Program

2015 ISPGR WORLD CONGRESS

June 28 to July 2, 2015
Seville, Spain
Melia Sevilla Hotel

ispgr

INTERNATIONAL SOCIETY FOR POSTURE & GAIT RESEARCH

www.ispgr.org

PROGRAM AT A GLANCE

Time	Sunday, June 28	Monday, June 29	Tuesday, June 30	Wednesday, July 1	Thursday, July 2
9:30:00 AM				Free time	Round Table with the ISPGR President
10:00:00 AM			ISPGR Committees Information Meeting		
10:15:00 AM					
10:30:00 AM		Keynote 2: Karen Adolph (10:30 - 11:30)	Keynote 3: Amy Bastian (10:30 - 11:30)		Keynote 5: Lena Ting (10:30 - 11:30)
10:45:00 AM					
11:00:00 AM	Pre-conference workshops				
11:15:00 AM					
11:30:00 AM		Posters Session 1 & Exhibitors (11:30 - 13:30) Refreshments provided	Posters Session 2 & Exhibitors (11:30 - 13:30) Refreshments provided		Posters Session 3 & Exhibitors (11:30 - 13:30) Refreshments provided
11:45:00 AM					
12:00:00 PM					
12:15:00 PM					
12:30:00 PM					
12:45:00 PM					
1:00:00 PM					
1:15:00 PM					
1:30:00 PM		Lunch and Exhibits (buffet) (13:30 - 14:30)	Lunch & Exhibits (Boxed Lunch) (13:30 - 14:30) AGM (13:45 - 14:15)		Lunch & Exhibits (buffet) (13:30 - 14:30)
1:45:00 PM					
2:00:00 PM	Free Time				
2:15:00 PM					
2:30:00 PM					
2:45:00 PM		Oral 1 (14:30 - 16:30) / Oral 2 (14:30 - 16:30) / Oral 3 (14:30 - 16:30)	Oral 4 (14:30 - 16:30) / Oral 5 (14:30 - 16:30) / Oral 6 (14:30 - 16:30)	Keynote 4: James Lackner (14:30 - 15:30)	Oral 7 (14:30 - 16:30) / Oral 8 (14:30 - 16:30) / Oral 9 (14:30 - 16:30)
3:00:00 PM					
3:15:00 PM					
3:30:00 PM				PYSA talk - Melvyn Roerdink (15:30 - 16:30)	
3:45:00 PM					
4:00:00 PM					
4:15:00 PM	Pre-conference workshops				
4:30:00 PM		Refreshment Break (16:30 - 17:00)	Refreshment Break (16:30 - 17:00)	Refreshment Break (16:30 - 17:00)	Refreshment Break (16:30 - 17:00)
4:45:00 PM					
5:00:00 PM					
5:15:00 PM					
5:30:00 PM					
5:45:00 PM		Symposium 1 (17:00 - 19:00) / Symposium 2 (17:00 - 19:00) / Symposium 3 (17:00 - 19:00)	Symposium 4 (17:00 - 19:00) / Symposium 5 (17:00 - 19:00) / Symposium 6 (17:00 - 19:00)	Symposium 7 (17:00 - 19:00) / Symposium 8 (17:00 - 19:00) / Symposium 9 (17:00 - 19:00)	Symposium 10 (17:00 - 19:00) / Symposium 11 (17:00 - 19:00) / Symposium 12 (17:00 - 19:00)
6:00:00 PM					
6:15:00 PM	Free Time				
6:30:00 PM					
6:45:00 PM					
7:00:00 PM	Opening Ceremony (19:00 - 19:30)				
7:15:00 PM					
7:30:00 PM				Drinks Reception & Honorary Member Presentations (19:00 - 20:30)	Free time
7:45:00 PM	Keynote 1: Daniel Wolpert (19:30 - 20:30)				
8:00:00 PM					
8:15:00 PM					
8:30:00 PM	Opening Reception (20:30 - 22:00)	Free time	Free time		
8:45:00 PM				Free time	
9:00:00 PM					Closing Dinner (20:30 - 1:30)
10:00:00 PM					
11:00:00 PM					
12:00:00 AM					
1:00:00 AM					

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ABOUT ISPGR

The International Society for Posture and Gait Research (ISPGR), formerly called the International Society of Posturography is a staff-supported, member driven organization with 500+ members located in over 20 countries around the world.

The society provides a multidisciplinary forum for basic and clinical scientists, provides member benefits and holds regular meetings in order to:

- Present and discuss the latest research and clinical findings relating to the control of posture and gait and related disorders.
- Facilitate interaction between members who meet from all corners of the globe.
- • Promote the broad discipline of posture and gait research.

ISPGR History

The International Society for Posture and Gait Research was formed in 1969 under the name the International Society of Posturography, by a group of basic scientists and clinicians who had similar interests in quantifying postural sway during stance.

Most of the Society members in the first years were from Europe and Japan.

The first meetings took place in *Madrid* (1971), *Smolenica* (1973), *Paris* (1975), *Sofia* (1977), *Amsterdam* (1979), *Kyoto* (1981) and *Houston* (1983). At the 1983 meeting in Houston the founders realized that interest in posturography had expanded to include the entire area of balance and gait control and at the annual meeting in 1986, the Society was renamed to its current name. By the 1992 meeting in Portland, Oregon, the Society had grown to over 300 members worldwide and member interests expanded to include sensory and motor control neurophysiology, biomechanics, movement disorders, neural circuitry, vestibular function, neurological disorders, effects of development and aging, rehabilitation, robotics, modeling, neural compensation, and motor learning as related to control of balance and gait.

Download the official ISPGR Mobile App!

ISPGR is excited to announce the launch of our interactive mobile application for the 2014 World Congress! The ISPGR Mobile App is available for iPhone, Android, Blackberry and any smartphone or tablet that has web-enabled browser capability. Maximize your time and experience with the ISPGR Congress – scan the QR code on the back of your badge to download the app.

