSL[5]	Professional vs Elderly	Mean	37	(2)	0.0015	-0.012 – 0.02[illegible]	Good
		Maximum	37	(0)	0.0010	-0.021 – 0.020	Good
	Professional present vs Professional absent	Mean	35	(2)	0.0004	-0.051 – [illegible]	Fair
		Maximum	35	(2)	0.0062	-0.054 – [illegible]	Fair
Chair Test	Professional vs Elderly	A	23	(3)	-0.0081	-1.129 – [illegible]	Fair
		B	27	(1)	0.0456	-1.001 – 0.332	Good
	Professional present vs Professional absent	A	23	(2)	-0.2257	-2.259 – 1.030	Fair
		B	27	(2)	-0.3011	-2.951 – 2.440	Fair
Gait Speed	Professional vs Elderly	Mean	26	(2)	-0.0031	-0.199 – 0.125	Fair
		Maximum	26	(3)	-0.0127	-0.298 – 0.266	Fair
	Professional Present vs Professional absent	Mean	26	(2)	-0.0815	-0.302 – 0.138	Fair
		Maximum	26	(3)	-0.0451	-0.340 – 0.251	Fair

Agreement was based on the following clinically relevant differences: MSL: difference ± 5 cm; Chair test: difference ± 2.2 seconds; Gait speed: differences ± 0.1 m/s

n = participants without missings

[1] Outliers: values outside the limits of agreement: 0 = green, 1-2 orange, ≥ 3 red

[2] Mean difference to line of equality: mean difference between the two compared measurements: no clinically relevant difference = green, clinically doubtful difference = orange, clinically relevant difference = red

[3] Limits of agreement: mean difference ± 1.96 standard deviation: clinically acceptable limits = green, clinically doubtful limits = orange, clinically not acceptable limits = red

[4] Agreement: good agreement = 3 x green or 2 x green + 1 x orange, poor agreement = 3 x red or 2 x red + 1 x orange, fair agreement = all the intermediates

[5] MSL can be calculated by multiplying the values by a mean step length of 52 cm

P2-M-136 Is stair descent in the elderly associated with momentary periods of high CoM downward accelerations?

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BACKGROUND AND AIM: When descending stairs bodyweight becomes supported on a single limb while the lead-limb is swung forwards/downwards in order to make contact with the lower level. This is

associated with lowering of the centre of mass (CoM), which in order to occur in a controlled manner, requires increased ankle, knee and hip joint torque production relative to that in overground walking[1] and older people operate at a higher proportion of their maximum eccentric capacity[2] and at, or even above their joint range of motion limits[2,3]. It is perhaps no wonder that stair descent in the elderly has been described as 'controlled falling'[4,5]. The present study investigates whether elderly individuals have periods during descent when their CoM 'falls' towards the ground. METHODS: 15 older (mean 75 years) and 17 young (mean 25 years) healthy adults descended a 4-step staircase, leading with the right limb on each stair. Analysis focussed on determining age differences in CoM downward velocity and acceleration profiles. To determine the strategy used in making contact with the lower level we also determined age-differences in lead-foot downward velocity. RESULTS: CoM peak downward velocities and accelerations and peak downward lead-foot velocity were greater in young compared to older participants. Instant of when the CoM first began to accelerate downwards and instant of when CoM peak downwards acceleration occurred were unaffected by age ($p>0.11$), but step duration was longer for elderly participants. CONCLUSIONS: Findings indicate that older adults do not 'drop' with gravity when descending stairs (at least not in controlled conditions). Indeed, in comparison to young adults they have reduced CoM peak downwards velocity and acceleration. Differences between CoM and lead-foot peak downward velocities were greater in young compared to older adults ($p=0.009$). This suggests the elderly used a strategy whereby their lead-foot was lowered along with their CoM, whereas the young allowed their lead-foot to be lowered more rapidly than their CoM. Although there was an accompanying increase in step duration in older adults, the instant when CoM downwards acceleration began and instant of peak downward acceleration as a percentage of movement time, was reduced. This indicates that the period when CoM downwards acceleration was reducing (i.e. period from instant of peak acceleration up to foot contact) was longer (relative and absolute terms) in older adults. These findings suggest young adults lower quickly and confidently and use their lead limb to arrest the resulting downward momentum following contact with the lower level, whereas older adults adopt a cautious strategy to ensure they gain only minimum downward momentum during the lowering phase.

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P2-M-137 Fall evaluation at a large, academically integrated VA hospital

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BACKGROUND AND AIM: A Falls Assessment and Prevention Referral Clinic was established to provide a thorough evaluation of patients with a history of falls METHODS: A large database of history and exam elements from 112 consecutive patients referred to the Clinic with a history of falls was compiled and analyzed to discern fall risks pertinent to this patient population. RESULTS: The greatest number of patients were in the seventh and eight decades (30 patients from each group, compared to 6 patients in the fifth, 10 in the sixth and 4 in the ninth decade). Symptoms commonly considered as predisposing to falls were not strongly represented (light headedness 16 patients, dizziness 12, weakness 23, numbness 10, tinnitus 10, confusion 7). Taking greater than 4 medications was strongly represented (95 patients). A history of neurological disorder was present in 85 patients, while 70 patients had rheumatological disorders. Cardiac and endocrine histories were present in 49 and 51 patients respectively. Having stairs in the home was present in 86 patients, while living alone, tobacco use, alcohol use and use of illicit drugs was not (34, 21, 44 and 0 respectively for those groups). Orthostatic blood pressure drops were present in 31 patients, 13 of whom had persistent or worsening decrease in blood pressures at 3 minutes. Exam elements strongly represented in patients with falls were abnormal visual acuity (59), hearing problems (51), abnormal reflexes (80), abnormal pin sensation (61) abnormal position sense (61), abnormal vibratory exam (83), positive Romberg (59), and abnormal tandem gait (61). A Timed Get Up and Go score of greater than 10 seconds was noted in 66 patients. Cognitive testing by SLUMS examination resulted in scores of 21-26 (suggesting Mild NeuroCognitive Disorder) in 41 patients, and 1-20 in 4 patients. Interestingly, abnormalities in the fundoscopic, carotid, heart, pupils, visual fields, eye movements, tongue and palate, motor strength and tone, coordination and gait exams were not strongly represented in these patients with falls. CONCLUSIONS: This study provides information about findings associated with falls in an elderly VA population. Surprisingly, cognitive disorders did not seem strongly associated. Taking greater than four medications and a history of neurological and rheumatological disorders comprised a majority of patients and is intuitively reasonable as are the large number of patients with sensory loss as well as decreased vision and hearing. Although orthostatic hypotension was present in only about one-third of the patients, the importance of testing for this seems reinforced. The Timed Get Up and Go appears to be a useful tool. In general, these data provide the framework for a more focused database as well as where further correlative work should be focused to obtain a better understanding of identifiable risks for falls in the elderly.

P2-M-138 Load carrying-obstacle avoidance behaviour may be categorized into two alternative gait patterns: A preliminary study

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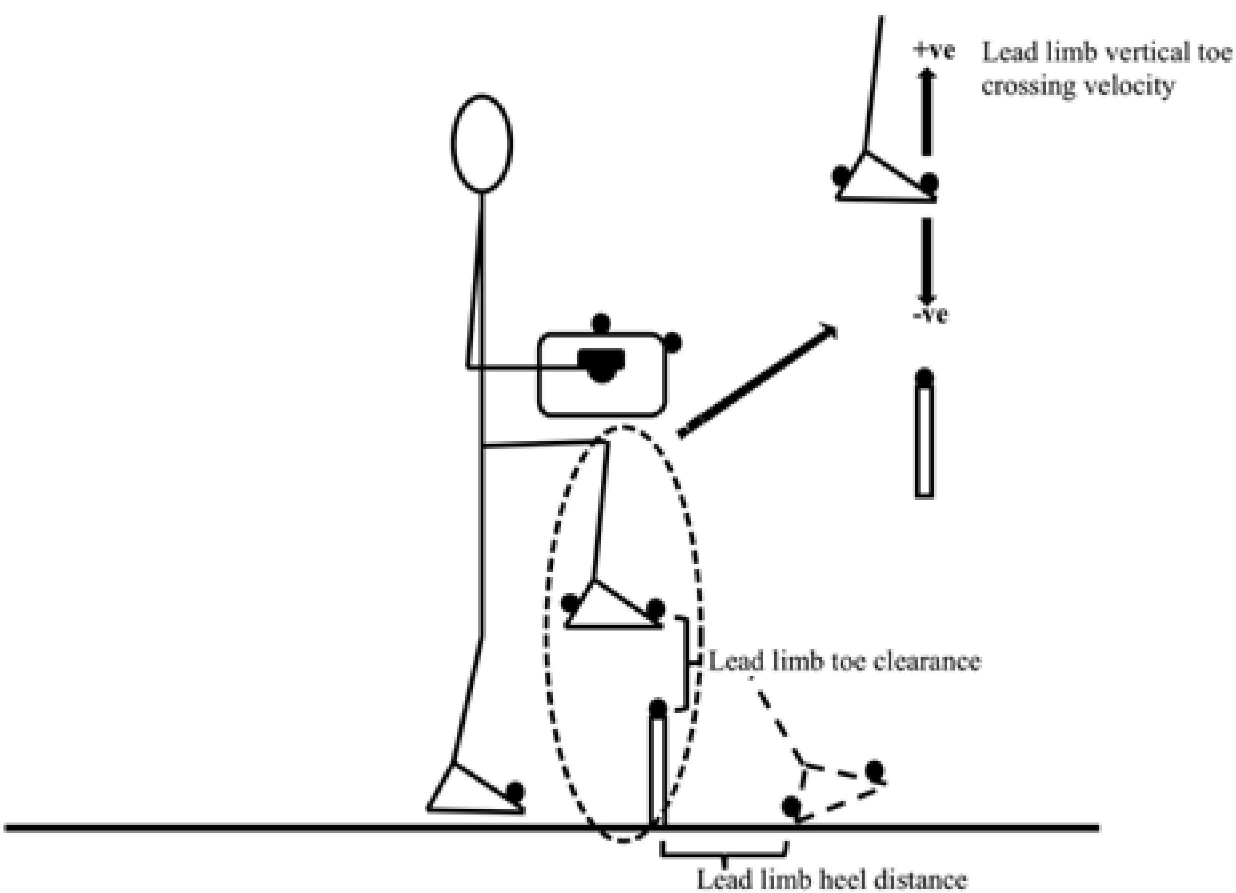
BACKGROUND AND AIM: Obstacle avoidance during gait is a common day-to-day challenge and an essential component of successful ambulation. Carrying an object places an added challenge on an individual attempting to cross an obstacle safely. Occlusion of the visual field from carrying an object during the approach of an obstacle has been linked to adoption of a conservative gait strategy [1]. The purpose of this study was to assess the effect of anterior load carriage on obstacle crossing behaviour, with a focus on lower limb gait parameters. METHODS: Nine male participants (age 23±1.8 years, height 176±5.0cm) were recruited from the York University student population. Participants walked down a 7m walkway without a load (No Load), or carried a load (2KG (empty box), 5KG, and 10KG), and stepped over a collapsible wooden obstacle (20x110x2cm) with their right foot. Vision of the obstacle was obscured 1.0m to 1.3m prior to the obstacle when carrying a load. Dependent measures included:

vertical crossing speed (VCS), lead limb vertical toe clearance (TC), and lead heel distance (LHD) (Figure 1). RESULTS: Analysis of VCS showed two alternative gait patterns at toe crossing in the Box, 5KG and 10KG load conditions. "Ascenders" (ASC) (n = 4) were those who demonstrated an average positive VCS whereas "descenders" (DSC) (n = 5) had an average negative VCS at toe crossing. This was not the case in the NL condition (p=0.06). Evaluation of TC and LHD demonstrated no significant difference between gait patterns in NL (TC: p=0.42, LHD: p=0.09), Box (TC: p=0.18, LHD: p=0.09), 5kg (TC: p=0.42, LHD: p=0.08), and 10kg (TC: p=0.18, LHD: 0.08) load conditions, and also no significant difference when collapsed across load conditions (TC: p=0.24, LHD: p=0.09). While not significant, TC was 22% greater and LHD was 14% greater for ASC compared to DSC as the obstacle was navigated. CONCLUSIONS: The results may suggest a less cautious gait pattern that allows the foot to negotiate, and remain closer to the obstacle, at and after obstacle crossing for DSC. Under these circumstances, contact with the obstacle during crossing would mean less time is available for balance recovery, perhaps increasing the likelihood of a trip and fall incident. The root of this behaviour may stem from a role for physiological arousal (PA). It may be that DSC were more comfortable performing the task and less threatened by the risk of falling from occluded vision due to holding the load and therefore, potentially less aroused. A limitation of the current study was that PA was not measured. Therefore, future studies investigating this behaviour should attempt to measure PA on obstacle crossing behaviour.

Figure 1: Diagram of walking protocol and dependent measures



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P2-M-139 Influence of additional sensory information, plantar tactile information, on roll tilt perception

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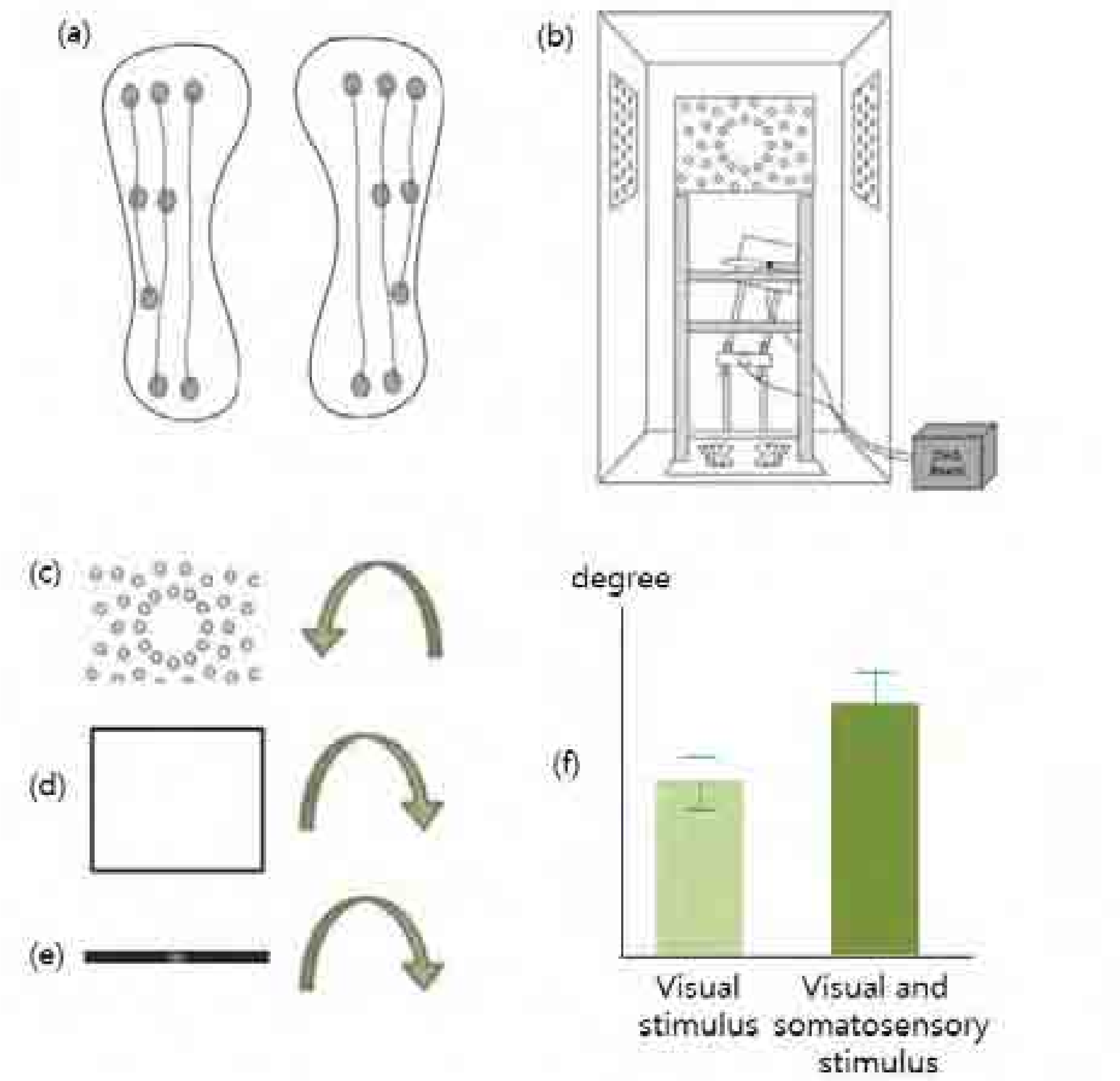
[1]KAIST

BACKGROUND AND AIM: Motion perception induced by other sense proceeds motion control. In previous study, research to improve motion performance by sensory prosthesis was conducted such as balance. However, it has not yet been discussed whether motion perception increases or not from applying additional sensory information. Thus, in this study, we examined relationship between applying additional tactile sensory information and roll tilt perception. METHODS: 10 subjects who do not have somatosensory disorder participated in two test sessions: 1) visual stimulus only and 2) visual and somatosensory stimulus. Each test consists of 3 trials. The sinusoidally rotating visual stimulus which peak velocity of 7.5 degree/s and frequency of 0.08 Hz was applied to subjects for 183 secs. Somatosensory vibration stimulus applied by vibrator insole which was composed by 20 small vibrators. The magnitude of the stimulus was proportional to the degree of room rotated and vibration stimulus was synchronized with the direction of vection. To examine the influence of visual and somatosensory stimulus, subjects were hold by bars not to sway their bodies. First, subjects were trained to adjust to vection, somatosensory bar task and vibration. Subjects were instructed to rotate somatosensory bar to be parallel to horizon and we measured this degree. To analyse the data, data were divided by a cycle, and each cycle was fit sinusoidally. Magnitudes of each cycle were compared to study the influence of visual and somatosensory stimulus. RESULTS: The result indicates that under the visual and somatosensory stimulus, subjects rotated the somatosensory bar more than under the only visual stimulus. Increase of degree which subjects rotated means that increase of roll tilt perception. This implies that somatosensory stimulus which notifies the room is rotating has an influence on roll tilt perception. CONCLUSIONS: In conclusion, motion perception can be improved by additional sensory information.



P2-M-140 Compensatory balance reactions during walking: Comparison between young and older adults

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BACKGROUND AND AIM: Age-related deterioration in balance recovery responses is a major contributor to falls in older adults. Such deterioration results in an impaired ability to correct for postural disturbances experienced in everyday life, such as slips, trips, and pushes. Studies showed demonstrated

reduced step length, decreased likelihood to take a "crossover" step, increased frequency of collisions between the legs during lateral perturbations, more steps to recover balance during perturbation and a second lateral step that follows the forward or backward step, failure to recover equilibrium. These postural "reflexes" were studied extensively in standing. We aimed to explore compensatory stepping reactions to unexpected platform translations during treadmill walking, which more closely mimics "real life" situations. METHODS: We exposed 8 healthy young (21-29 years old) and 2 healthy older subjects (62 and 65 years old) to lateral unexpected platform translations. The platform translation was systematically increased from 1cm to 16cm in steps of 1cm, during comfortable treadmill walking, and during standing. Subjects were allowed to respond in a "natural" manner (no instructional constraints). Step characteristics (e.g., step initiation, foot-off and -contact time, step length) were collected through a three-dimensional motion analysis system. RESULTS: during the standing trials the step initiation time, i.e., time from perturbation to foot lift-off the ground initiating the stepping response, was 62.2ms faster in older compared with young adults, and the compensatory step time, i.e., the time from perturbation to foot contact the ground completing the step, was 172.6ms faster in older adults with shorter step length (5.1cm vs. 16cm, respectively). The older adults initiate stepping at lower levels of instability compared with young adults (8.5cm vs. 15.1cm). However, when we applied the same study protocol during treadmill walking, the compensatory step initiation was 104.2ms faster in young adults compare with older adults (183.3ms vs. 287.5ms, respectively). The compensatory step time was almost 200ms faster in young compared with in older adults (396.9ms vs. 593.5ms, respectively), with a longer step length in young adults (15.3cm vs. 11.5cm, respectively), although the magnitude of platform translation to initiate stepping response was 9.5cm in older compared with 11.6cm in young adults. CONCLUSIONS: These results indicate that testing balance recovery reactions during standing does not reflect balance recovery reactions during walking, thus, testing recovery responses during walking may be a better marker for falls in older adults. Further, there is an increased need for specifically targeting the balance recovery reactions during walking in future research projects.

P2-M-141 Development of a novel device for measuring stepping performance including multilateral parameters and fall risk in older adults: Applying infrared laser sensor

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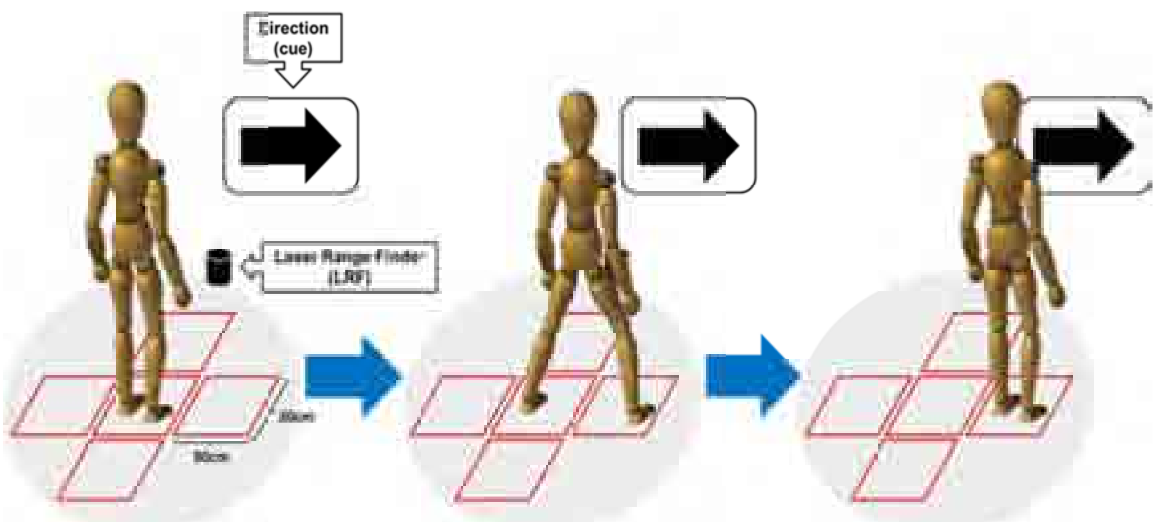
BACKGROUND AND AIM: Avoiding a fall requires fast and appropriate step responses, which has been assessed by only stepping speed as a fall risk indicator in older adults. We developed a new device that applied an infrared laser sensor (Laser Range Finder: LRF) for convenient assessment of stepping performance including temporal and spatial parameters such as speed, length, and accuracy. The aim of this study was to determine whether this device can detect differences in the fall risk in older adults. METHODS: A total of 151 elderly volunteers (mean ± SD, 73.9 ± 4.6 years) participated in this study. Participants were made to stand at a specific position and were required to quickly move both legs into one of four squares arranged in a plus shape around the starting position. The stepping direction--

forward, backward, and sideways-- was indicated by a visual cue. As temporal and spatial parameters, foot-off time (FO), foot-contact time (FC), step length, and the percentage of correctly executed steps were extracted from the LRF data. Each subject was categorized as a high-risk or a low-risk individual, based on the falling history within the past year. The subjects also took a 10-m walking test (WT), Timed Up and Go test (TUG), and the Rapid Dementia Screening Test (RDST) as motor and cognitive function tests. Based on the coefficients of the logistic regression model, we developed a combined score (Fall risk score) that used a weighted sum of the fall assessment parameters (age, FC, step length, and the percentage of correctly executed steps). RESULTS: High-risk participants had significantly slower FO and FC than low-risk participants ($p < 0.05$). There were statistically significant correlations between the temporal parameters, FO and FC, and the motor and cognitive functions, determined from WT, TUG, and RDST ($p < 0.05$). Step length as spatial parameter showed significant correlations with motor functions determined from WT and TUG ($p < 0.05$). The receiver operating characteristic (ROC) curve demonstrated a high area under the curve (0.65), sensitivity (0.62), and specificity (0.60) for Fall risk score ($p < 0.01$). CONCLUSIONS: This study indicates that our new stepping performance device can identify elderly individuals at risk of falls and reflect multilateral parameters such as motor and cognitive functions. Our device is fairly inexpensive and portable; it can be used in clinical settings and the homes of older adults as both an assessment and training device. A prospective cohort study is needed, to further evaluate the relationship between fall incidents and Fall risk score. We hope that our device is not only useful for fall assessment but also opens avenues for development in cognitive-locomotion science.



P2-M-142 Influence of perturbation velocity on balance control in Parkinson's disease

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BACKGROUND AND AIM: Current investigations of balance impairment using support-surface platforms do not provide reliable diagnostic indicators nor do they correlate well to clinically-rated impairments. Previous studies typically employed fast perturbations which allow healthy subjects to use the passive forces generated by the platform deceleration to attenuate their postural instability. Akinetic rigid subjects, such as Parkinson's disease (PD) patients, may also benefit from the generated forces during fast perturbations, thereby obscuring possible balance impairments. In contrast, slow perturbations (where postural performance mainly depends on adequate sensory feedback) may better disclose postural instability in PD, particularly in light of increasing evidence for somatosensory processing defects in this disorder. We therefore investigated whether perturbation velocity affects the difference in balance reactions between PD patients and controls. METHODS: We instructed eight PD patients and eight controls to maintain balance following 24 backward rotations. The rotations occurred at three different speeds: fast (75 deg/s), medium (60) and slow (35). These different velocities were presented in random order. Each subject completed the protocol both with eyes open and eyes closed. Balance reactions were measured with a motion analysis system and converted to centre of mass (COM). Near-falls were recorded and COM displacement was correlated with UPDRS scores. RESULTS: PD patients were most unstable during fast perturbations, as shown by a larger COM displacement following fast perturbations compared to slow perturbations (difference 36%; $p< 0.01$). In addition, the difference in COM displacement between PD patients and controls was also larger when using fast perturbations (39%) compared to slow perturbations (3%; $p< 0.01$). However, eye closure significantly increased the difference in COM displacement between PD and controls for slow perturbations (41%; $p<0.01$), but not for fast perturbations (12%). We recorded seven near-falls during fast perturbations (all with eyes closed) and five during slow perturbations. Three of the latter falls were recorded in a patient with a strikingly high uADL sensory complaints score. COM displacements did not correlate with UPDRS scores. CONCLUSION: Despite the rapid deceleration of the platform during fast perturbations, the higher intensity compared to slow perturbations produced larger COM displacements in PD. However, the absence of visual feedback increased COM displacements during the low-intensity slow perturbations. Furthermore, marked instability following these slow perturbations was observed in a single patient with substantial sensory complaints. Future studies should investigate the effect of delayed decelerations on balance control in PD using both high and low acceleration profiles. More patients should be included, and balance scores should be correlated to clinical scores, in particular of axial symptoms such as kinaesthesia.

P2-M-143 Biomechanical factors influencing probability for head impact during falls in older adults: Analysis of video footage of real-life falls in long-term care

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BACKGROUND AND AIM: Falls are the leading cause of injuries in older adults, and approximately 32% of fall-related hospitalizations are head injuries, most of which are due to direct impact to the head [1]. This study provides the first evidence from real-life falls captured on video in the long-term care (LTC) environment of the factors that determine whether a fall results in head impact. METHODS: Over a 39-

month period, we captured video footage of 219 falls at two partner LTC facilities. We used a validated questionnaire to analyze the cause and circumstances of each fall. We then examined how seven explanatory variables (cause of fall, fall direction, landing configuration, occurrence of hand impact, held objects, age and gender) associated with the likelihood for head impact, using a generalized linear statistical model. RESULTS: A total of 37% of falls involved head impact. Initial fall direction and landing configuration had a significant effect on the occurrence of head impact. The risk for head impact was three times greater in an initially forward directed fall (and two times greater when landing forward) than other fall directions. Other variables, including the occurrence of hand impact (present in 77% of falls), had no effect on the probability of head impact. CONCLUSIONS: In our sample of video-captured falls by older adults residing in LTC, head impact occurred in over one-third of cases. Forward falls had the greatest associated risk for head impact. While upper extremity impact was common, it was largely ineffective at protecting against head impact (Figure 1). These results indicate the need for muscle strengthening programs to enhance the ability of older adults to safely arrest a fall with the upper limbs. An alternate strategy of axial rotation during descent, as commonly trained in martial arts, was observed frequently and appeared to be effective in reducing the risk of head impact.

Figure 1. Real-life falls captured on video, involving apparent attempts to prevent head impact by arresting the fall with the outstretched hands. (A) Successful use of hand impact to prevent head impact. (B) Unsuccessful attempt (while carrying object), possibly due to non-optimal hand placement or insufficient muscle force development at impact.

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P2-M-144 The maximum step length: Feasible and valid self-test for gait and balance monitoring in older persons

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[1]Radboud University Nijmegen Medical Centre

BACKGROUND AND AIM: The Maximum Step Length (MSL) decreases with age and is correlated with mobility measures, such as the Timed-up-and-Go (TUG) and Tinetti-test outcomes, which predict an individual's fall risk. MSL is simple and easy to perform and therefore has the potential to be the first 'fall-risk' test that elderly can perform themselves at home. We investigated the feasibility and concurrent validity of MSL as self-test in a cohort of community dwelling older people. METHODS: In a cohort study in community dwelling older people of 70 years and over, a comprehensive geriatric assessment (CGA) was performed in an outpatient clinic. The following characteristics were collected by a geriatrician and a specialist nurse: frailty score (Fried score 0-5), functional performance (Katz), disease burden (CIRS-G), cognitive functioning (MMSE, FAB), handgrip strength, MSL, TUG, gait speed and Short Physical Performance Battery (SPPB). Being unable to stand without aid was an exclusion criterion for the MSL. RESULTS: 594 elderly (mean age 77±5 years; 56% female) were included in the study; 92% could perform MSL. The people in whom MSL could not be established were not able to walk safe without support. Mean MSL was 1.07±0.23. Significant Pearson correlations were found between MSL and TUG (-0.61, p<0.01), SPPB (0.59, p<0.01), and gait speed (0.64, p<0.01). Handgrip strength and Fried's frailty score showed moderate correlation (0.5 and -0.51, respectively, p<0.01). MSL showed lower correlations with CIRS-G -0.37, Katz -0.44, Fried -0.51 and MMSE/FAB 0.2 (all p<0.01). CONCLUSIONS: MSL could be measured by almost all elderly and correlated well with classical mobility and strength measures that cannot be used as self-test. MSL meets the principal criteria of being simple, safe, feasible, and showed criterion validity, which warrants further development as a self-test for assessing gait, mobility and 'fall-risk' in community dwelling older people.

P2-M-145 The impact of exhaustion on gait smoothness among Japanese older people.