The ISPGR app allows you to:

- View all congress information (sessions, abstracts, speakers, exhibitors, maps, attendee profiles, etc.) on your mobile device
- Build a personalized schedule and access any session handouts
- Find information quickly with the universal search feature
- Opt into messaging with other attendees
- Receive important congress-related notifications and updates
- Take notes on your mobile device during specific sessions with the ability to extract the information later
- Browse local restaurants and attractions
- **And much more…**

WELCOME LETTER

Dear Colleagues,

We are honoured and delighted to act as co-chairs for the 2015 World Congress of the International Society of Posture and Gait Research, which follows a long history of over 40 years of rich scientific discussion and exchange.

We are also pleased to welcome you to the beautiful and historic city of Seville. It may not have escaped your attention that neither one of us is Spanish nor do we have any professional links to this wonderful city. While the initial society meetings were informal gatherings of posture and gait scientists and were located at the institution of the hosts, our society has grown to include over 600 members from 30 different countries. For the first time this year, the venue was chosen independently of co-chair affiliation with a view to offering our membership value for money, accessibility, great conference facilities, tourist attractions and weather! Our record number of scientific abstracts submitted suggests that this is a popular decision and although we are not intimately familiar with all aspects of Seville, our management company has worked hard with the Congress & Conventions Bureau to ensure great congress, dining and tourist experiences.

In planning this Congress, we have built on the success of previous meetings and responded to member feedback by providing more of the sessions that we have been told are valued most. Accordingly, we have increased the number of pre-congress workshops, keynote speakers and member-led symposia sessions. As in previous years, we have allocated significant time and attention to poster presentations and scheduled them in such a way as to encourage attendance. We have also continued the Society's tradition of focusing on young researchers and student members by supporting a student-run symposium and recognizing the excellence of student research through the Young Investigator's award and the NDI Aftab Patla student poster awards. The impact of the Society's dedication to student participation is highlighted by the fact that over 40% of our Congress attendance is made up of student members this year!

We have five world-class keynote speakers highlighting some of the most innovative and novel research in our field, and an exciting scientific program that features: 10 pre-conference workshops, 72 oral presentations, 12 symposia, and 412 poster presentations covering a broad spectrum of posture and gait research.

We want to extend sincere thanks to all individuals who have dedicated their time to help organize this Congress. We extend special thanks to the members of the Scientific Content Committee, and particularly its Chair and ISPGR Vice-President, Dr Mark Carpenter, who have worked hard to help us objectively select this year's symposia, oral and poster presentations. We are also especially grateful to the members of the Awards Committee that have the challenging task of choosing winners for the Young Investigator's award and student poster awards. We also would like to thank the ISPGR board members for their continued support, and our Conference Organizers at Podium Conference Specialists, who have been an essential partner to the Society as we transition into a central role of organizing our future ISPGR World Congresses and other activities. Finally, we thank you, in advance, for your individual contributions and efforts to help make this a memorable and successful Congress for all.

We encourage you to take advantage of the opportunity to share and discuss your work, but also to develop new networks of friends and colleagues, plan future collaborations, and create and exchange new ideas and perspectives.

Friends, colleagues,
"Bienvenidos a Sevilla" and the
2015 World Congress of the ISPGR!

Mark Hollands
Congress Co-Chair

Shirley Rietdyk
Congress Co-Chair

LEADERSHIP

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2014 - 2018

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Fondazione Santa Lucia, Italy

Sue (Sukyung) Park (Asia-Pacific)
Korea Advanced Institute of Science and Technology, Republic of Korea

Scientific Content Committee

Committee Co-Chairs:

Mark Hollands	Liverpool John Moores University
Shirley Rietdyk	Purdue University

Committee Representatives:

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Martijn Müller	University of Michigan, USA
Toshihisa Murofushi	Teikyo University, Japan
Antonio Nardone	Fondazione Salvatore Maugeri (IRCCS), Italy
Alice Nieuwboer	KU Leuven, Belgium
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Mirjam Pijnappels	VU University, Netherlands
Rebecca Reed-Jones	University of Prince Edward Island, Canada
Vivian Weerdesteyn	Radboud University, Netherlands
Geoffrey Wright	Temple University, USA
Will Young	Brunel University, UK

CONGRESS GENERAL INFORMATION

Meeting Venue

Melia Sevilla

Calle Dr. Pedro de Castro, 1
41004 Sevilla, Spain

(please review the floor plan at the back of the program for further details)

Registration

World Congress Registration
Registration for the Congress includes admission to all sessions, access to all coffee breaks and lunches daily. In addition, all social events, including the Welcome Reception and Gala Dinner are included in your registration.

Additional Tickets
Tickets can be purchased separately for your guests and/or children for all conference excursions, the Welcome Reception, and Gala Dinner.

Name Badges
Your name badge is your admission ticket to the conference sessions, coffee breaks, meals, reception and Gala. Please wear it at all times. At the end of the conference we ask that you return your badge to the registration desk, or at one of the badge recycling stations.

ISPGR Board Members, Exhibitors and Staff will be identified by appropriate ribbons.

Dress Code
Dress is casual for all ISPGR meetings and social events.

Registration and Information Desk Hours
The Registration and Information Desk will be open during the following dates and times:

Sunday, June 28	10:00 – 20:30
Monday, June 29	10:00 – 19:00
Tuesday, June 30	09:45 – 19:00
Wednesday, July 1	09:30 – 19:30
Thursday, July 2	09:45 – 19:00

Speaker Information
For Oral Sessions, each room will be equipped with

- 1 PC laptop
- 1 LCD projector
- 1 microphone
- 1 laser pointer

All speakers in Symposia and Oral Sessions must upload their presentations at least 2 hours prior to their presentation at in the Speaker Ready Room located in Prado. If you have any questions, please visit the registration desk.