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[1]National Center for Geriatrics and Gerontology

BACKGROUND AND AIM: The older people had lower physiological capacity such as total energy expenditure than young adults, and a decrease in physiological reserve necessitates inactive life-style to save the energy expenditure. As a result, the older people experience behavioral changes including cessation of brisk walking to prevent themselves from exhaustion in daily activities.[1] In fact, exhausted older people had slower speed or lower gait endurance than non-exhausted ones.[2] Compared with assessment of gait speed, a spatial-temporal gait parameter was able to detect more sensitively decline of several functions among older people, e.g., fall risk or pre-frail condition.[3, 4] An assessment of spatial-temporal gait parameters may be an objective and sensitive measurement of exhaustion. But little is known about the relation between exhaustion and spatial-temporal gait parameters including smoothness among older adults. The purpose of this study was to identify characteristics of spatial-temporal gait parameters among exhausted older people. METHODS: t Ninety-eight adults were classified by Study of Osteoporotic Fractures index into exhausted group: EG (n = 33, 74.5years, female 14.0%) and non-exhausted group: non-EG (n = 66, 75.0years, female 54.5%). Accelerometers were used to assess spatial-temporal gait parameters under single task (ST) gait condition and dual task (DT) gait condition. The harmonic ratio (HR) was calculated from accelerometer data to measure gait smoothness. The demographic data, physical function, cognitive function, and physical activity (life-space assessment: LSA) were measured as potential confounding factors. RESULTS: The EG showed

significantly lower scores in HR of DT and LSA than the non-EG. There were no significant differences in other measurements between the two groups. Multivariate logistic regression analysis, forced entry method, revealed that HR under DT-gait condition (OR (95%CI): 0.50 (0.26 - 0.91)) and LSA (OR (95%CI): 0.95 (0.91 - 0.98)) were significantly associated with exhaustion, adjusted for demographic variables. CONCLUSIONS: The EG lacks gait smoothness during dual-task condition compared with the non-EG. The relationships between reduced smoothness during gait and exhaustion may induce limited life-space in daily living of the older adults. Prior to decline of gait speed and endurance, the older people with exhaustion could be identified more sensitively by the assessment of HR under DT condition. Longitudinal studies are needed to clarify the causal connections.

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P2-M-146 Wide base-of-support footwear to increase lateral stability of older adults

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BACKGROUND AND AIM: Age-related difficulty in controlling lateral stability during stance, gait and compensatory stepping is of crucial importance because lateral falls increase risk of debilitating hip-fracture injury. This study examined whether a small increase in footwear sole width can improve lateral stability of older adults. We hypothesized that wide base-of-support (BOS) footwear would improve lateral stability during: 1) single-leg and tandem stance; 2) compensatory stepping evoked by lateral perturbation (increased ability to recover equilibrium without stepping or with fewer steps); 3) compensatory stepping evoked by antero-posterior perturbation (fewer lateral steps; larger anticipatory postural adjustments when stepping over obstacles). METHODS: The study involved 16 healthy, ambulatory older adults (aged 65-78) with no neuromusculoskeletal disorders. Wide-BOS overshoes were prepared by fixing polystyrene foam blocks (20mm wide) on the medial and lateral sides of rubber overshoes as shown in Fig.1. Subjects wore the wide-BOS overshoes on their own shoes and were also tested with normal-BOS overshoes in a separate session (order of sessions was balanced across subjects). Balance perturbations were applied using a large (2x2m) motion platform, and FICSIT-4 tests (feet together, semi-tandem, tandem and one-leg stance) were performed to assess static balance. Gait and mobility tests (preferred- and maximum-speed gait, tandem gait, Timed Up & Go, 180° turn test) were carried out to see if the wide-BOS shoes affected gait and agility (either positively or adversely). Performance on the balance tests was assessed using force plates and a video-based motion analysis system; a gait mat was used to record spatial-temporal step parameters during the gait tests. RESULTS: Preliminary analyses indicate that the wide-BOS shoes improved ability to stabilize the body without stepping when responding to lateral perturbation (p=0.002). Depending on the perturbation magnitude, the frequency of stepping was reduced by up to 25% (64% of normal-BOS trials vs 39% of wide-BOS

trials), in trials where subjects were instructed to try not to step. Full results of all analyses will be reported at the meeting. CONCLUSIONS: This study will provide new information about the effects of footwear on balance control in older adults. The results may ultimately be used to develop new footwear for older adults.

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P2-M-147 High grip footwear outsole using hybrid rubber surface pattern to prevent slip and fall

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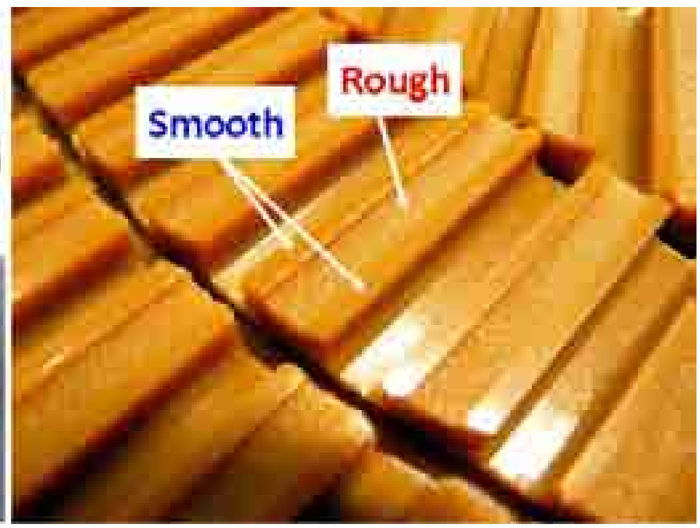
BACKGROUND AND AIM: Increased static and kinetic friction coefficients at the contact interface between footwear sole and floor are of importance to prevent slip and fall during walking. We found that a rubber block with a rough surface had high static friction coefficient and low kinetic friction coefficient while a rubber block with a smooth surface had low static friction coefficient and high kinetic friction coefficient on a smooth surface contaminated with a glycerol solution. In this study, we developed a rubber surface pattern with rough and smooth surfaces (hybrid rubber surface pattern) which shows both high static and kinetic friction coefficients on a contaminated stainless steel surface. We applied the hybrid rubber surface pattern to footwear outsole and tested whether the footwear reduced risk of slip and fall on a slippery contaminated floor through gait trials. METHODS: NBR (nitrile butadiene rubber) block samples with the hybrid rubber surface pattern, in which a rubber block with a rough surface (Ra = 30.4 ìm) was sandwiched between two rubber blocks with a smooth surface (Ra = 0.98 ìm), were prepared. The ratio of the rough surface area to the whole rubber block surface area r

was 0, 30, 50, 80, and 100%. Static and kinetic friction coefficients, between rubber block and stainless steel plate contaminated with a glycerol solution, were measured using a linear-motion-type sliding friction tester. Footwear with an outsole using the hybrid rubber surface pattern was prepared as shown in Fig. 1. Gait trials were performed on a slippery contaminated floor to examine risk of slip and fall for the developed footwear. The trials involved fourteen healthy male adults. RESULTS: The hybrid rubber surface pattern with the rough surface area ratio r of 50 % achieved the values of static and kinetic friction coefficients of greater than 0.4 on the contaminated stainless steel surface. The footwear with the outsole using the hybrid rubber surface pattern (r = 50 %) significantly reduced frequency of trials with slip and fall as compared with conventional commercially available footwear which is commonly used in food factories and restaurant kitchens (p < 0.01). CONCLUSIONS: The footwear outsole using the hybrid rubber surface pattern developed in this study will contribute to a reduction of slip and fall accidents in workplaces such as restaurant kitchens and food factories. The results will provide new design criteria for the surface pattern of the footwear outsole to prevent slip and fall on slippery contaminated surfaces.



P2-M-148 Fast-walking patterns increase the risk of multiple incidenct falls in older people - the TASCOG study

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BACKGROUND AND AIM: Falls are common in older people. An essential goal of geriatric care is early identification of those at risk. This study aimed to investigate the relationship between fast-walking and falls risk in a population-based study of older people. METHODS: Individuals aged 60-86 years were randomly selected from the Tasmanian electoral roll. Gait speed, step length and cadence were collected at preferred- and fast-walking on a computerised walkway. Apart from individual gait measures, the walk ratio (step length/cadence) was used as an exposure variable that combined

temporal and spatial gait measures together. Falls were recorded prospectively over 12 months. Log multinomial regression was used to estimate the relative risk of single and multiple falls associated with each gait measure at fast-walking. Covariates included age, sex, sensorimotor and cognitive measures, physical activity and mood. RESULTS: The risk of multiple falls was increased for those with a smaller walk ratio (shorter steps, faster cadence) during fast-walking (RR 0.92, CI 0.87, 0.97) and greater reduction in the walk ratio (smaller increase in step length, larger increase in cadence) when changing to fast-walking (RR 0.73 CI 0.63, 0.85). These gait patterns were associated with poorer physiological and cognitive function (p <0.05). A higher risk of multiple falls was also seen for those in the fastest quarter of gait speed (p=0.01) at fast-walking. A trend for better reaction time, balance, memory and physical activity for higher categories of gait speed was stronger for fallers than non-fallers (p<0.05). CONCLUSION: Tests of fast-walking may be useful in identifying older individuals at risk of multiple falls. There may be two distinct groups at risk - the frail person with short shuffling steps, and the healthy person exposed to greater risk.

P2-M-149 Falls in women with osteoarthritis: Sensitivity and specificity of different assessment tools

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BACKGROUND AND AIM: Falls result from a complex interaction of predisposing and precipitating factors in a person's environment. A variety of risk factors have been identified in literature including among them, age over 60, prior history of falls, cognitive impairment, female gender and osteoarthritis. Aim of this study was to identify, in a sample of women with multi-joints osteoarthritis admitted to a rehabilitation hospital, the characteristics of patients with or without fall history. A secondary purpose was to evaluate which tools are more sensitive for identifying the risk of falling. METHODS: we recruited 38 women affected by osteoarthritis aged over 65 years. We excluded patients with associated neurological diseases. Patients underwent a series of clinical evaluations including: Body Mass Index, visual analogue scale of pain, Kellgren-Lawrence osteoarthritis grade, a fall survey questionnaire, Mini Mental State Examination, Barthel index, Cumulative Illness Rating Scale (CIRS) separately scored for severity and number of comorbidities, Morse scale. In addition, the following functional evaluations were administered: spatial and temporal variables of gait with the GAITRite system, Berg Balance Scale (BBS), Timed Up & Go (TUG) Test. For each evaluation, sensitivity and specificity were calculated. RESULTS: on the basis of the fall survey questionnaire, patients were divided in two groups: fallers (F, n=17) and non-fallers (NF, n=21). No age difference was found between the two groups. Among the clinical evaluations, only CIRS (severity) and Morse scale were significantly increased in F with respect to NF. CIRS showed the largest sensitivity (86%) and specificity (88%) in classifying retrospectively fall history. Functional evaluations showed that BBS was marginally sensitive for identifying F from NF, whilst no difference was found between the two groups in TUG and gait analysis. CONCLUSIONS: falls in a sample of patients with multi-joints osteoarthritis were not associated with the severity of the disease itself but rather with the severity of comorbidity. BBS was less powerful than CIRS in discriminating F from NF possibly because patients with associated neurological diseases had been excluded. Since no

difference was found in gait variables between the two groups, we conclude that falls in this patient population does not appear to depend on worsening of gait abilities connected with osteoarthritis itself.

P2-M-150 Effects of Xavix Measured Step System on balance in the aged.

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BACKGROUND AND AIM: Aging is a big issue in the world. The fall and unstable balance may cause serious clinical problems in the aged [1].The balance is one of the intrinsic factors of falling risk [2]. Previous research showed that the specified exercise could enhance balance and reduce the fall rate [3]. The purpose of this study is to evaluate the effects of Xavix Measured Step System (XMSS) on balance in the aged. METHODS: This is a crossover-designed study. The participants of the study included 28 community-living subjects with age more than 65 years (72.1±4.8 years). The subjects were divided into two groups. The group A underwent the XMSS training in the initial 6 weeks, and then suspended in the subsequent 6 weeks. The group B did not receive treatment in the first 6 weeks, and then performed XMSS training in the following 6 weeks. The Berg Balance Scale (BBS), Timed Up and Go Test (TUGT), Modified Fall Efficacy Scale (MFES), and Unipedal Stance Test (UST) were evaluated before experiment, after the initial 6 weeks, and at the end of the subsequent 6 weeks in all participants. Center of pressure (COP) path length, velocity and area of bipedal stance with open eyes and closed eyes were also measured at the same time. RESULTS: The BBS, MFES and UST in the group A and B increased after the XMSS training ($p<0.001$). The TUG, COP sway area with open eyes and sway velocity with closed eyes decreased after training ($p<0.001$). The COP sway area with closed eyes, sway velocity and length with open eyes decreased post-training ($p<0.01$). All of the above measurements showed no change before and after the suspended period in both groups. CONCLUSIONS: The XMSS can improve balance after 6 weeks XMSS training. Furthermore, the beneficial effects can partially persist after the XMSS training stopped. Further investigation is needed to determine if XMSS training is superior to the traditional physical therapy.

P2-M-151 Perturbation walking training intervention to improve balance control function and reduce fall rates in the elderly: A randomized controlled trial

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BACKGROUND AND AIM: Age-related deterioration of gait and balance increases the risk of falls. Fall related injuries are serious public health problem in terms of the high costs to society and in terms of human suffering. To this date most fall prevention training programs did not include perturbation training in their training protocol thus ignored the importance of training postural recovery reactions during gait. We propose a novel training program using an innovative device that combines walking and perturbation exercises. Objectives: To present pilot results of a novel Balance Training program using

the Balance Measure & Perturbation System (BaMPer System). we will present early results of a Novel Gait and Balance training program - comprising of functional, progressive & specific gait training that includes external unexpected perturbation exercises using the BaMPer System. we hypothesize that the novel training can improve balance reactions, with corresponding improvement of Balance, Quality of Life, fear of falling and also reduce fall rates. METHODS: a Randomized Controlled Trial of 48 elderly persons. Gait and Balance control, quality of life and fall rates will be evaluated by qualitative and quantitative techniques before and after 12-week intervention program (e.g. 24 training sessions using the BaMPer system). The following tests will be performed :(1) Compensatory Step Execution Times during standing; (2) Compensatory Step Execution Times, during walking; (3) Voluntary step execution Test; (4) The 6 meter narrow base walk test: (5) Late Life Function and Disability Index; (6) Fear of falling index; (6) Tinetti Performance-Oriented Mobility Assessment; and (8) prospective monitoring of fall rates. RESULTS AND CONCLUSION: This is an ongoing study and preliminary results of the primary outcome measures along with patient satisfaction measures of the new training programs will be presented.

P2-M-152 The effect on functional balance and fear of falling using the Otago Exercise for the frail elderly: Group-based versus home-based intervention.

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BACKGROUND AND AIM: The Otago Exercise Programme (OEP) is an individually tailored home based strength- and balance- exercise-programme that has demonstrated success to decrease falls and improve functioning in older home-dwelling persons. Recent studies have demonstrated better effect of group- than home based exercise on functioning in older persons. The aim of the present study was to compare the effect of the OEP performed as group and home training in frail fall-prone older home-dwelling on balance, mobility, functional leg strength and fear of falling. METHODS: The study was a single blind randomized clinical trial with parallel groups with older fall-prone persons referred to an outpatient falls clinic. Participants (n=125) were allocated to OEP , delivered as group-based (GB) or home-based (HB) training. Group training was performed twice weekly in group of 4-8 persons and lead by a physiotherapist. Home training followed the OEP protocol including 4 visits by a physiotherapist. All participants were encouraged to perform at least 2 weekly outdoor walks. The exercise period lasted for 12 weeks. Balance was assessed by the Berg Balance Scale, mobility by the Timed Up-and-Go test, functional leg strength by a 30 second Sit-To-Stand test (STS) measured as number of trials and Fear of Falling by the 7 items Falls Efficacy Scale International (FES-I). Assessments were performed at baseline, following exercise intervention (3 months) and 3 months after ended training (6 months). Group differences in change were assessed by Analysis of Covariance, controlling for baseline values, and changes for each of the groups by paired sample t-tests. RESULTS: Ninety-one women (72,8 %) and 34 men (27,2%) participated. Mean age was 82.5 (±5.7) years and 58% lived alone. Mini Mental Status Examination score was 27.1(±2.3). Mean score at Barthel ADL Index was 17.9 (±2.3). Seventy-four percent had fallen and 37% had a hospital stay due to fall-related injuries previous year. Table 1 shows BBS , STS, TUG and FES-I scores at baseline and follow-up tests for both training groups. Both groups

improved functioning from baseline to 3 and to 6 months follow-up. There were group differences in change in favor of group training for BBS and STS from baseline to 3 months, and for STS and FES-I from baseline to 6 months. CONCLUSION: Both interventions improved functioning, and most effects persisted 6 months after start of intervention. Balance and functional leg strength improved more in GB compared to HB. Fear of falling was significantly lower for GB at 6 months follow-up. In frail home-dwelling persons OEP is even more effective performed as group training than home training.

	Baseline				3 months				6 months				Group differences in change (p-value)		
	Home training		Group training		Home training		Group training		Home training		Group training		0-3 months	3-6 months	0-6 months
	n	mean (SD)	n	mean (SD)	n	mean (SD)	n	mean (SD)	n	mean (SD)	n	mean (SD)			
BBS	63	35.7 (10.7)	62	34.6 (10.8)	46	41.3 (10.4)	46	43.4 (9.4)	39	41.5 (9.0)	39	42.1 (10.8)	**0.019**	0.608	0.365
TUG	62	18.9 (7.8)	59	19.3 (8.0)	41	15.0 (6.2)	44	14.5 (6.7)	39	15.5 (6.1)	36	13.8 (6.3)	0.076	0.555	0.055
STS	62	5.1 (4.4)	59	3.9 (4.5)	45	5.9 (4.3)	43	6.9 (5.1)	40	5.6 (4.3)	37	6.3 (5.7)	**0.006**	0.643	**0.029**
FES-I	56	13.1 (4.2)	56	13.5 (4.7)	44	11.4 (3.5)	44	10.7 (3.7)	38	11.2 (3.6)	37	10.3 (3.9)	0.128	0.294	**0.006**

BBS= Berg Balance Scale; TUG= Timed Up-and-Go; STS=30 second sit-to-stand test; FES-I= 7 item Falls Efficacy Scale International

P2-M-153 Implementation of fixed-point fall detection and activity monitoring algorithms for a wearable long-term monitoring sensor

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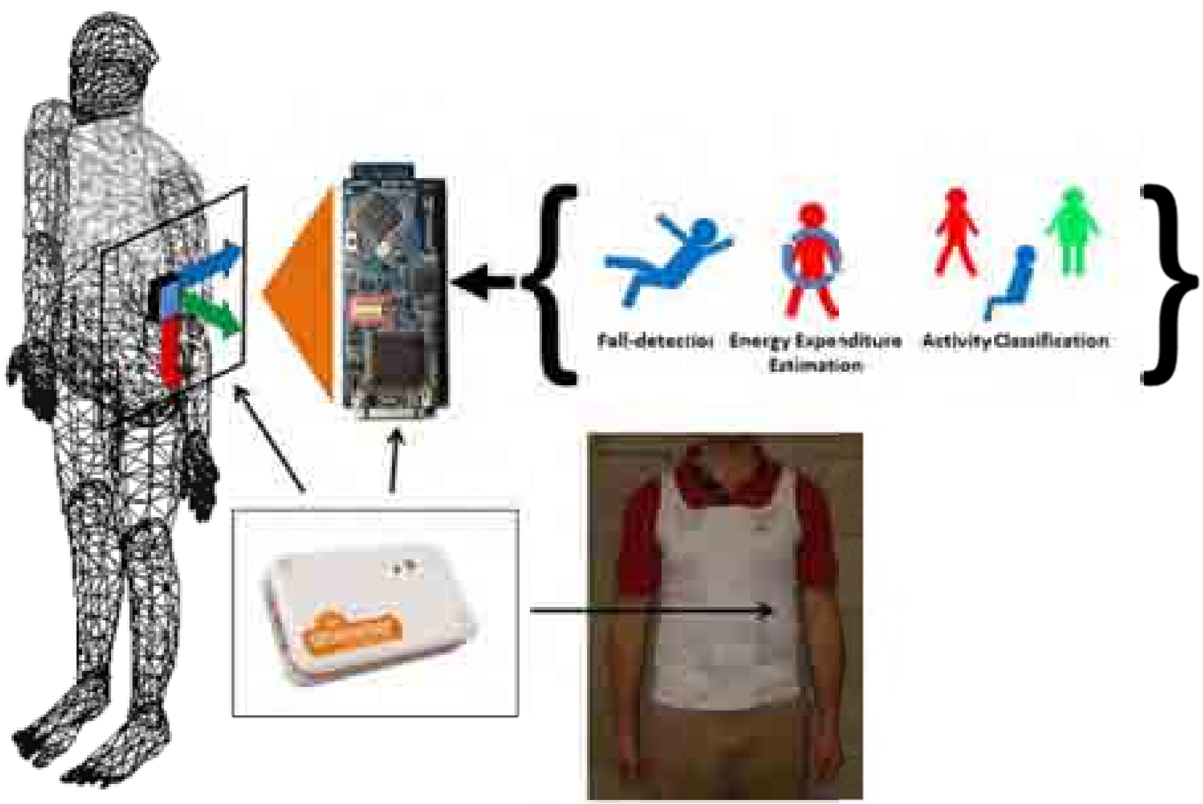
BACKGROUND AND AIM: The world's population is "greying", with the proportion of the world's population aged 65 and older is set to double to more than 1 in 5 by 2050. This demographic shift, is set to increase the load on health service provision. With the recent progress in wearable sensor technology and increased affordability, this has enabled the development of more inexpensive wearable health monitoring systems, which can reduce this projected burden on state and private health care services. Thus enabling and promoting independent living of older adults for longer. The development of algorithms for the classification of; the intensity and type of activity and the detection of falls, using body-worn tri-axial accelerometers (TA) have thus increased dramatically in the last 20 years. One project targeting an integrated health signs monitoring system for elderly people is the European Union, funded eCAALYX project (Enhanced Complete Ambient Assisted Living Experiment). As part of this system a sensor located at the left-under arm, embedded into a vital sign monitoring garment. This sensor, based on the SHIMMERTM sensor is capable of; detecting falls, monitoring mobility and providing an estimate of energy expenditure, Fig. 1. METHODS: A total of three trials were performed where a SHIMMER tri-axial accelerometer was attached to the left-under arm of the body. To develop the activity classification algorithm, a total of 8 older adults (77.2±5.38years) were recorded performing a set of 8 scripted, lying, sitting and walking activities and 6 older adults (77.2±5.38years) who were recorded over a period of 5 days each. In total of 171 hours or unscripted normal activities were

recorded as well as 192 scripted activities. To develop the fall detection algorithm a total of 10 young health volunteers ranging from 24 to 35 years (27.2±3.6years) performed a series of 8 different fall types in all directions, performed with both legs straight and knee flexion. An additional 4 normal activities were also recorded. The activities recorded in the first trial were also used to develop the fall detection algorithm. To develop the energy expenditure algorithm a total of 14 volunteers (>65 years) were recorded using the Oxycon Mobile portable metabolic system. Volunteers were recorded for a total of 2.5hours each performing a series of 10 free living physical activities or varying degrees of intensity. RESULTS: A fixed point implementation was adopted to increase the sampling rate to an acceptable 25Hz. A reduction in algorithm processing time was achieved through a fixed point low-pass and band pass filter implementation using a specific scaling factor. CONCLUSIONS: In conclusion we have developed a wearable sensor capable of real-time monitoring and the detection of falls, classification of normal activities of daily living and estimation of energy expenditure.



P2-M-154 The perceptions of general practitioners on falls prevention and the role of technology

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BACKGROUND AND AIM: Primary Care Teams provide the opportunity to address falls and falls prevention with a multifactorial approach including assessment, prevention, monitoring, and treating people who are at risk of falling within our community. Technology that can assess and monitor falls and the movement characteristics of people who are at risk of falling is being increasingly advocated in the literature. Currently, understanding the perceptions of clinicians regarding the use of technologies within the context of falls prevention is in its infancy. The aim of this exploratory study was to investigate the opinions of General Practitioner's (GP's) working in Primary Care Teams (PCTs) on the use of technology in the context of falls and falls prevention. METHODS: GP's from the Mid-Western region of Ireland were invited to participate in the study. Postal questionnaires were distributed to 135 GP's working within 33 PCTs. RESULTS: Thirty two questionnaires were completed and returned (response rate of 43.2%). The majority of respondents (78%) n=25 agreed that technology had a role in falls prevention (n=25), with over a third of the GP's responding positively about the use of use of technology as a means of assessing and monitoring people that are at risk of falling in the community. However, a number of respondents 44% (n=14) stated that they did not have experience or knowledge regarding technology that can be used for this purpose. A smaller proportion (22% n=7) responded negatively about the use of technology for this purpose, citing various reasons from cost-effectiveness, underdeveloped technology, lack of resources and older people "not into technology." Factors such as availability of the device and appropriate personnel to interpret the information provided by the device also require consideration. CONCLUSIONS: Despite the majority of the GP's agreeing that technology had a role in falls prevention, there appears to be gap between research and current practice. This is due to inadequate resources and communication, leading to inexperience and a lack of knowledge regarding the uses of technology in the context of falls prevention

P2-M-155 An interpretation of the gait behaviour in Parkinsonism

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BACKGROUND AND AIM: Bipedal gait is an exceedingl complex skill, with multiple degrees of freedom and a delicate balance between the rival needs for stability and far saving energy. Reducing degrees of freedom entails expending more energy but increases stability and lowers the risk of falling. Parkinsonian gait illustrates this. Degrees of freedom are reduced by eliminating pelvic and trunk rotation, with the result that neck and shoulder girdle are also immobile and there is therefore no arm swing to be controlled. With small steps and feet close together the force couple that would rotate the pelvis is reduced. In exteme cases only the legs are seen to move, and even their movement may cease as the patient approaches a turn or a doorway. This gait is not the result of limited joint movement or rigidity. METHODS AND RESULTS: In a study aimed to improve gait, 20 patients taught to use whole-body movements in walking and other activities showed a 40-50% decrease in performance times. But meeting these patients two years later revealed that three ahd started to fall. Maybe they would have an yway. But I began to suspect that what we see in a Parkinson patient walking (and what we ahd tried to change) may be not his problem but rather the solution, the compensatory and protective adaptation that enables him to get around without falling. Comparison with gait at the other end of the life cycle is

informative. Nothing could be more flexible than the trunk of a small child, but he walks like a Parkinson patient: nothing moves except the legs, there is no trunk rotation, no arm swing. In this he illustrates Bernstein's contention that skill acquisition begins with reducing degrees of freedom by massive joint fixation. Later, as coordination improves, the degrees of freedom cease to be a threat and their reactive forces can be used to produce the economical pattern and fluent turning of normal gait. CONCLUSIONS: Interpreting abnormal gaits as solutions to problems posed by pathology enables one to see the protective nature of Parkinsonian gait and to relegate the primary impairment to some more generalized distrubance of motor conrol. This, whatever it is, amkes walking as threatening for the Parkinson patient as it is for the young child or indeed for the healthy adult walking on a slippery surface, and the adaptive response is the same: to fix the trunk and take very small steps.

P2-M-156 The effects of vibrotactile biofeedback training on trunk sway in Parkinson's disease patients.

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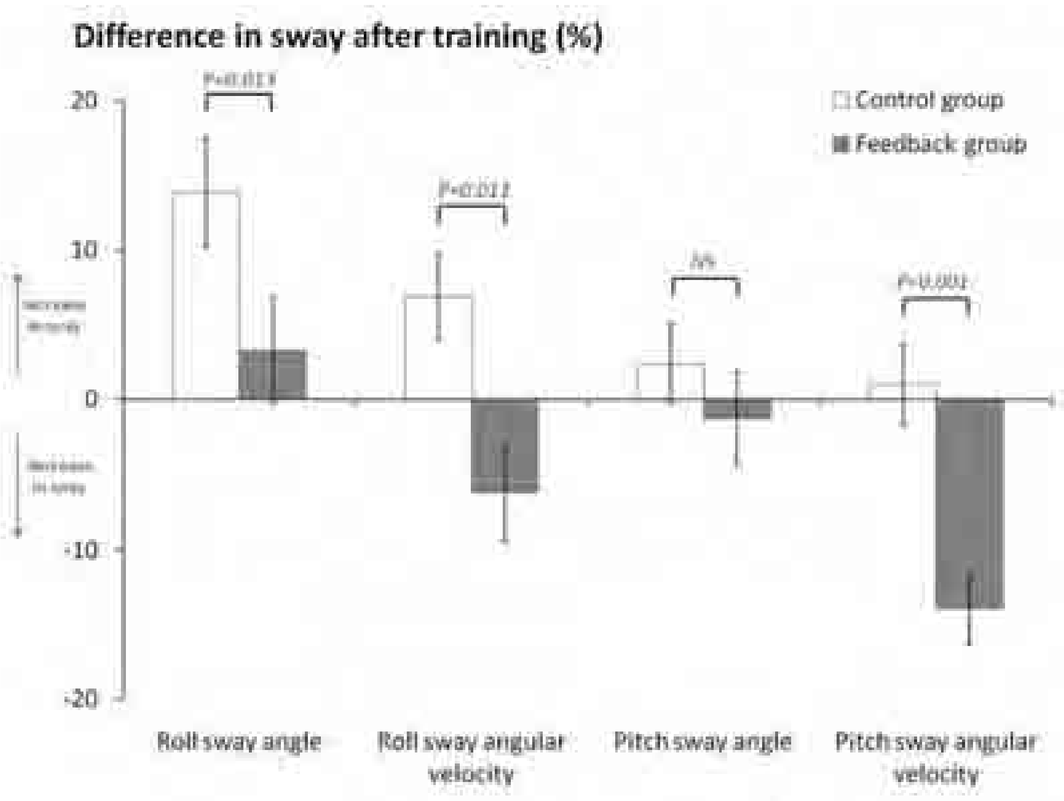
BACKGROUND AND AIM: Postural instability is one of the main features of Parkinson's disease (PD) and can lead to falls, resulting in major injuries and loss in quality of life [1]. Since measures of trunk sway provide useful information on balance deficits leading to falls in PD patients, additional information on trunk sway could be beneficial in an attempt to enhance balance in PD [2]. The aim of this study was to investigate the effect of a vibrotactile biofeedback intervention on trunk sway in PD patients, using an artificial biofeedback system that acts as a supplement to natural sensory inputs [3]. METHODS: Twenty patients with idiopathic PD were assigned to a control group (n=10) or a feedback group (n=10). First, all patients performed a set of 6 gait tasks and 6 stance tasks twice (pre-training assessment). Subsequently, all subjects repeatedly trained 6 selected tasks 5 times (balance training). Subjects in the feedback group received vibrotactile feedback of trunk sway at the head during training only. After the single training session both groups repeated all the twelve tasks without the biofeedback system (post-training assessment). During the tasks pitch and roll movements of the trunk were measured with a SwayStar© device. Vibrotactile biofeedback was provided using 8 vibrotactile sensors, spaced equally around a head band. The head band was connected to the SwayStar system and was active when sway velocity exceeded a threshold in the direction of a vibrotactile sensor. Main outcome measures were sway angle and sway angular velocity in the roll and pitch plane, and duration of the task. We calculated differences between pre- and post-training assessment measures, and compared these between the two groups. RESULTS: Overall, patients in the feedback group had a significantly greater improvement in roll (P=0.011) and pitch (P<0.001) sway angular velocity (Figure 1) with the greatest improvement (17%) in the trained tasks. Improvement was equal in stance and gait tasks. Moreover, roll sway angle increased more in the control group after training, indicating better training effects in the feedback group (P=0.013). CONCLUSIONS: Training balance in PD patients by means of a biofeedback system showed direct beneficial effects for one session of the training, compared to a group that trained on the same tasks without biofeedback. Further research should examine if these effects are increased after a more intensive or repeated training program and if there are long term carry-over effects.