Poster Information

Set-up and Removal
There are three Poster Sessions during the Congress. Poster presenters must set-up and remove their posters during the following times:

Poster Session 1 - Monday, June 29

Set-up:	09:00 – 10:00
Dedicated time:	11:30 – 13:30
Remove:	by 20:00

Poster Session 2 - Tuesday, June 30

Set-up:	09:00 – 10:00
Dedicated time:	11:30 – 13:30
Remove:	by 20:00

Poster Session 3 - Thursday, July 2

Set-up:	09:00 – 10:00
Dedicated time:	11:30 – 13:30
Remove:	by 20:00

Please note, each poster session will be divided into 2 parts, with odd poster numbers being presented from 11:30-12:30 and even poster numbers being presented from 12:30-1:30. You may present your poster for the entire 2 hour period if you wish.

Information on Poster Authors (Lead), Poster Numbers and Poster Titles begins on page 62.
For a complete copy of all the poster abstracts, please visit the ISPGR website, where you can download an electronic copy.

Easy reference Poster floor plans can be found on **page 100**.

CONGRESS GENERAL INFORMATION

Staff

ISPGR staff from Podium Conference Specialists can be identified by the orange ribbons on their name badges. Feel free to ask any one of our staff for assistance.

Internet Services

IPSGR attendees have access to complimentary WI-FI in the meeting space area.

WI-FI Intructions: **Username:** **ax006**
Password: **jp91**

Membership

ISPGR International Society for Posture & Gait Research

Membership in ISPGR is open to scientists, researchers, clinicians and students from around the world involved in the many research and practical aspects of Gait and Posture. Membership dues support the ISPGR's mission of creating a community of multidisciplinary posture and gait researchers and students.

Member Benefits

- Exclusive opportunity to **submit abstracts** for review and consideration for presentation at Society Meetings
- Opportunity to register for Society Meetings at **reduced registration rates**
- Professional **development and networking**
- Access to **online resources** and conference proceedings
- Opportunity to submit applications for **student scholarships and awards**
- **20% discount** on a subscription to ISPGR's official publication, Posture & Gait, published by Elsevier 8 times per year
- Ability to post and review **job and grant opportunities**
- Opportunity to post **news and information** on related events
- Opportunity to **vote** in annual elections for the Board of Directors
- Opportunity to **stand for election** to the Board of Directors
- Opportunity to **serve as an officer** of the Board of Directors
- Opportunity to **serve on Society committees**

Member Categories

Regular Members
Any person who is engaged in research or clinical practice related to posture and gait is eligible to be a regular member.

Students & Post Docs
Students enrolled in degree granting programs at institutions of higher learning and post doctoral fellows are eligible to be student members.

Member Dues
ISPGR membership dues are paid annually and cover the calendar year from October 1 to September 30 each year. Current membership dues are:

Regular Member **$100**
Student/Post-Doc Member **$50**

Join a Society Committee

All current ISPGR members are encouraged to serve on a Society committee and actively engage in the future planning of the Society and World Congress. Committees include:

- Scientific Content Committee
- Awards Committee
- Industrial Relations Committee
- Communications Committee

If you would like to learn more about committees or the society, please join us on Tuesday, June 30 at 10:00am in Buhaira at the Committees Information Meetings.

Santa Cruz and Alcazar Guided Visit

10:00am – 12:30pm
$55.00 per person (minimum of 30 people)

You will be picked up in the lobby of the Grand Melia hotel and escorted to the Alcazar (Reales Alcazares) of Seville, the oldest royal palace in continuous use as a royal residence in the world. Even today, it is still the official residence of the King and Queen of Spain when they visit Seville. The original fort was build around 884AD to defend against the Norman invasion of Seville and following the re-conquest of Seville by King Ferdinand III the Saint in 1248, various other palaces were constructed of which only the walls and a few ruins remain. The Alcazar has been witness to great historical events of all kinds, given its character as a royal residence. Inside its walls, the trips of the first discoverers were planned, such as the first journey around the world of Magallanes. It was also here that Charles V celebrated his marriage to Isabella of Portugal and more recently it hosted the wedding of Princess Elena and Don Jaime de Marichalar, Duke and Duchess of Lugo. Following the Alcazar, you will be escorted through the Santa Cruz Quarter. Visitors come to the popular Barrio de Santa Cruz in Seville to experience the quarter's characteristic narrow streets, its stately manors, its flower-studded courtyards, the murmur of its fountains, the scent of orange blossom, and the enchantment and legends that surround it. In the Plaza de Santa Cruz, originally home to the church that gives the quarter its name, a plaque signifies the remains of the famous painter, Bartolome Esteban Murillo. A beautiful forged cross presides over the centre of the plaza, surrounded by a well-tended garden. Following the tour of the Quarter, you will be brought back to the hotel for lunch at leisure before the conference continues.

Santa Cruz and Santa Iglesia Cathedral Guided Visit

10:00am – 12:30pm
$55.00 per person (minimum of 30 people)

You will be picked up in the lobby of the Grand Melia hotel and escorted to popular Barrio de Santa Cruz in Seville to experience the quarter's characteristic narrow streets, stately manors, flower studded courtyards, the murmur of its fountains, the scent of orange blossom, and the enchantment and legends that surround it. In the Plaza de Santa Cruz, originally home to the church that gives the quarter its name, a plaque signifies the remains of the famous painter, Bartolome Esteban Murillo. A beautiful forged cross presides over the centre of the plaza, surrounded by a well-tended garden. Following the Santa Cruz Quarter, you will be escorted to the Santa Iglesia Catedral, Seville's breathtaking cathedral. The Cathedral was built on top of the largest Almohad mosque in ninth century Seville, erected by King Abd-al-Rahman II, on the same site as the earlier Byzantine Basilica de San Vicente. The old mosque's minaret has been saved and is now the Cathedral's nearly 100 meter tall bell tower, crowned with a weathervane called the Giraldillo. Also saved was the Patio de los Naranjos, the courtyard where necessary ablutions were performed before entering the mosque. The Santa Iglesia Catedral is the largest Gothic temple in the world and the third in all of Christianity, occupying 22.720 square meters. Its Flemish stained glass windows, dated from the eleventh to the nineteenth century, are magnificent. The mausoleum in the interior of the Cathedral houses the remains of Christopher Columbus. The Cathedral of Seville was declared a national monument in 1928, and in 1987 UNESCO declared it a World Heritage Site. Following the tour of the Cathedral, you will be brought back to the hotel for lunch at leisure before the conference continues.

PRE-CONGRESS WORK SHOPS – Sunday, June 28, 2015

Morning Session 11:00 – 14:00 (lunch on own)

Workshop 1 *Location: Ecija*

Physical Behaviours and persons with mobility limiting conditions - how do we get person centred outcomes from body-worn accelerometer data

Presenters: **Malcolm Granat** University of Salford
Douglas Maxwell PAL Technologies Ltd
Kristen Hollands University of Salford

The main goal of this workshop is to demonstrate how, using event-based analysis, we can develop person-centred outcomes from free-living physical behaviours derived from body-worn accelerometer data. From our study of physical behaviours we know people have common free-living needs. We can look at these in terms of abilities (for example how fast you can rise from a chair) and connect this with participation (how often do you stand up). For example the fractured walking bouts can be expressed and a 'claudication index' or it could be expressed as Walking Breaks Index and be applied to any population. We know people make short stepping bouts in the house. When they go outside they take longer bouts. We know there is relationship between the upright container and the WBI. A person with claudication might have many short-moderate bouts in some upright containers and consequently a high WBI. We will demonstrate these techniques, for walking and sit to stand and sit to walk, in the stroke, intermittent claudication and Parkinson's disease populations. The workshop participants will have a formal introduction of the methodology, and exemplar data, followed by structured group work on sample data and concluding with group presentations and structured discussion.

Workshop 2 *Location: Utrera*

Introduction to simple and complex Movement Disorders- A video journey

Presenter: **Mandar Jog** Western University

This workshop will feature a series of videos that will showcase all of the subtypes of movement disorders including Parkinsonism, dystonia, Huntington disease, Ataxias of various kinds both simple and complex. The overall dysfunction in biomechanics and especially that of gait, balance and posture will be shown. The approach will be to define the conditions, review the main features of the movement disorder and then see the video cases in order to learn the complexities of these conditions and their biomechanics.

The entire workshop will be video based. It is likely that there will be some didactic components as required to define the conditions and put into perspective the syndromes and the core features of these conditions. Otherwise the workshop will be a journey through videos of a large variety of these conditions.

Workshop 4 *Location: Estepa*

A new age for health and fitness professionals: Assessment of postural and core stability

Presenters: **Erika Zemkova** Comenius University
Jose M. Muyor University of Almerìa
Gabriela Stefanikova Comenius University
Michal Jelen Slovak University of Technology
Zuzana Kovacikova Palacký University

Traditionally, health and fitness professionals supported assessment of physical performance that was related to specific training goals, such as improvement of the capability of cardiovascular system or strength and power. The aim was to evaluate the efficiency of the training and to design the program that will further increase the individual´s performance. However, when these subjects get injured or develop chronic aches and pains, they give up their exercise programs, and usually go to rehab physical therapy specialists. Only few of the fitness professionals were able to utilize the tests that assess neuromuscular functions, e.g. after lower limb injuries. Thus, small number of people benefited from testing of sport-specific performance. Moreover, most of the current population suffers from chronic pain, for instance of the low back, because of prevalence of sedentary lifestyle. Therefore, tests that allow objectively evaluating fundamental abilities and skills, such as coordination, core stability, posture and spinal mobility are needed. Recently, the importance of function of the central core of the body for stabilization and force generation in all sports activities has become increasingly recognized. Core stabilization and core strenghtening have been promoted as a performance-enhancing program, a preventive regimen, and a form of rehabilitation for various lumbar spine and musculoskeletal injuries. However, there are limited and conflicting scientific evidence on efficiency of core training. It is mainly due to a lack of standard evaluation system of core stability and core strength. Moreover, measurement of core stability is more challenging to measure than core muscle strength as it requires incorporating assessment of coordination and balance. The workshop will focus on presentation of portable diagnostic systems and novel methods for assessment of postural and core stability under various conditions that can be use in the sporting field for individuals of different age and performance level. Power point presentation will be complement with practical demonstration of posture and core stability assessment (testing protocols, data analysis, applications, etc.).

Workshop 5 *Location: Carmona*

Binocular eye movement control and posture

Presenters: **Chrystal Gaertner** CNRS
Arnaud Foisy CNRS
Eric Matheron CNRS
Zoi Kapoula CNRS

It has been shown since the eighties that eye movement commands transfer to neck muscles, even when the head is stable. Neck muscle activity can even start before the eyes move. Among the different types of eye movements, vergence eye movements deal on one hand with the vertical alignment of the two eyes (vertical vergence), and

on the other hand, with the adjustment of the angle of the optic axis according to the distance in depth (convergence/divergence). Such vergence eye movements (vertical or horizontal) are particularly embodied as they involve bilateral neck muscle activation. Even at the cortical level, their programming involves bilateral activation of several oculomotor areas. Therefore vergence eye movements and the quality of binocular eye alignment can be critical for postural control and equilibrium. Much has to be done to characterize this synergy (e.g. namely simultaneous neck EMG and eye movement studies are needed). In this workshop we propose a series of presentations of human studies revealing the interaction between horizontal vergence eye movements or vertical binocular eye alignment and quality of postural control in children and adults. The format will consist of oral presentations, plus clinical demonstrations at the end.

Afternoon Workshops: 15:00 - 18:00

Workshop 6 *Location: Ecija*

Controversies in Mechanisms Underlying Parkinsonian Gait: What environmental obstacles can tell us about PD?