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P2-M-157 Feasibility and tolerability of virtual rehabilitation programs on post-fall syndrome in elderly subjects

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BACKGROUND AND AIM: After a fall, physicians mostly focus on immediate injuries and on traumatic consequences, under-estimating it psychological consequences. Indeed, a fall can cause a real psychological trauma to elderly subjects. These different psychological consequences that may occur after a fall, as the loss of confidence, the impairment of body image or the insecurity that result can contribute to the emergence of a post-fall syndrome. This post-fall syndrome involves a motor component resulting in disorders of posture and gait and a psychological component. Psychologically, the presentation may be similar to a post-traumatic stress disorder (PTSD) with a major anxiety mostly during the standing phase. It can lead to severe psychomotor inhibition as if there was a blockage of all

the automatisms of balance and walking. The main risk of such an event is a loss of autonomy. METHODS: For over 20 years, virtual reality has been developed to treat various psychological disorders and PTSD. This could, on the same way, be used to treat post-fall syndrome. RESULTS: A post-fall syndrome represents a geriatric emergency. The virtual technology could intervene very quickly and at two levels: motor and psychological. For the motor part, the virtual system can permit a faster and more complete rehabilitation. It combines an interactive 3D virtual environment with traditional techniques of rehabilitation. Psychologically, the aim is that the patient exposed to a virtual environment has the illusion of being directly confronted to the traumatic experiment. This immersion in virtual reality could be ultimately more practical than the cognitive-behavioural therapy. But it is important to estimate the feasibility and tolerability of such techniques in elderly subjects. CONCLUSIONS: With this project, we will try to establish that a system with full immersion, well tolerated in elderly subjects, can be used to rehabilitate post-fall syndrome. The next step will be to prove that it can be useful in emergencies department, where, elderly person are often directly transported after a fall, which makes it the main support for such events. As to be reversible post-fall syndrome must be caught early in a specific way, virtual reality appears as an original support of work.

P2-M-158 Ankle-foot orthoses in the rehabilitation after stroke: the effect on falls

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BACKGROUND AND AIM: Ankle-foot orthoses (AFOs) are often used to improve gait and safety after stroke. However, evidence for long-term effects and research studying the effect of timing of providing AFOs after stroke is lacking. Therefore, we started a large longitudinal study in 2010, measuring the effects of AFO provision at different moments in time after stroke, including the effect of AFOs on falls. METHODS: Acute stroke subjects admitted to the rehabilitation centre are randomized for "early" AFO-provision (at inclusion) or "late" AFO-provision (8 weeks after inclusion). The measurements include dynamic gait analysis, clinical scales and questionnaires during 18 weeks with follow-up measurements at 26 and 52 weeks. As part of this longitudinal study the occurrence of falls were studied using diaries to compare subjects who trained with (early group) and without AFO (late group). "Falls" (falling on the ground) and "almost falls" (could grasp just in time) were discriminated including a description of the situation (where/how), whether or not the AFO was worn and possible injuries. Reports of falling were compared with related clinical scales (Berg Balance Scale (BBS) and Functional Ambulation Categories (FAC)). RESULTS: So far, 15 subjects completed the first 8 weeks of the study (early n=8, late n=7). Only 3 subjects did not reported (almost) falls. The other 12 subjects reported 13 incidents: 5 falls and 8 almost falls. Most of these reports were in the early group, see Table 1. At the same time the subjects in the early AFO group showed slightly higher levels of independence of walking measured with the FAC and higher levels of balance measured with the BBS (results not shown). All 5 subjects who fell did not use an AFO at the time of the fall. From the 8 almost falls that were reported, 3 occurred when wearing the AFO (by definition all 3 were in the "early" group) and 5 occurred when not wearing the AFO. The majority of the incidents (10 of 13) were reported in the bathroom (going to toilet/taking a shower) or bedroom (shifting from wheelchair to bed or vice versa) and resulted in bruises in some occasions. No

serious injuries were reported. CONCLUSIONS: AFOs are expected to improve safety and diminish falls. However, our first preliminary results show that most incidents were reported by subjects in the early group compared to the late group. Most incidents reported in the early group occurred while no AFO was worn. At the same time, the scores for independence of walking and balance were slightly higher in the early AFO group. These higher scores suggest a higher activity level in the early group which might explain the higher number of fall incidents. Future results of the longitudinal study should elucidate whether provision of AFOs at different moments in time after stroke affects the number of (almost) falls and whether or not these fall characteristics are associated with higher activity levels.

Table 1:
Number of (almost) falls reported in total and in the early and late AFO group

				randomization					
				early			late		
		AFO			AFO			AFO	
	total	with	without	total	with	without	total	with	without
almost fall	8	3	5	4	3	1	4	-	4
fall	5	-	5	4	-	4	1	-	1
total	13	3	10	8	3	5	5	-	5

P2-M-159 Considerations in determining stabilization times following a perturbation

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BACKGROUND AND AIM: Perturbations can cause movement of the center of pressure (COP), requiring a postural response to regain balance equilibrium. Investigating mechanisms of balance recovery has been an integral component of many research projects, although perturbations have generally been in the antero-posterior direction. Consensus on the methodology for determining time to reacquire balance has not been achieved. COP velocity and displacement are the most common measures evaluated and are generally compared with a baseline. Mazza et al. [1] proposed analysis methods to determine stabilization time (ST) for a multi-directional perturbation that examines mean COP velocity (MV) and 95% confidence circular areas (CA) within the trial, thus, not requiring a baseline. Current research aims are to investigate the impact of methodological factors. METHODS: Forty-five male participants aged 18-65 years maintained a forward kneeling position for 60s. An auditory signal prompted participants to stand up at a self-selected pace with feet shoulder width apart. Kinematic data were collected at 100Hz using a 12-camera infrared motion capture system. COP position data was sampled from two 40cmx60cm force plates at 100Hz. Twenty seconds of motion and force data were filtered using zero-lag 4th-order low-pass Butterworth filters at 8Hz and 6Hz, respectively. Participants

completed 3 replications with at least 1 minute of rest between trials. Analysis methods using MV and CA were based on those presented by Mazzà et al. [1]. ST was determined when the measure of interest within a 100-frame sliding window, incremented one frame at a time, was below the mean of windows encompassing the rest of the trial. RESULTS: An ANOVA using mixed models indicated a significant effect of analysis method. ST was significantly shorter (p<0.001) when using the analysis method based on CA (STCA=3.35s) as compared to MV (STMV=5.24s). Furthermore, STCA was consistently smaller than STMV for each trial. Variability in ST was also smaller using CA with a coefficient of variation equal to 42%, as compared to 45% for MV. CONCLUSIONS: A plethora of research has investigated balance recovery mechanisms. Much of this research examined initial reactions to perturbations, although attempts have been made to quantify length of time necessary to reacquire balance. A number of factors must be considered when defining balance in these circumstances. Results of the current research have shown that MV and CA do not produce equivalent ST. By definition, CA is not as sensitive to short-term deviations in displacement, thus making it less susceptible to movements later in trial not related to initial perturbation. Conclusions cannot be drawn, however, regarding appropriateness of one method over the other since many factors need to be considered when determining ST and suitability should be determined based on the application being explored.

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P2-M-160 Application of the six meter narrow base walk test to identify elderly fallers

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BACKGROUND AND AIM: Age-related changes in frontal plane stability during walking are associated with impaired balance and increased fall risk in older adults. Narrow base walking requires increased frontal plane stability, and adding a concurrent cognitive task (dual task) may further challenge stability, potentially allowing identification of older adults fallers that are not detected under single task conditions. The purpose of this study was to assess the use of the six meter narrow base walk test to identify fallers. METHODS: Ninety-two healthy adults participated in a cross-sectional study from two self-care, residential facilities. Thirty-four subjects reported at least one fall at the past year, and 58 were non-fallers. Participants walked at their own selected comfortable pace within a narrow path (6 m' long) under both single and dual task conditions. To produce a similar challenge for individuals with different body morphologies the width of the path was normalized to 50% of (the distance between the participant's anterior superior iliac spines + the width of the subject's shoe). Participants performed 3 trials in each condition: three single task trials and 3 dual tasks (i.e. 3 different cognitive tasks). All trials were videotaped for later analysis of the results. The average trial time and trial velocity, the average number of steps and the average steps errors that represent frontal plane instability (e.g. stepping outside the walking path) and cognitive task errors during single and dual task conditions were calculated. RESULTS: We found a statistically significant difference between non-fallers and fallers in the average trial time and trial velocity under the single task condition (8.9±3.5 sec vs. 10.9±4.1 sec, p=0.017; and 0.7±0.2 m/s vs. 0.6±0.2 m/s, p=0.028, respectively). There was no significance difference in

the average number of step errors during single task condition. Adding cognitive load to the six meter narrow base walking Test revealed statistically significant differences between non-fallers and fallers in the average number of steps, trial time and trial velocity (15.9 ±3.3 vs. 17.5±4.4, p=0.05; 13±6.3 sec vs. 16.5±6.8sec, p=0.018; and 0.5±0.1m/s vs. 0.4±0.1m/s, p=0.018, respectively). There was trend significance in the average number of step errors during dual task walking between non-fallers and fallers (5.98±4.2 vs. 7.8±5.8, p=0.09, respectively). CONCLUSIONS: The study provides evidence that a simple, safe measure of balance function, the six meters narrow base walking test can identify older adults who fell recently. The addition of a concurrent cognitive task results in reduced speed in both groups. The added value of dual task for fall prediction is still questionable. There was trend to significance in the frontal plane instability (e.g. step errors) during dual-task but not during single task condition in fallers vs. non fallers

P2-M-161 The development of a new analytical approach to quantifying obstacle negotiation abilities based on empirical mode decomposition

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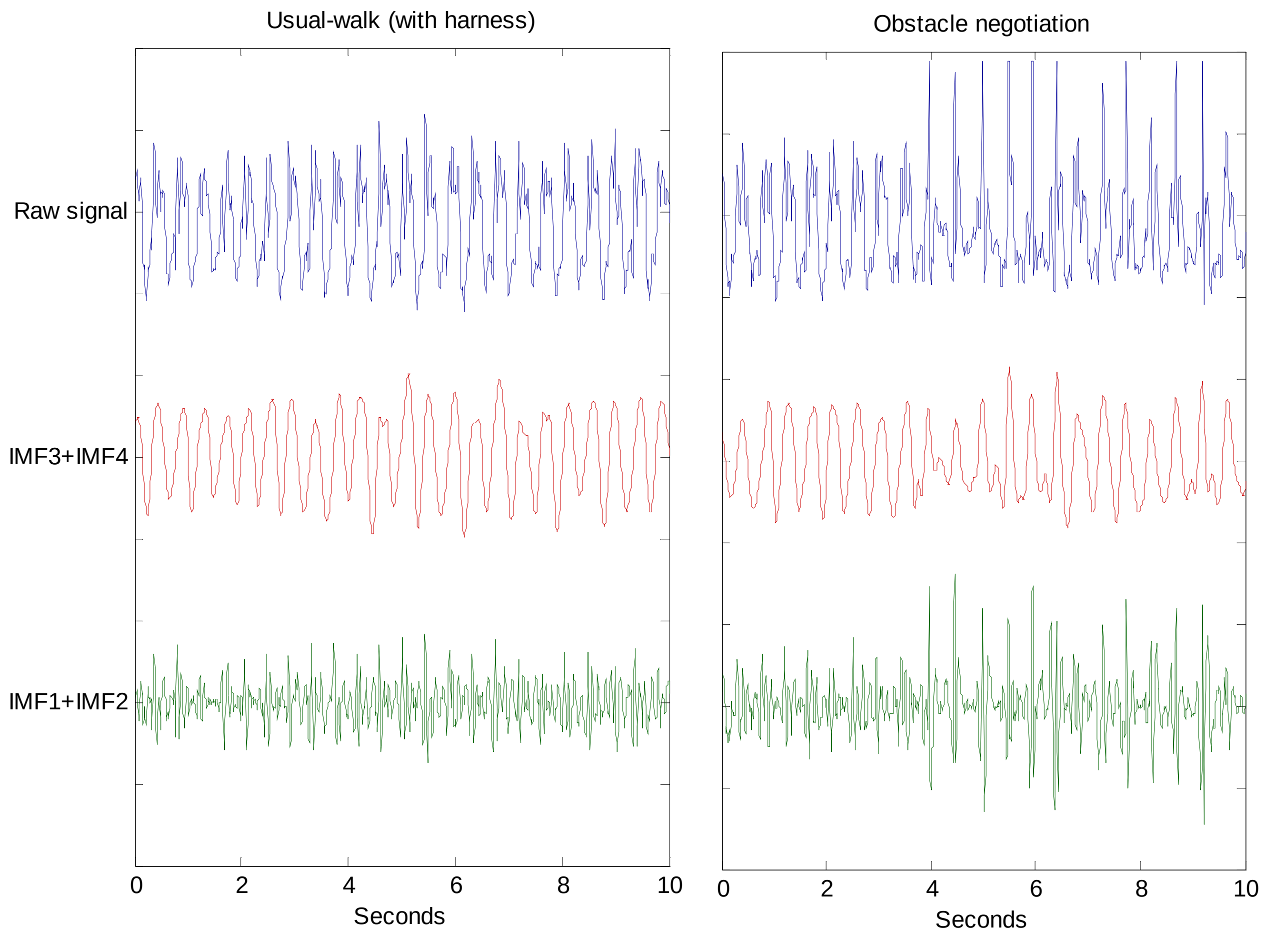
BACKGROUND AND AIM: The ability to safely navigate obstacles has been associated with fall risk among older adults. However, testing of obstacle avoidance capabilities in the laboratory setting is hampered by the fact many of the traditional measures of gait and balance are not applicable. The empirical mode decomposition (EMD) technique is a powerful tool that has been applied to the analysis of nonlinear and non-stationary data. Given the non-stationary nature of walking while dealing with obstacles, we speculated that the EMD may be helpful in quantifying locomotor stability. The goal of the present work was to develop a method of quantifying obstacle negotiation abilities among older adults, based on measurements of a single body-fixed sensor worn. METHODS: 36 subjects were studied: 15 (mean age: 78 yrs) had a history of two or more falls in the past year (fallers) and 21 (mean age: 78 yrs) reported no falls in the past year (controls). Subjects completed a usual-walk with or without harness and obstacle course walk with a harness while wearing an accelerometer on the lower back (each about 1 minute). With the EMD technique, the acceleration signal was decomposed into a complete set of "intrinsic mode functions" (IMFs) based on the local characteristic time scale of the data. This adapts (self-fitting) to the data in a highly efficient manner, with minimal a priori assumptions. Based on the dynamical patterns of the IMFs, we concluded that IMF3 and IMF4 represent the dominant oscillatory pattern of the stride, while IMF1 and IMF2 represent faster modulations within the step. We observed a possible balance of the "energy" distribution among these two components during normal walking. Furthermore, with unsteady strides, more energy appears to be distributed toward the IMF1 IMF2 (faster modulation within each step) and less energy to the dominant oscillatory pattern. A new Step Stability Index (SSI) was defined: SSI = (SD of IMF3 SD of IMF4) / (SD of IMF1 SD of IMF2), assuming that higher SSI value indicates a more stable step pattern. RESULTS: The SSI index was higher in the controls in all walks. During usual-walking, the SSI was higher (p=0.013) in the controls (1.795) than in the fallers

(1.473). During obstacle negotiation, the SSI index became lower in 20 of 21 controls ($p<0.001$) and 14 of 15 fallers ($p=0.01$), consistent with the possibility of less stable walking during obstacle negotiation. An example of the IMF under these two conditions is shown in Figure 1. Interestingly, the group differences in the SSI became stronger during obstacle negotiation (controls: 1.438; fallers: 1.162; $p=0.005$), consistent with the possibility that the fallers have more difficulties with obstacle negotiation. CONCLUSIONS: These preliminary results suggest that an approach that combines an accelerometer with an algorithm based on the EMD method may have utility in evaluating obstacle negotiation abilities and fall risk among older adults.

Figure 1: Comparison of intrinsic mode functions (IMF) during portions of usual-walk (with harness)



(left) and during obstacle negotiation (right).

P2-M-162 Clinical balance assessment: Perceptions of current measures and practices among physiotherapists in Ontario, Canada

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BACKGROUND AND AIM: Assessment of balance in the clinical setting is important for identifying impairments, treatment planning, and evaluating change over time. While a plethora of measures exist, little information is available regarding how clinicians perceive available balance assessment tools and whether they are satisfied with their current ability to assess balance. The purposes of this study were to evaluate the perceived utility of commonly used standardized balance measures, explore satisfaction with current balance assessment practices, and identify factors associated with satisfaction. METHODS: A cross-sectional survey was conducted. A questionnaire was mailed to 1000 practicing physiotherapists in Ontario, Canada who treated adults with balance impairments. The questionnaire asked respondents to rate the utility of balance assessment tools, whether they wanted to improve their ability to assess various components of balance, and what influenced their ability to assess balance. RESULTS: Three hundred sixty nine individuals completed the questionnaire. The respondents reported high utility of the most commonly-used measures; over 80% of respondents indicated that the Single Leg Stance test and Berg balance scale were useful for clinical decision making and evaluating change over time, while the Timed Up-and-Go test was rated as useful for decision making by 66% of respondents and useful for evaluating change over time by 78% of respondents. In spite of these findings, 79% of respondents also reported that they wanted to better assess standing balance, and 83% of respondents wanted to better assess reactive postural control. Lack of time was the most frequently cited factor influencing assessment of standing balance (62% of respondents), while lack of knowledge was the most frequently cited factor influencing assessment of reactive postural control (58% of respondents). CONCLUSIONS: Although Ontario physiotherapists reported that commonly used balance measures are useful, they expressed a desire to do better. Numerous factors influenced current assessment practice, which should be addressed in the development and implementation of any new assessment tools in order to optimize uptake in clinical practice.

P2-M-163 A novel perspective on conventional experimentation models: standardizing response type rather than perturbation

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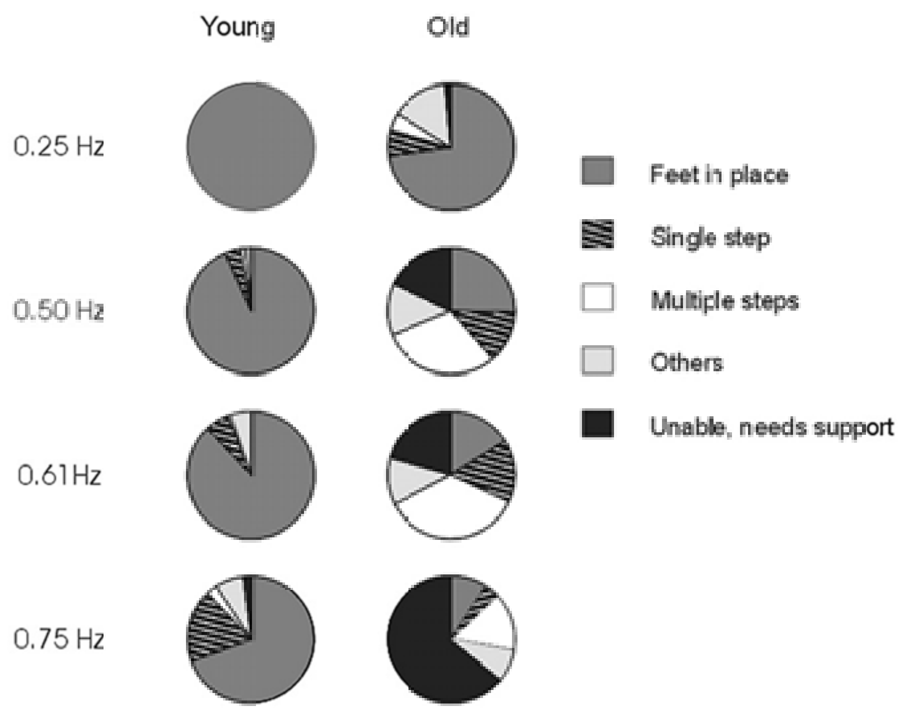
BACKGROUND AND AIM: Hypothesis-driven studies of postural responses to a perturbation use two main conventional experimentation models: detection of the perturbation threshold for a certain response type, such as taking a step [1], and observation of the execution characteristics of one such response type [2]. The latter model requires accurate standardization of the perturbation across conditions and/or populations [3]. Neither of these models is sufficient for clinical assessment of execution characteristics of one response type. The aims of this study were to clarify the inherent limitations of each model, and to investigate implementation of a new model by standardizing response type rather than perturbation characteristics. METHODS: We revisited data from a previous study in which stepping responses to termination of continuous oscillation of support surface were compared between young (n= 15, 24±2.2 yrs) and old (n= 15, 70.1±5.9 yrs) adults [4]. Response types to different

oscillation frequencies were examined for agreement between groups and consistency within groups. These data helped conceptualize a new experimentation model. Various practical and clinical implications of the new model were reviewed. RESULTS: Young adults stepped at 0.75 Hz while older adults at 0.5-0.61 Hz (fig. 1), and variation between subjects indicated that in order to observe stepping there is a need for individualized threshold detection. The variation of responses within subjects indicates the need for probabilistic threshold detection. This suggests a benefit from standardizing response type whilst modifying perturbation characteristics. Consequently, combining individualized threshold detection to quantify individual destabilization with subsequent execution observation to quantify population-based variations in responsive capabilities comprises an improved experimentation model. This new model aligns closely with clinical diagnostic assessment [5]. CONCLUSIONS: The proposed new experimentation model can help scientists/clinicians in developing comparative experiments when responses are varied within and between groups as well as probabilistic in nature. Future challenges are in identifying ordinal rather than binary response types. Initial work with a psychophysical threshold detection algorithm has produced promising results.



ACKNOWLEDGEMENTS:
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P2-M-164 Influence of sensorimotor and cognitive factors on the balance recovery: A numerical approach

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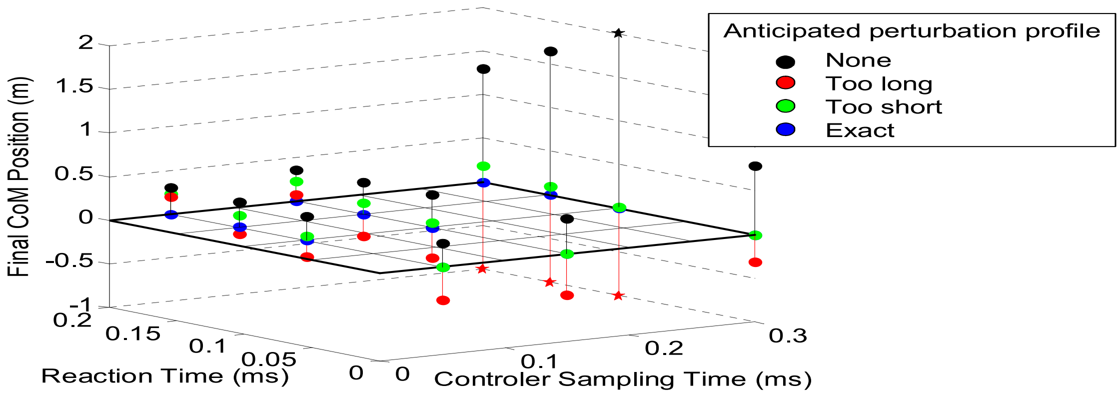
BACKGROUND AND AIM: Falls are currently one of the first cause of death among elderly and a major public health issue. However, so far little is known about the actual biomechanical or cognitive mechanisms leading to a fall. This study focuses on the influence of sensorimotor and cognitive factors on the ability to recover from a perturbation. Its particular goals are 1) to evaluate the capacity of a simulation tool to emulate different kinds of balance recovery reactions when sensorimotor and cognitive factors are modified; 2) to quantify the influence of these factors on the simulated recovery. METHODS: The balance recovery simulation tool consists of a mechanical model of the human body, reduced in 2D for this study, and a controller. Each time it is called, this controller estimates the appropriate recovery reactions over a time horizon from the state of the mechanical system. These reactions are then applied to the mechanical system. They can be a displacement of the center of pressure within the base of support and/or recovery steps (where and when to place the foot for one or multiple recovery steps, considering limitations on the foot dynamics).The use of upper body inertia could be considered but were not included in this study. Ability of this tool to correctly reproduce human recovery reactions was shown for single or multiple recovery steps in tether-release conditions.:The perturbation considered in this study was a semi-sinusoidal backward acceleration of the base of support (600 ms duration and peak acceleration of -4 m/s²). Steps duration could be chosen by the controller between 100 and 300 ms. Three factors, potentially affected by ageing, were manipulated: the reaction time, i.e. the delay between the onset of the perturbation and the first call of the controller; 2) the frequency at which one can re-plan a recovery action, i.e. the delay between each call of the controller; 3) the a priori knowledge of the perturbation profile, that is included in the choice of the balance recovery reaction. RESULTS: The resulting kinematics varies largely according to these factors, from a very efficient recovery to backward or forward falls (see Figure). Typically, anticipatory reactions can be emulated, typically resulting in backward motions of the CoM at the very beginning of the simulation pre-empting on the foreseen forward motions. On the other hand, wrongly planned perturbations may result in a degraded balance recovery capacity. Typically, if the foreseen perturbation is too long, the system overreacts, inducing in some cases a fall backward. CONCLUSIONS: This simulation tool is still a bit simplistic and the obtained results need to be validated against experimental data. However, it allows emulating interesting and realistic behaviours, and appears as an interesting candidate for a better understanding of the balance recovery mechanisms.



Recovery distance (position of the CoM at the end of the recovery) as a function of the reaction time and the controller sampling time, for different a priori knowledge of the perturbation: none, a too short or too long perturbation profiles (300 ms or 900 ms respectively instead of 600 ms) but with the correct shape and peak acceleration, or an exact perturbation profile. Stars instead of dots indicate unsuccessful recoveries (falls).

N - Cognitive Impairments

P2-N-165 Balance, parkinsonian signs and falls in persons with Alzheimer's disease

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BACKGROUND AND AIM: It has been reported that persons with Alzheimer's disease (AD) fall more frequently, have more impaired balance and parkinsonian signs than healthy elderly [1-3]. The relationship between parkinsonian signs and balance remains unexplored in persons with AD. The purpose of this study was to examine the relationship between balance and parkinsonian signs in community dwelling persons with AD. We also wanted to look at which motor tests could distinguish fallers from non-fallers. METHODS: The study had a cross-sectional design. A convenience sample of 20 community dwelling persons with AD was included from geriatric units at two hospitals in Norway. The patients had no other medical conditions known to cause balance impairments and did not use any neuroleptic medication. Balance was measured by Berg Balance Scale (BBS) and the motor examination from the Unified Parkinson's Disease Rating Scale (UPDRS) assessed parkinsonian signs. Scores for the UPDRS gait and posture items were omitted from the UPDRS motor examination score to avoid collinearity with BBS due to overlapping constructs. Mini Mental State Examination (MMSE) was used to evaluate global cognitive dysfunction. Falls were recorded retrospectively by interview with the patient and a close relative. Descriptive statistics were used to provide means and distribution, Pearson's correlation coefficient was used in the bivariate analysis, and multiple regression analysis determined the variable that accounted for variance in the BBS. Mann-Whitney U test was used for analysis between fallers and non-fallers. Statistical significance was set to $p = 0.05$. RESULTS: Mean age was 80.3 years (SD 7.4), 50 % were female and 50 % had fallen the previous year. A wide range in AD severity was reflected in the MMSE score ranging from 7-28 points, median 19.5 points. Mean BBS was 48.8 points (SD 6.4), mean UPDRS motor examination score was 18.5 points (SD 7.3). BBS was associated with the UPDRS motor examination score ($r = -0.49$, $p<0.05$), and also with age ($r = -0.46$, $p<0.05$). The association between BBS and the UPDRS motor examination score remained significant ($p=0.03$) when adjusted for age, and this model explained 33% of the variance in BBS. The fallers had a worse score on the UPDRS gait and posture ($p=0.013$) and a lower MMSE score ($p=0.04$) than the non-fallers. The fallers also walked slower ($p=0.07$) and had lower BBS score ($p=0.15$) but these measures did not reach level of significance. CONCLUSIONS: Examination of parkinsonian signs may contribute to the understanding of both balance dysfunction and falls in persons with AD. Studies with larger samples and prospective fall recordings are needed to explore these findings further.

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P2-N-166 The effects of multicomponent exercise on gait performance among older adults with mild cognitive impairment: A randomized controlled trial

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BACKGROUND AND AIM: Mild cognitive impairment (MCI) is considered as a prodromal of Alzhimer's disease (AD) and, the early intervention for MCI is a crucial preventive strategy for preventing AD [1]. Exercise program including enhancement of physical activity has recently been developed for elevating cognitive function among older adults with cognitive impairment. We have also developed multicomponent exercise (ME) for the purpose of enhancing cognitive function in MCI. However, benefits of ME for gait performances among MCI were still unclear. The aim of this study was to investigate the effects of ME program on gait performance in a randomized controlled trial. METHODS: Subjects were 100 older adults with MCI fulfilled Peterson's criterion (age: 75 ± 7 yrs, men: 51) and randomly allocated to intervention group and control group. Intervention group conducted ME, 90-minutes twice a week, 40 sessions during 6 month. ME included aerobic exercise, balance training, walking and dual-task exercise. We assessed gait performance at baseline and after 6 month intervention. Gait analysis was conducted using a miniature tri-axial accelerometer attached to the L3 spinous process and on 11-m walkway under two conditions; normal walking (NW) and dual-task walking (DTW), walking while backward counting. The outcome was gait speed, stride length, harmonic ratio (HR) indicating smoothness of trunk movement. To investigate the effects of intervention, we conducted an analysis of covariance for each gait parameters (covariates: sex and gait speed). Statistical significance was set at $p < 0.05$ a priori. RESULTS: There were no differences of subjects' characteristics and all of gait performances between groups at baseline. The effects of ME was significant for stride length, HR in anteroposterior and HR in vertical under both NW and DTW conditions ($p < .05$), although gait speed under both NW and DTW conditions was not improved. CONCLUSIONS: Our study demonstrated multicomponent exercise had benefit for enhancement of stride length and trunk smoothness during not only normal walking but dual-task walking. The effects of multicomponent exercise may be selective for gait parameters. To generalize the availability of multicomponent exercise, appropriate intensity, frequency and duration should be further investigated.

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P2-N-167 A comparison of cognitive and manual dual-task challenges on gait in people with Mild Cognitive Impairment: A cross-sectional study.

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BACKGROUND AND AIM: Gait impairment is an important risk factor for falls in older adults and is a prevalent feature among older adults with cognitive impairment. Assessing gait parameters using the dual-task paradigm, using a secondary cognitive or manual task, is an accepted way to evaluate the interaction between cognition and mobility. Dual-task testing also provides a valid means to identify fall

risk in older adults by exposing mobility deficits. Comparative studies on differential effects by the type of dual-tasks have been restricted to the influence of different cognitive tests on gait performance. The objective of this study was to evaluate the effect of manual and cognitive dual-task challenges on gait performance in people with Mild Cognitive Impairment (MCI). METHODS: Cross-sectional study of 57 adults with MCI (mean age=75.4 (6.4)) recruited from a memory clinic at a university hospital and 25 cognitively normal controls (mean age=71.5 (4.1)). Gait was assessed using an electronic walkway under single, dual-task (counting backward from 100 by ones, counting backwards from 100 by sevens, and carrying a glass of water) and multi-task test conditions. Gait velocity and dual-task cost were the main outcome measures. To assess the effect of cognitive group and walking condition, an adjusted repeated measure ANOVA was performed. RESULTS: Gait velocity was significantly slower in the group with MCI under all task conditions. The manual dual-task of carrying a glass of water confers a challenge not different from the cognitive dual-task of counting backwards by ones while walking for people with MCI and normal cognition. Performance of the more complex cognitive task of serial seven subtractions produced a significant reduction in gait velocity in both groups, but there was a greater dual-task cost in the MCI group at 31.8%. Dual-task costs are additive under simple manual and cognitive challenges. The addition of the simple manual task to serial seven subtraction while walking did not add to dual-task gait costs but did negatively affect the cognitive performance in people with MCI. CONCLUSIONS: This study has demonstrated that not all dual-task challenges are equivalent with respect to their ability to challenge an individual and identify deficits. This lack of interchangeability of tasks, between manual and cognitive secondary tasks and among cognitive tasks, is important for translating research into clinical practice by providing a framework for a graded progression of task difficulty.