Presenters: **Quincy Almeida** Wilfrid Laurier University
Lilian Gobbi UNESP
Simon Lewis University of Sydney and Royal Prince Alfred Hospital
Bastiaan Bloem Radboud University Medical Center

Mobility deficits are arguably one of the most debilitating symptoms of PD. Gait in PD has distinctive features, leaving individuals with PD with an increased risk of trips and falls. In many cases, freezing of gait (FOG) can be the most severe gait disorder associated with advanced PD, leading to an even greater risk of falling5. Since gait deficits become progressively more stereotyped as the disease progresses, and patients experience greater problems adapting gait to different environmental surroundings, investigations of the underlying mechanisms of gait impairment can be critical to our understanding of normal human locomotion (as well as the pathogenesis of other basal ganglia disorders). A variety of neural networks are essential for the planning and control of human locomotion, but the interaction between sensory, perceptual and cognitive networks is not easy to disentangle. Sensory and perceptual systems are

required to accurately detect and make judgments about objects and obstacles that we interact with. These systems are also needed to interpret the progression of successful (or unsuccessful) planned movements relative to environmental obstacles or threats. In addition, higher level cognitive processes (attention, executive function) are required for recognition and semantic processing of environmental stimuli. Thus the goal of the workshop is to consider the controversies related to how gait and balance control might be compounded by interactions between these processes. Further, translation of the concepts into therapeutic interventions being developed in Canada, Brazil and Australia and the Netherlands will be discussed.

Each speaker would be asked to present their point of view, as well as their countries approach for treatment. Following each speaker, the discussant would lead a provocative discussion of alternative approaches, with participation encourage from the audience as well as the panel of speakers.

Workshop 7 *Location: Lebrija*

Advanced rehabilitation technology to study and treat movement disorders

Presenters: **Frans Steenbrink** Motekforce Link
Sanne Roeles Strathclyde University
Melvyn Roerdink VU University

In this workshop the participants will experience hands-on how a research question related to balance and locomotion can be translated into a real-time feedback application. Participants will learn about rehabilitation technology and how to translate research paradigms into clinical dynamic and interactive Virtual Reality applications to study and/or treat the various aspects of balance and locomotor disorders. Various types of hardware will be available, such as motioncamera's, forceplates, force-sensors, accelerators and an electromyography systems. Data from these hardware sources will be processed in real-time and available for application development. In an interactive session the ideas of the participants will be transformed into applications which the participants can try and evaluated themselves. The workshop will learn the participants to understand the possibilities of measuring balance and locomotor behavior under various conditions and using motion parameters in dynamic and interactive virtual reality application for advanced research questions and clinical treatment.

In this workshop we will present some basic information, but we will rapidly switch to an example, demonstration, followed-up by an interactive session with the participants. The participants can input their own research ideas and questions during the workshop and they will be guided through the process of developing new ways to study impaired balance and locomotion control.

Workshop 8 *Location: Utrera*

Visual dependence and visual vertigo: interpretation, diagnosis and treatment

Presenters: **Adolfo Bronstein** Imperial College London
Jeffrey Staab Mayo Clinic
Sue Whitney University of Pittsburgh
Marousa Pavlou King's College London

Visual dependence is an individual trait which makes certain people place increased weight on visual input for the control of spatial orientation and balance. These traits are also associated with certain psychological characteristics and with poor outcome in vestibular disorders. In this workshop, participants will gain understanding on the basic psycho-physiological principles underlying visual dependence, how this can develop into a syndrome of visual vertigo (visually-induced dizziness) and how to treat patients with balance disorders and visual vertigo. There will be three main individual slots, one be a neurologist/neurophysiologist (Bronstein) one by a psychologist/psychiatrist (Staab) and one by physiotherapists (Whitney and Pavlou), all preceded by a general introduction to the topic. Each presenter will leave 5-10mins of time for questions followed by a general panel extensive Question & Answer discussion session of between 20-30mins at the end. The organiser Professor Adolfo Bronstein is well experienced in promoting active participation by members of the audience.

PRE-CONGRESS WORK SHOPS – Sunday, June 28, 2015

Workshop 9 *Location: Estepa*

Consensus Meeting on Clinical Stabilometry

Presenters:
Kathryn Sibley University of Manitoba
Lorenzo Chiari Universita' di Bologna
Antonio Nardone Universita' degli Studi del Piemonte Orientale "Amedeo Avogadro"
Sebato Mallone University of Bologna
Martina Mancini Oregon Health & Science University
Kazuo Ishikawa Toho University

This workshop aims to take to a conclusion the process started during the ISPGR congress in Bologna, when a group of members of the Society reconvened to refresh and update a discussion started in the early 80's (see Kapteyn et al, 1983) about standardization in clinical stabilometry. The discussion took a relevant step further during the meetings in Akita and Vancouver, where a Consensus Document was drafted and opened for discussion, and a roadmap towards finalization of the Consensus approved. This includes the collection of feedbacks on the Consensus Document till March 2015, whose results shall be presented and discussed during this workshop. In addition, the workshop shall be an opportunity to train and/or update the audience on some recent achievements in the field of force-plate stabilometry and introduce preliminary results in the direction of inertial sensors-based stabilometry.

The workshop will include six communications (summing up to 120 min) to update the audience on relevant discussions held at previous ISPGR meetings and to present the conclusions of the Delphi-like Consensus process. A significant amount of time (about 60 min), though, will be dedicated to discuss the results of the Consensus process and to outline a shared strategy on the implementation of the agreement and its widespread publication.

Workshop 10 *Location: Carmona*

Aging, Central Nervous System and Mobility: Intervention Strategies to Prevent and Improve Late Life Gait Decline

Presenters:
Caterina Rosano University of Pittsburgh
Linda Krogh Harootyan The Gerontological Society of America
Caterina Rosano University of Pittsburgh
Stephanie Studenski National Institute on Aging
Michelle C. Carlson Johns Hopkins Center on Aging and Health
Wen G. Chen PhD, Co-Chair, National Institute on Aging
Howard Aizenstein University of Pittsburgh
Neil Alexander University of Michigan
David Bennett Rush University Medical Center

Presenters: **Sandra Black** University of Toronto
Richard Camicioli University of Alberta
Luigi Ferrucci National Institute of Aging
Jack Guralnik University of Maryland School of Medicine
Jeffrey Hausdorff Tel-Aviv Sourasky Medical Center
Jeffrey Kaye Oregon Center for Aging and Technology
Lenore Launer National Institute on Aging
Lewis Lipsitz Institute for Aging Research Harvard Medical School
Anne Newman University of Pittsburgh
Farzaneh Sorond Harvard Medical School
Joe Verghese Albert Einstein College of Medicine

This workshop aims to move beyond discipline-specific and disease-based approaches to suggest priority topics and strategies for future research on CNS-related mechanisms of mobility limitations and to identify successful prevention and intervention strategies that can be disseminated on a large scale. This workshop builds on a very successful conference series started in 2012-2014 and supported by the NIA and the Gerontological Society of America that reviewed evidence in favor of an association between CNS and mobility in older adults who have no overt neurological conditions. Specific objectives are: a) identify main components of a toolbox to assist clinicians to better manage gait problems in older adults; b) prepare a document to summarize the proceedings of the workshops, with specific attention to novel intervention strategies and suggestion of study designs to test the effectiveness of such interventions. Attendees are invited to participate actively to the discussion and contribute perspectives from basic, clinical, and epidemiological approaches to the fields of geriatrics, gerontology, movement science, neurology, neuropsychology, neurosciences, and rehabilitation.

The workshop will be divided into two main themes through a combination of presentations and roundtable discussions. First, we will discuss CNS plasticity as a potential mechanism to explain the high variability in gait decline that exists between older individuals and also to explain the variable response to rehabilitative interventions. Secondly, we will critically review cutting-edge intervention strategies that have shown promise and been successful in aging and other fields/conditions and that could be also successful for older adults. Initial evidence suggests that interventions targeting multiple domains and systems appear promising, including drug therapies to reduce cognitive impairment, transcranial magnetic stimulation, mild to moderate goal-directed physical and cognitive activity, virtual walking with distraction training, and noise-based approaches to enhance sensory function. However, application of these interventions in older adults has been sparse to date.

DETAILED PROGRAM

Sunday, June 28, 2015

Morning Pre-Congress Workshops

11:00 – 14:00

WS 1 Physical behaviours and persons with mobility limiting conditions - how do we get person centred outcomes from body-worn accelerometer data

WS 2 Introduction to simple and complex movement disorders - A video journey

WS 4 A new age for health and fitness professionals: Assessment of postural and core stability

WS 5 Binocular eye movement control and posture

Afternoon Pre-Congress Workshops

15:00 – 18:00

WS 6 Controversies in mechanisms underlying Parkinsonian gait: What environmental obstacles can tell us about PD?

WS 7 Advanced rehabilitation technology to study and treat movement disorders

WS 8 Visual dependence and visual vertigo: Interpretation, diagnosis and treatment

WS 9 Consensus meeting on clinical stabilometry

WS 10 Aging, Central Nervous System and Mobility: Intervention Strategies to Prevent and Improve Late Life Gait Decline

Opening of World Congress

19:00 – 19:30 **ISPGR World Congress Opening Ceremony**
Location: Giralda I-II

19:30 – 20:30 **Opening Keynote – Daniel Wolpert**, University of Cambridge, UK

Probabilistic models of sensorimotor control and decision making

Chair: **Brian Day**, University College London, UK

20:30 – 22:00 **Opening Reception**
Location: Pool

Monday, June 29, 2015

10:30 – 11:30 **Keynote Presentation - Karen Adolph**, Infant Action Lab, USA
Location: Giralda I-II

How Infants Learn To Walk (And How They Don't)

Chair: **Christine Assaiante**, CNRS, France

11:30 – 13:30 **Poster Session 1 & Exhibitors** (refreshments provided)

13:30 – 14:30 **Lunch & Exhibits**

14:30 – 16:30 **Oral Sessions 1-3**

Oral Sessions

O.1 Brain Imaging

Location: Giralda I-II

Co-Chairs:
Klaus Jahn University of Munich, Germany
Caterina Rosano University of Pittsburgh, USA

O.1.1 ***The role of the frontal lobe in complex walking tasks in healthy older adults and patients with Parkinson's disease: An fNIRS study***

Inbal Maidan, Sourasky Medical Center, Israel

O.1.2 ***Anisotropy of human vertical and horizontal navigation in real space: behavioral and PET correlates***

Andreas Zwergal, University of Munich, Germany

O.1.3 ***A cerebral dissociation between motor imagery of gait and dynamic balance in Parkinson's disease***

Murielle Ferraye, Radboud University, Netherlands

O.1.4 ***Cortical control of human gait function: Similarities and differences in corticomuscular coherence during treadmill walking and overground walking***

Luisa Roeder, Queensland University of Technology, Australia

O.1.5 ***Increased functional connectivity of the central executive network in patients with Parkinson's disease with a history of falls***

Keren Rosenberg-Katz, Tel Aviv Sourasky Medical Center, Israel

O.1.6 ***The integrative role of the pedunculopontine nucleus in human gait***

Marie Laure Welter, Groupe Hospitalier Pitié-Salpêtrière, ICM, France

O.1.7 ***Increase in frontal brain activation during dual task walking after training using a Smartphone-based biofeedback system in patients with Parkinson's disease: a fNIRS study***

Jeffrey Hausdorff, Tel Aviv Sourasky Medical Center, Israel

O.1.8 ***Brain activity related to stabilizing gait in young and older adults***

Sjoerd Bruijn, VU University Amsterdam, Netherlands

O.2 Sensorimotor Control I

Location: Santa Cruz

Co-Chairs:
Jaak Duysens, KU Leuven, Belgium
Mike Cinelli, Wilfrid Laurier University, Canada

O.2.1 ***Both standing and postural threat decrease Achilles tendon reflex inhibition from tendon electrical stimulation***

Brian Horslen, The University of British Columbia, Canada

O.2.2 ***The role of hip abductor proprioception in mediolateral balance control of gait in older adults***