P2-N-168 Falls and fall risk factors in older persons with mild to moderate intellectual disabilities

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BACKGROUND AND AIM: Falls and fall related injuries occur more often in persons with Intellectual Disabilities (ID) compared to the general population. Little is known about the risk factors for falls in persons with ID. The aim of this study was to prospectively study falls and fall risk factors in elderly persons with mild to moderate ID. METHODS: Ninety older persons with mild to moderate ID were included (mean age 62.5 (SD:7.6) years) in the study. Possible risk factors for falls were derived from comprehensive baseline assessments. Motor performance was measured by the Berg Balance Scale, Timed Up and Go Test, Single Leg Stance, Functional Reach and 10 meter walk test. Furthermore, assessments on behavior, social and cognitive level were performed. Falls were prospectively monitored for one year with monthly fall calendars and weekly diaries. When a fall occurred, circumstances and consequences of falls were collected with a fall incidence questionnaire. The baseline assessments of the fallers and non-fallers will be compared in order to identify risk factors for falls in persons with mild to moderate ID. RESULTS: Falls were registered by 82 persons of which 37 experienced a fall (range: 1-6 falls). The fall rate was 1.03 falls/person year. Falls usually occurred in a familiar environment (89%),

during the day (73%) and more often outside the house (63%). Most falls occurred during walking (60%), mainly because of tripping, slipping or loss of balance. The clinical measurements on motor performance were feasible. Persons with ID performed significantly worse than the general population on all tests. Final analyses to identify the contributing risk factors for the falls in persons with ID are currently being conducted and will be available at the time of the conference. CONCLUSIONS: This study showed that it was possible to prospectively monitor falls in elderly with mild to moderate ID and to conduct several clinical balance and gait tests to identify risk factors for falls. The results show that fall rate is increased in this population compared to healthy elderly. The contributing fall risk factors are currently being determined, and will help in the development of appropriate interventions to prevent falls in persons with ID.

P2-N-169 Gait analysis: An objective measurement for grading and subgrouping fibromyalgia patients

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BACKGROUND AND AIM: Given the heterogeneity of fibromyalgia, frequently associated with cognitive impairment; and the interconnection between motor control of gait, affect and cognitive functions, we assumed that gait-derived markers could be altered differently in fibromyalgia. This study aimed at characterizing gait disorders in fibromyalgia, looking for correlations between gait markers and psychometric measurements, and subgrouping fibromyalgia patients according to gait markers: stride frequency, stride regularity, and cranio-caudal power which measures kinesia [1, 2]. METHODS: A multicentre, observational open trial enrolled patients with primary fibromyalgia, and matched controls. Outcome measurements and gait analyses were available for 52 pairs. A 3-step statistical analysis was carried out: a blind k-means cluster analysis of gait markers, an open descriptive analysis of gait markers and psychometric measurements, and a cluster analysis of each gait marker. RESULTS:Stride frequency was the most discriminating gait variable (73% of patients and controls). Stride frequency, stride regulatity and cranio-caudal power were different between patients and controls. There was a non-significant association between stride frequency, fibromyalgia impact questionnaire and physical components Short-Form 36 ($p=0.06$). Stride regularity was correlated to fibromyalgia impact questionnaire ($p=0.01$) and catastrophizing ($p=0.05$) while cranio-caudal power was correlated to pain ($p=0.01$). The stride fequency cluster identified 3 subgroups with a particular one characterized by normal stride frequency, low pain, high activity and hyperkinesia. The stride regularity cluster identified 2 distinct subgroups: the one with a reduced stride regularity was distinguished by high fibromyalgia impact questionnaire, poor coping and altered affective status. CONCLUSION: Gait analysis could provide an objective measurement in fibromyalgia, and may be useful in the subgrouping and follow up of fibromalgia patients. Further research is needed in order to better understand gait analysis implications in FM.

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P2-N-170 The effect of rhythmic auditory cueing on temporo-spatial gait measures and gait variability in people with Alzheimer's disease

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BACKGROUND AND AIM: Rhythmic auditory cueing has been shown to improve temporo-spatial gait measures and gait variability in various clinical populations. Increased gait variability is associated with increased risk of falling. Slowed and more variable walking due to Alzheimer's Disease (AD) may be modifiable using this approach. The aim of this study was to evaluate whether rhythmic auditory cueing alters temporo-spatial gait measures and gait variability in people with AD and whether different cue types produce different effects. METHODS: Twenty-one people (M=13, F=8, 77.7±8.2 years) with AD (MMSE range 8-28) walked on an electronic walkway in time to (i) rhythmic music and (ii) a metronome set at their mean self-selected comfortable speed cadence. Gait measures were velocity (cm/s), stride length (cm) and swing time (s), and variability was calculated using coefficient of variation (CV). Uncued baseline, cued and retest measures were compared using a one-way repeated measures ANOVA. RESULTS: Significant effects for cue condition with large effect sizes occurred for gait velocity ($p = 0.005$, partial eta squared = 0.50), stride length ($p = 0.003$, partial eta squared = 0.52) and stride length variability ($p = 0.003$, partial eta squared = 0.53). Post hoc tests using the Bonferroni correction showed significant decreases compared to baseline with both music and metronome cues in velocity (Baseline = 111.9±28.9, Music = 103.2±30.5, Metronome = 104.7±30.0) and stride length (Baseline = 122.0±22.9, Music = 111.9±23.8, Metronome = 113.5±25.3). There was a significant increase in stride length variability compared to baseline only with music cues (Baseline CV = 3.7%, Music CV = 5.8%). Swing time and swing time variability did not differ significantly from baseline with either cue type or at retest. CONCLUSIONS: Rhythmic auditory cueing produced shorter strides, slower walking and increased spatial variability in this group of people with AD suggesting it may behave as a secondary, competing task for this group. Participants found similar difficulties with both simple beat and more complex rhythmic music cues. The effects did not persist at retest. Further work is required to show whether rhythmic auditory cues might be used to elicit dual task gait training effects in people with dementia.

P2-N-171 Freezing of gait and cognitive deficits in visuospatial perception and reasoning in Parkinson's disease subjects.

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BACKGROUND AND AIM: Freezing of gait (FOG) is considered as one of the most disabling features of advanced Parkinson's Disease (PD). It has been reported that freezers have higher stride-to-stride variability and walk with less rhythmic and symmetric cycle than non-freezers (Hausdorff et al., 2003; Plotnik et al., 2005). We have recently documented this relationship using a novel quantitative measure of freezing from a stepping in place (SIP) task (Nantel et al., 2011). Also, it has been suggested that, contrary to healthy subjects, PD subjects may require cognitive resources to generate efficient stepping (Plotnik et al., 2009, Yogev et al., 2007). Specifically, executive dysfunction has been correlated with higher scores on the FOG questionnaire (FOG-Q). Finally, external visual cues can restore the act of stepping and walking (Nieuwboer et al., 2007), which suggests that mechanisms underlying FOG may be connected with visuospatial perception/processing. The aims of this study were to investigate whether freezing is related to the executive and/or visuospatial cognitive functions and assess the relationships between these functions and the SIP cycle symmetry and rhythmicity. METHODS: Thirty PD subjects and fifteen healthy age-matched controls participated in the study. The clinical evaluation included: The Unified Parkinson's Disease Rating Scale (UPDRS) III, (motor disability), the FOG-Q and a comprehensive neuropsychological evaluation, including the Trail making B (TMTB), the Wisconsin card sorting (WCST), the Initiation/Perseveration Dementia Rating Scale-2, and measures looking at visual spatial skills (perception and construction), such as the Matrix Reasoning (WASI subtest) and the Block Design. SIP rhythmicity and symmetry using three, 100 s trials of alternative stepping while standing on two force platforms were performed by both PD and control subjects. PD subjects were off their medication for this latter evaluation. RESULTS: FOG-Q total score was higher in freezers compared to non-freezers ($P<0.001$). Compared to controls ($P<0.001$) and non-freezers ($P<0.001$), freezers had larger cycle asymmetry and arhythmicity ($P<0.05$), Table1. Only the Block Design and Matrix reasoning could discriminate between freezers and non-freezers for both ($P=0.01$), Table 1. Arhythmicity showed negative correlations with the five cognitive tests. The highest correlations were found for Block Design ($r = -0.57$, $P < 0.01$) and Matrix Reasoning ($r = -0.56$, $P < 0.01$). Initiation/perseveration ($r = -0.49$), TMTB ($r = -0.47$) and the WCST ($r = -0.42$) were also significantly correlated ($P < 0.05$). Asymmetry negatively correlated with Block Design ($r = -0.44$, $P < 0.05$). CONCLUSION: Neurocognitive tests related to visuospatial function had higher correlations with arhythmicity and asymmetry and differentiated freezers from non-freezers in PD, while deficits related to executive function did not. Organizing visual information might trigger FOG episodes.

TABLE 1. SIP cycle parameters for control, non-freezer and freezer subjects, and neurocognitive tests for non-freezer and freezer subjects

	Controls (n=15)	Non-Freezers (n = 8)	Freezers (n = 16)	P values
Mean stride duration (s)	111.4±15.7	101.0±25.0	90.3±14.4†	**0.003**
Arhythmicity	2.96±0.83	3.38±1.18	8.18±5.49†‡	**<0.001**
Asymmetry	4.43±2.29	6.08±3.08	10.99±5.91†‡	**<0.001**
Block design	-	60.6±6.7	51.4±8.3‡	**0.01**
Matrix Reasoning	-	64.0±3.7	51.1±13.3‡	**0.01**
Initiation/ Perseveration	-	36.6±0.7	35.1±3.2	0.38
Trail-making B	-	49.1±10.1	44.2±12.0	0.33
Wisconsin card sort	-	0.07±0.04	0.04±0.03	0.11

† Different from controls ‡ different from non-freezers

O - Habilitation and Rehabilitation

P2-O-172 Prosthetic-limb ankle kinetics and energy storage and return when using a hydraulic ankle device in unilateral trans-tibial amputees.

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BACKGROUND AND AIM: Dynamic-response prosthetic feet typically have carbon-fibre heel and forefoot keels. Their deformation simulates ankle motion: i.e. deformation of the heel keel during loading response (1st rocker) simulates plantarflexion while deformation of the forefoot during 2nd rocker, simulates dorsiflexion. Energy stored as the heel and forefoot keels are deformed is returned aiding progression and push-off respectively. Traditionally such feet have a rigid attachment to the shank.

Recently, an ankle device has been developed allowing passive, hydraulically-dampened sagittal plane movement (9° range). This device, located at the top of the foot, attaches it to the prosthetic shank. This study investigates how use of this device affects prosthetic-limb ankle kinetics and energy storage and return. METHODS: Eight active male trans-tibial amputees (age 43.9 ±13.1 yrs,) completed over-ground walking trials at their self-selected speed using both their habitual prosthetic foot and one with hydraulic ankle attachment (Endolite, UK). Stance-phase kinetics at the prosthetic-limb ankle (middle of prosthetic shank, same height as intact-limb ankle) were determined using standard inverse-dynamics modelling. Energy absorbed and returned was determined as the negative and positive portions of the prosthetic-limb ankle power curve respectively. RESULTS: Two energy absorption and return phases were evident corresponding to compression and recoil of the heel and forefoot keels in early and mid-to-late stance respectively. Use of the hydraulic ankle device led to changes in the initial absorption-return phase (corresponding to 1st and 2nd rocker). The change from a dorsi- to plantarflexion moment occurred sooner (22% from 32% stance, $p=0.028$) and the energy returned during this period was reduced by 68% ($p=0.035$). In addition, peak plantar-flexion, occurring during loading response, increased by 3.2° ($p<0.001$) and prosthetic limb step length increased by 0.03m ($p=0.004$). CONCLUSIONS: The reduced energy return in early stance highlights the device attenuated the 'recoil-effect' of the heel keel during 2nd rocker. This is more reflective of able-body gait and indicates progression of the shank over the foot was more controlled. The increased and dampened plantar-flexion during initial loading meant the prosthetic foot could be placed further forward without an accompanying increase in the magnitude of the braking GRF. The earlier change to a plantarflexion moment, also more reflective of able-body gait, when the hydraulic device was used, may explain why participants indicated the feeling of a 'flat-spot' or having to 'climb over' the foot was absent and why they were able to increase prosthetic step length. While the benefits of using the hydraulic device appear to be limited to first and second rocker, it is likely these changes reduce the compensatory joint kinetics for the intact limb, which we are currently evaluating.

P2-O-173 Force platform with visual feedback using for the balance training and reducing fall risk in post-stroke patients with central hemiparesis syndrome.

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BACKGROUND AND AIM: The stroke is the main cause of the disability in Russia. There are stride length increasing, shifting the center of mass on the healthily limb, and the standing and gait energy costs increasing characteristically for the central hemiparesis syndrome gait stereotype changes. Also, all of these changes increase the fall risk with high probability of the fractures [2,3]. It is known that exist a correlation between the deviation of the centre of pressure (COP) in the frontal plane and quality of the postural control and the possibility of effective use of the force platforms with visual biofeedback for the reducing COP deviation and improving the postural control and gait in the post-stroke patients with central hemiparesis syndrome [3]. METHODS: We assessed the efficacy of the force platforms with visual biofeedback training on balance and gait in post-stroke patients with central hemiparesis syndrome. 120 patients were randomized in three groups. In the first (n=39) group patients received

traditional neurorehabilitation methods: proprioceptive correction in "Adeli" suite, massage, physiotherapy. In second group patients had complex treatment (traditional traditional neurorehabilitation methods and balance training with visual biofeedback). In the third group (n=40) patients got only biofeedback training on the force platform. In the 2nd and 3rd groups MBN «Biomechanic» force platform (Moscow) was used for the biofeedback training. Duration of each training was 20-30 minutes. The aim of the trainings was shifting the COP on to the paretic side - approaching real COP to the "ideal". For assessment these methods we used the neurological status assessment, clinical balance assessment by the Berg Balance scale, gait function scoring (Gait dynamic index) and functional independence (D. Barthel). Also, all patients were assessed by computerized stabilometry [1]. RESULTS: In the first group patients had significant improvement by the stabilometry and Berg Balance Scale data (Wilcoxon nonparametric test: $p<0,05$). Fall risk in this group stayed high after the treatment course. In groups 2 and 3 we obtained significant improvement in gait and balance by the scales score and decreasing of fall risk. CONCLUSIONS: Thus, results of this research confirmed the high fall risk in post-stroke patients with central hemiparesis syndrome. Isolate using of the visual biofeedback COP shifting method or with traditional neurorehabilitation complex (proprioceptive correction in suite, massage, physiotherapy and etc.) can decrease risk of falls and improve gait and balance in those patients.

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P2-O-174 Decrease in venous return due to postural change is mitigated by functional electrical stimulation for people with spinal cord injury

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BACKGROUND AND AIM: When a postural change causes venous pooling and a progressive decrease in venous return (VR), and they are not adequately counteracted, orthostatic hypotension (OH) occurs. Due to autonomic dysfunction and paralysis of the lower extremities, people with spinal cord injury (SCI) are susceptible to OH. This is problematic especially in early stages of rehabilitation when orthostatic intolerance is more severe: some people cannot benefit from therapies that induce orthostatic stress, such as standing training or locomotor training. Consequently, rehabilitation is hindered and the outcomes are diminished. Our group has found that, for improving orthostatic tolerance in able-bodied people, simultaneously applying functional electrical stimulation (FES) and passive movements to the lower extremities is more effective than isometric stimulation of the leg muscles alone. To our knowledge, the combined effect of FES and passive leg movements on OH has only been studied in able-bodied people. Therefore, we examined this effect in participants with SCI. METHODS: Ten people with chronic SCI participated in the experiment. While being tilted head-up to 70 degrees from the supine

position, the participants underwent four 10-minute conditions in a random sequence: 1) no intervention, 2) passive stepping, 3) isometric FES of leg muscles, and 4) FES of leg muscles combined with passive stepping. Each condition was preceded by a 10-minute rest in the supine position. During the last minute of each condition, the inferior vena cava (IVC) was imaged in the transverse plane using an ultrasound system. During passive stepping alone, the electromyographic (EMG) signals of the leg muscles were recorded. Throughout the experiment, beat-to-beat blood pressure was recorded non-invasively. RESULTS: Without any intervention, head-up tilt significantly increased heart rate and significantly decreased stroke volume (SV). FES and passive stepping independently mitigated a decrease in SV and helped to maintain the mean blood pressure (MBP). The effects of FES on MBP and SV were greater than those of passive stepping: passive stepping did not induce VR as effectively as FES but still somewhat mitigated a decrease in arterial pressure. When combined, FES and passive stepping did not synergistically increase SV or MBP. Nonetheless, combining them resulted in a greater increase in MBP. EMG signals did not indicate significant muscle activity during passive stepping in any participant. Reliable data could not be obtained from the ultrasound imaging of the IVC. CONCLUSIONS: A combined intervention of FES and passive stepping may prevent OH more effectively than FES or passive stepping alone for people with chronic SCI. Such interventions may facilitate neurorehabilitation by enabling people that are otherwise orthostatically intolerant to participate in standing training or locomotor training.

P2-O-175 Enhancing motor learning in computer game dancing simulation through action observation: young and old gamers compared

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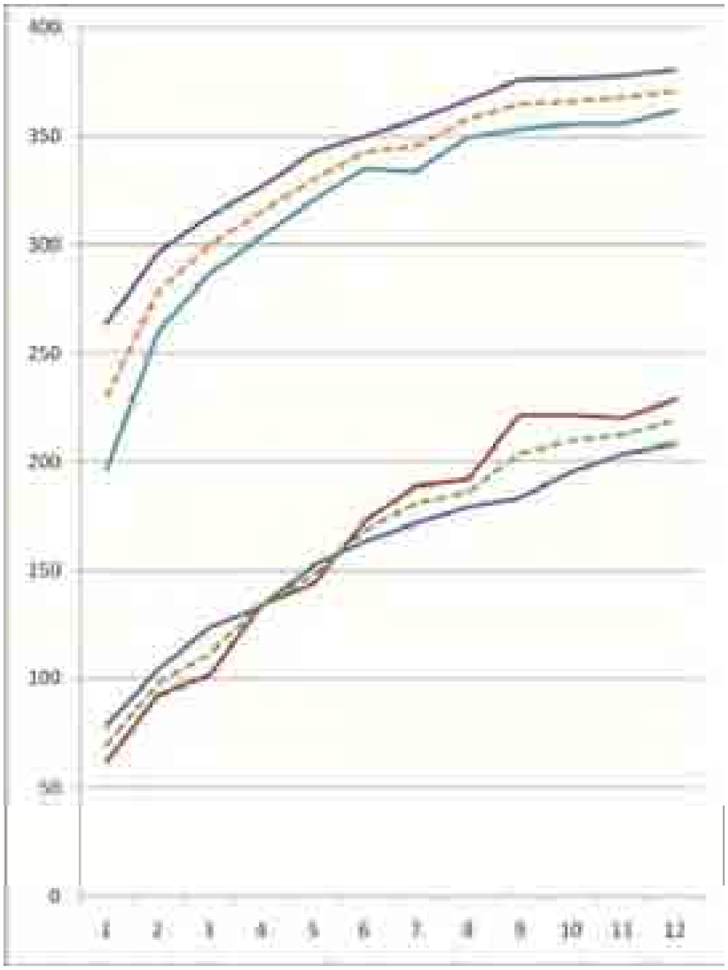
BACKGROUND AND AIM: The observation of a movement performed by another subject may enhance motor learning [1,3] and action execution [2,3]. The goal of the present study was to verify if action observation can be used to enhance learning of playing a computer game dancing simulation (CGDS) in young and elderly individuals. METHODS: 13 older (70.1±4 years) and 20 younger (28.3±2.5 years) adults participated. 12 computer game dancing sessions during 4 weeks were performed. Effects of motor training with arrows-action-cues (AC) and person-with-arrows-action-cues training (PAC) was tested. Dependent measure (DM) performance score was assessed in each session. Data were analysed with a 2 (AC/PAC) x 12 (Sessions) ANOVA, with repeated measures on the last factor per group. RESULTS: The between groups tests indicated that the variable AC/PAC failed to reach significance in performance curves in both young $F(2.63,47.4) = 2.836$, $p = 0.055$ and old $F(3.22, 35.37) = 2.238$, $p = 0.097$ (Greenhouse-Geisser corrected) adults, however, showed clear trends towards interaction effects in favour of PAC for both groups (Fig. 1). CONCLUSIONS: Our results indicate that action observation may have a positive additional impact on training of motor functions with a computer game in elderly. The form of instruction, AC or PAC, influenced young learners early in training and enhanced performance in elderly later in training.



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P2-O-176 Differentiating exercise programs for people with PD requires instrumented measures.

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BACKGROUND AND AIM: While it is believed that exercise is beneficial in improving balance and gait in Parkinson's disease (PD), examining the effects of different exercise programs in PD is hampered by crude and insensitive measurements. Here we compare outcomes from a novel sensorimotor-agility-program to those of a high-intensity treadmill-based program. We hypothesize that instrumented measures will be more sensitive to program specific changes. METHODS: Thirty-nine people with idiopathic PD (Age: 65.3±8, UPDRS: 35.9 ±15) participated. Two baseline pretests (4 weeks apart) were obtained to determine stability of measures without intervention. Following the second pretest, subjects were randomized into either an Agility program or a Treadmill based program. Both groups

were under the direct supervision of a physical therapist, 4 times a week for 4 weeks, after which a post-test was administered. Subjects were tested in the ON medication state using the following measures: Clinical scales included the UPDRS, PDQ-39, Mini-Bestest. Instrumented measures were obtained using the instrumented Timed Up and Go Test (ITUG) and instrumented Sway (ISway) in which wearable sensors were used. All testing and exercise sessions were performed ON medication. For all measurements, standardized response mean (SRM) was calculated for the 2 baseline measures and for baseline vs intervention. SRM is the mean change (d) reported in units of standard deviation of change (SDdiff), SRM=d/SDdiff . For SRM, a value of 0.20 represents a small change, of 0.50 a moderate, and a value of 0.80 represents a large change. RESULTS: Clinical Measures: Both Agility and Treadmill groups improved after intervention in all clinical scales except for the UPDRS motor. Both groups had large changes in the Mini-BESTest (.94 Treadmill vs 1.04 Agility) moderate changes in quality of life- PDQ-39 (.47 vs .64) and ADL (.48 vs .51). Instrumented Measures: Unlike clinical measures, instrumented measures showed program-specific changes. Specifically, only the Treadmill group improved in stride velocity (.68 vs .30) while only the Agility group improved in turning parameters (step time .01 vs .65; turn duration .33 vs .50 and speed of turn .62 vs 67). Sway during quiet stance improved only in the Agility group for medio-lateral range (.001 vs .77) and medio-lateral frequency (.04 vs 52). CONCLUSIONS: We concluded that although some clinical tests are adequate to show general improvements after exercise, instrumented tests can determine changes related to specific exercise. Also, the agility program improved more components of mobility and balance than the treadmill program.

P2-O-177 The analysis of forces and moments in the knee joints during drop landing

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BACKGROUND AND AIM: Mechanical loading with physical activity (PA) has been shown to alter bone mineral density (BMD) and articular cartilage metabolism. Negative changes in bone and cartilage health are associated with diminished quality of life in older adults. Traditionally, animal models have been used to study dose-response effects of mechanical loading on BMD and cartilage health, to date no such human model has been developed. The aim of this study was to establish a reliable model to elicit minimal inter-individual variability in joint forces and moments in humans using a drop-landing PA that can be used to explore the effects of mechanical loading on bone and cartilage metabolism. METHODS: 20 young healthy males volunteered. From a standing posture, participants performed drop-landings from two heights: 22 (LOW; L) and 44 (HIGH; H) cm, under 3 "instruction" conditions: "land natural" (NAT), "softly" (SFT), and "stiffly" (STF). 10 trials, blocked by condition and drop height, for each of the 6 conditions were performed. The order of blocks was randomized. Infrared light-reflective markers were affixed on specific body landmarks to define the following segments: foot (2), shank (2), thigh (2), pelvis, and trunk. Ground reaction forces were recorded with two AMTI OR6-7 force plates. Three-dimensional joint forces and moments were estimated using inverse dynamics (Visual3D, Kingston, Canada). Peak compressive knee joint forces and extensor moments were normalized to participants' body mass. RESULTS: Two-way repeated measures ANOVA revealed a significant main effect of drop height

(F(1,19)=67.8; p<0.0001) and condition (F(2,38)=89.5; p<0.0001) for the peak compressive knee joint forces. Peak forces were larger for the H height (17.8±2.59N/kg; mean±SE) than L (14.3±0.67N/kg). The SFT condition produced lower forces (11.8±0.43N/kg) than both NAT (17.0±0.81N/kg) and STF (20.2±0.93N/kg); the forces produced in the NAT were lower than in the STF (Fig. 1). Two-way repeated measures ANOVA revealed a significant main effect of drop height (F(1,19)=191.6; p<0.0001), condition (F(2,38)=8.8; p=0.0007), and a significant interaction between drop height and condition (F(2,38)=14.0; p<0.0001) for the peak knee joint external moments. Peak external moments were not different in L-SFT (1.49±0.068Nm/kg), L-NAT (1.45±0.075Nm/kg), and L-STF (1.50±0.088Nm/kg). In the H-SFT (1.88±0.086Nm/kg) moments were larger than in L-SFT, L-NAT, and L-STF, but lower than in both H-STF (2.24±0.080Nm/kg) and H-NAT (2.21±0.085Nm/kg), which were not different from each other (Fig. 1). CONCLUSIONS: The results indicate scaling of vertical knee joint forces between the three landing conditions, at both heights. Peak joint forces increased with increased landing stiffness, and the drop height. Extensor joints moments increased with the drop height. Our next step is to implement the drop-landing protocol in a study of bone and articular cartilage metabolism biomarker expression.

Figure:

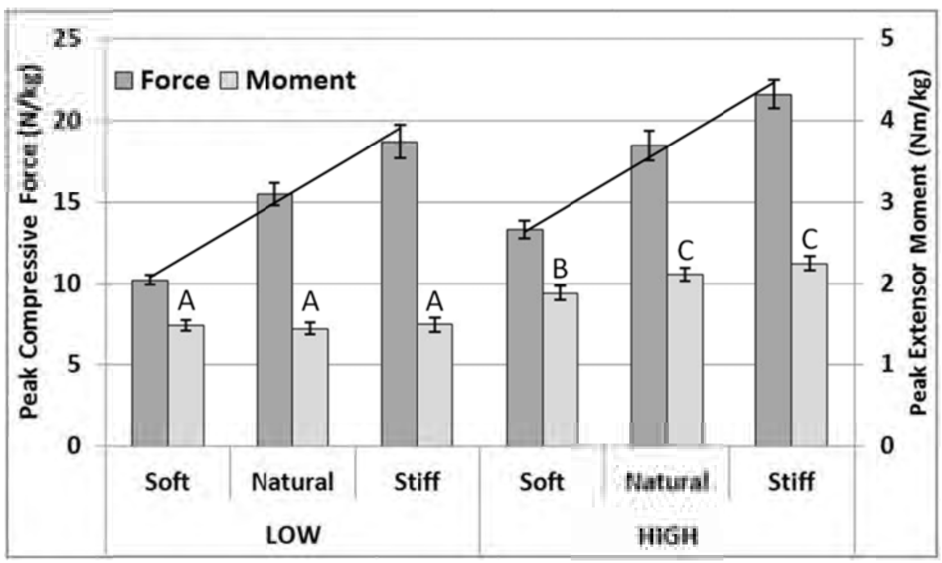

Fig. 1. Normalized peak vertical knee joint FORCE and extensor MOMENT (mean±SE). Lines – difference between drop height and landing type (FORCE). Different letters – difference between levels (MOMENT).

P2-O-178 Sensitivity to change of paper-pencil and computerized methods for assessing motor performances in geriatric patients: influence of test instructions and conditions

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BACKGROUND AND AIM: Sensitivity to change of motor assessment is crucial for obtaining effects of geriatric rehabilitation. However, currently there is only little information on sensitivity to change of both established paper-pencil and computerized assessment methods. In particular, impact of different test instructions (maximum vs. habitual performance) and test conditions (normal vs. adjusted condition for reducing floor effects) has not been evaluated with respect to sensitivity to change. The aim of the present study was to investigate the sensitivity to change of several motor assessment methods with respect to different test instructions and conditions. METHODS: Gait performance (maximum vs. habitual performance) of 67 geriatric inpatients (mean age 83±6,1) was assessed by using computerized gait analysis (GAITRite®) velocity, cycle time, single and double support, cadence, stride and step length and base support). SitStandSit performance (maximum vs. habitual performance; normal and adjusted chair to knee height) was assessed by using a body-fixed sensor (DynaPort®Hybrid), which measures the duration of SitStand and StandSit and the duration and angular velocity of the flexion and extension phase of SitStand and StandSit. Balance performance (foot position: SideBySide, SemiTandem, Tandem) was also assessed by the DynaPort®Hybrid (sway path and area). Additionally mobility was assessed by a paper-pencil test (Short Physical Performance Battery, SPPB). Assessment was conducted at the beginning and prior to discharge of the three-week rehabilitation period. For detecting changes over time paired T-Tests were calculated. Sensitivity to change was calculated by using the standardized response mean (SRM). RESULTS: A higher number of gait parameters significantly changed ($p \le 0{,}05$) if maximum performance was obtained (velocity, cycle time, stride length, single and double support, cadence) compared to habitual performance (velocity, stride length, double support). However, SRMs were almost similar for both habitual (SRM=0,4-0,6) and maximum performance (SRM=0,4-0,5). For SitStandSit performance a higher number of parameters significantly changed ($p \le 0{,}05$) for the maximum performance (StandSit duration SRM=0,4; StandSit flexion duration SRM=0,5) compared to habitual performance (StandSit angular velocity of the extension SRM=0,4). No significant changes were found for adjusted chair height and balance assessment. The SPPB showed high sensitivity to change ($p<0{,}001$ SRM=0,6). CONCLUSION: Computerized assessment of gait performance and SitStandSit ability as well as assessment by the SPPB are sensitive to changes in motor performance of geriatric patients. No changes were obtained for balance assessment using a body-fixed sensor. Assessment of maximum performance is recommended since a higher number of variables significantly changed over time under this test instruction. Adjustment of chair height did not improve sensitivity to change.

P2-O-179 Relationship between floor reaction force in anterior and posterior area of the foot and upper and lower body motion in forward flexion

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BACKGROUND AND AIM: The foot is the only body part directly which receives floor reaction forces (FRFs) from several directions with the floor in standing. Therefore, understanding FRFs in detail and relation to body motion is useful. However previous studies use the FRF as a vector from the centre of pressure (COP) to analyze body motion. It is necessary to separate the FRF into functional foot parts and relate body motion, and study their relationship. The aim of the present study was to determine if there

are identifiable differences between FRFs of anterior and posterior area of the foot and upper and lower body motion in forward flexion used in a clinic. METHODS: Five young males (27±3.6 years, 61.3±2.9kg, 175.8±5.1cm) participated in this study. Subjects were asked to do forward flexion with standing without both knee joints bending and both plantar pedis were off the floor. The forward flexion speed was synchronized to a metronome beat. And subjects did the flexion under two conditions that subjects were load on anterior area of the foot and posterior area of the foot as possible for each five trials. The kinematic data from the subjects' body motions and FRFs were collected using a high speed motion capture system (Vicon) and force plates under the feet (AMTI), and sampled at 100Hz. Body motions were from six reflective markers located on the acromion, the centre of hip joint, the knee joint, the lateral malleous, and the head of fifth metatarsal. In this study, the anterior area of the foot was defined as in front of the line from the tuberosity of fifth metatarsal to the tuberosity of navicular, and the posterior of the foot was defined as behind the line. Upper body was defined by markers which were above the center of hip joint, and lower body was defined as markers which were below centre of hip joint. Forces under each foot were measured by four force plates as anterior area of right foot (ARF), posterior area of right foot (PRF), anterior area of left foot (ALF), and area of left foot (PLF) in forward flexion. Data were analyzed by an unpaired t-test. RESULTS: Some important results were obtained. All force plates reacted to FRFs through all trials. The sagittal component of FRFs indicated that ARF and ALF, and PRF and PLF were similar in all subjects. Our study found that differences in sagittal FRFs in anterior and posterior area of the foot under two conditions that subjects were load on between anterior and posterior of the foot. The results of the main study, currently in progress, will be presented at the meeting. CONCLUSIONS: Our results has shown that possibility about the forces which were received by anterior and posterior of the foot were related in body motion.

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