Mina Arvin, VU University Amsterdam, Netherlands

O.2.3 ***Full Body Kinematic Analysis of Altered Vestibular Reflexes Caused by Postural Threat***

Jonathan de Melker Worms, Manchester Metropolitan University, United Kingdom

O.2.4 ***Cervical stretch reflexes in normal subjects and bilateral vestibular patients***

Adolfo Bronstein, Imperial College London, United Kingdom

O.2.5 ***Noisy galvanic vestibular stimulation improves dynamic walking stability in healthy subjects***

Klaus Jahn, University of Munich, Germany

O.2.6 ***Precise coding of ankle rotation by lower-limb muscle spindle afferents***

Ryan Peters, University of British Columbia, Canada

O.2.7 ***Contribution of pla ntar-surface mechanoreception in recovery from a slip***

Stephen Perry, Wilfrid Laurier University, Canada

O.2.8 ***Detecting the height of the ground underfoot***

Marie-Laure Mille, Toulon University, France

O.3 Learning, relearning, and adapting

Location: Nervion I-II-III

Co-Chairs:
Marjorie Woolacott, University of Southern California, USA
Kristen Hollands, Liverpool John Moores University, UK

O.3.1 ***The Development of Trunk Control and its Relation to Reaching: A Longitudinal Study***

Jaya Rachwani, University of Oregon, USA

O.3.2 ***The effects of practice and disuse on quadrupedal gait in infants, children, and adults***

Whitney Cole, New York University, USA

O.3.3 ***Adults with Autism Spectrum Disorders do not use vision for postural control***

Susan Morris, Curtin University, Australia

O.3.4 ***Gymnastics skill level affects sensory reweighting processes during quiet stand in children***

Albert Busquets, Institut Nacional d'Educació Física de Catalunya - Barcelona, Spain

O.3.5 ***Gender affects the development of motor learning ability***

Kristin Musselman, Toronto Rehabilitation Institute/University of Toronto, Canada

O.3.6 ***Estimating metabolic cost during non-steady state walking***

Jessica Selinger, Simon Fraser University, Canada

O.3.7 ***Body lateropulsion and visual vertical tilts in unilateral midbrain infarctions: a lesion-behavior mapping and FDG-PET study***

Marianne Dieterich, Ludwig-Maximilians University of Munich, Germany

O.3.8 ***Effects of Levodopa on adaptation of reactive stepping in people with Parkinson's disease***

Daniel Peterson, Oregon Health & Science University, USA

16:30 – 17:00 **Refreshment Break**

17:00 – 19:00 **Parallel Symposia 1-3**

Parallel Symposia

S.1 *Location: Santa Cruz*

Directing motor control research in the 21st century: Should investigations be guided by strong hypothesis-driven questions (YES) or open to discovery of unexpected findings (NO)? - A Yes/No debate

Chair & Discussant: **Stephen Prentice**, University of Waterloo, Canada

Participants: **Michael Cinelli**, Wilfrid Laurier University, Canada
Jacques Duysens, KU Leuven, Belgium
Stephen Robinovitch, Simon Fraser University, Canada
Yuri Ivanenko, Fondazione Santa Lucia, Italy

S.2 *Location: Nervion I-II-III*

Balance implants or external prostheses or perturbation training: Which is the wave of the future?

Chair & Discussant: **John Allum**, University Hospital Basel, Switzerland

Participants: **Herman Kingma**, Maastricht University, Netherlands
Kathleen Sienko, University of Michigan, USA
Clive Pai, University of Illinois, USA
John Allum, University Hospital Basel, Switzerland

S.3 *Location: Giralda I-II*

Free-living activity monitoring in older persons - which outcomes are meaningful?

Co-Chair: **Kristin Taraldsen**, Norwegian University of Science and Technology, Norway

Co-Chair: **Jorunn Helbostad**, Norwegian University of Science and Technology, Norway

Discussant: **Malcolm Granat**, School of Health Sciences, University of Salford, UK

Participants: **Stephen Lord**, University of New South Wales, Australia
Mirjam Pijnappels, VU University Amsterdam, Netherlands
Silvia Del Din, Newcastle University, UK
Jeffrey Hausdorff, Tel Aviv Sourasky Medical Center, Israel

DETAILED PROGRAM

Tuesday, June 30, 2015

10:00 – 10:30 **ISPGR Committees Information Meeting**

10:30 – 11:30 **Keynote Presentation – Amy Bastian,** Kennedy Krieger Institute, USA

Location: Giralda I-II

Learning and relearning locomotor patterns

Chair: **Jeff Hausdorff,** Tel Aviv Sourasky Medical Center, Israel

11:30 – 13:30 **Poster Session 2 & Exhibitors** (refreshments provided)
Giralda III-IV-V Hall-1, Hall-2

13:30 – 14:30 **Lunch & Exhibits**

13:45 – 14:15 **AGM**
Location: Giralda I-II

14:30 –16:30 **Oral Sessions 4-6**

Oral Sessions

O.4 Neurological diseases

Location: Giralda I-II

Co-Chairs:
Lynn Rochester, Newcastle University, UK
Alice Nieuwboer, KU Leuven, Belgium

O.4.1 ***Does a startling acoustic stimulus accelerate postural responses to balance perturbations in stroke survivors?***

Milou Coppens, Radboud University Medical Center, Netherlands

O.4.2 ***Are delayed postural responses to perturbations associated with poorer balance capacity in people after stroke?***

Digna de Kam, Radboud University Medical Center, Netherlands

O.4.3 ***Altered functional connectivity correlates with motor and cognitive control measures within clinical subtypes of Parkinson's disease***

Griet Vervoort, KU Leuven, Belgium

O.4.4 ***Perturbation-based balance training improves step quality in people with chronic stroke***

Jolanda Roelofs, Radboud University Medical Centre, Netherlands

O.4.5 ***Effects of training with a new Smartphone-based biofeedback system (CuPiD) on mobility in people with Parkinson's disease: Clinical outcomes***

Pieter Ginis, KU Leuven, Belgium

O.4.6 ***Postural control alterations in healthy LRRK2 G2019S mutation carriers***

Yoav Beck, Tel Aviv Sourasky Medical Center, Israel

O.4.7 ***Gait is a sensitive marker of motor progression in early Parkinson's disease: A longitudinal correlational analysis***

Brook Galna, Newcastle University, United Kingdom

O.4.8 ***Measuring and minimizing walking-induced fatigue in people with Multiple Sclerosis.***

James McLoughlin, Flinders University, Australia

O.5 Cognitive, attentional and emotional influences

Location: Santa Cruz

Co-Chairs:
Karen Li, Concordia University, Canada
Will Young, Brunel University, UK

O.5.1 ***Prioritization during dual tasking on a circular path is different from prioritization on a straight walking path in older people with poor cognitive flexibility***

Markus Hobert, University of Tuebingen, Germany

O.5.2 ***A virtual reality avatar interaction (VRai) platform for context specific return to function assessment: an example of complex locomotor navigation for the military***

Bradford McFadyen, Laval University, Canada

O.5.3 ***Anxiety affects stance and locomotion in acrophobia and phobic postural vertigo***

Thomas Brandt, German Center for Vertigo and Balance Disorders, Germany

O.5.4 ***Balance impairment and its relation to cognition in a diverse population of elderly fallers and non-fallers***

Kim Dockx, KU Leuven, Belgium

O.5.5 ***Are attentional demands of walking affected by variations in lateral balance? A comparison of young and older adults***

Masood Mazaheri, MOVE Research Institute Amsterdam / VU University Amsterdam, Netherlands

O.5.6 ***Gait rather than cognition dominates the association with physical activity in incident Parkinson's disease***

Sue Lord, Newcastle University, United Kingdom

O.5.7 ***Stay focused! The effects of attentional focus on motor and motor-cognitive dual-task performance after acquired brain injury***

Elmar Kal, Heliomare Rehabilitation, Netherlands

O.5.8 ***Association between Smartphone-based long-term Monitoring Outcomes and Traditional Clinical Assessment Tools in Community-Dwelling Older People***

Sabato Mellone, University of Bologna, Italy

O.6 Coordination of posture and gait

Location: Nervion I-II-III

Co-Chairs:
Rebecca Reed-Jones, University of Prince Edward Island, Canada
Vivian Weerdesteyn, Radboud University Medical Centre, Netherlands

O.6.1 ***Adjustment of the step prior to foot-off in a visuomotor task***
Matthew Bancroft, University College London (UCL), United Kingdom

O.6.2 ***Foot placement adjustment is not always required for recovery in perturbed walking***
Mark Vlutters, University of Twente, Netherlands

O.6.3 ***Motor cortex excitability, attention networks and muscle synergies during single & dual task walking in elderly***
Eling de Bruin, IBWS ETH, Switzerland

O.6.4 ***Multi-limb coordination for lateral stabilization of one-legged balance***
Amy Wu, University of Michigan, United States

O.6.5 ***The effect of restricting arm movements on gait stability in children with Cerebral Palsy and Typically Developing children***
Pieter Meyns, UGent, Belgium

O.6.6 ***Rhythm perception and production abilities relate to motor impairment and temporal gait variability after stroke.***
Kara Patterson, University of Toronto, Canada

O.6.7 ***Do muscle strength and force development differ according to functional abilities in healthy elderly men?***
Charlotte Pion, Université du Québec à Montréal, Canada

O.6.8 ***Vertical ground reaction force during walking: Are they related to bone mineral density left right asymmetries?***
Marina Brozgol, Sourasky Medical Center, Israel

16:30 – 17:00 **Refreshment Break**

17:00 – 19:00 **Parallel Symposia 4-6**

Parallel Symposia

S.4 *Near-Infrared Spectroscopy: Applications of Functional Neuroimaging during Gait and Posture*

Location: Giralda I-II

Chair: **Andrea Rosso**, University of Pittsburgh, USA

Participants:
Patrick Sparto, University of Pittsburgh, USA
Hugh Nolan, Trinity College Dublin, Ireland
Andrea Rosso, University of Pittsburgh, USA
Anat Mirelman, Center for the Study of Movement, Cognition and Mobility, Israel

S.5 ***From Mathematical Theory to Practical Application: Using the Dynamical Systems Approach to Develop Clinical Assessments and Rehabilitative Techniques***

Location: Santa Cruz

Chair: **Joshua Liddy,** Purdue University, USA

Participants: **Denise Cruise**, Purdue University, USA
Brian Cone, University of North Carolina at Greensboro, USA
Michael Busa, University of Massachusetts Amherst, USA
Vivien Marmelat, Universite Montpellier, France

S.6 ***Gazing from bench to beyond: visual control of gait in the real-world and methodological challenges***

Location: Nervion I-II-III

Chair: **Lynn Rochester,** Newcastle University, UK

Participants: **Mark Hollands**, Liverpool John Moores University, UK
Rodrigo Vitorio, Sao Paulo State University, Brazil
Rebecca Reed-Jones, University of Prince Edward Island, Canada
Sam Stuart, Newcastle University, UK

Wednesday, July 1, 2015

10:00 – 14:30 **Excursions**

14:30 – 15:30 **Keynote Presentation – James Lackner,** Brandeis University, USA

Location: Giralda I-II

Experiments in unusual force environments unmask our postural adaptations to earth gravity

Chair: **Geoff Wright**, Temple University, USA

15:30 – 16:30 **Promising Young Scientist Award Talk – Melvyn Roerdink,** MOVE Research Institute Amsterdam, The Netherlands

So you think you can … walk?

16:30 – 17:00 **Refreshment Break**

17:00 – 19:00 **Parallel Symposia 7-9**

Parallel Symposia

S.7 ***Structure of Variability as a Window into what Matters during Mobility***

Location: Santa Cruz

Chair: **Young-Hui Chang**, Georgia Institute of Technology, USA

Participants: **Young-Hui Chang**, Georgia Institute of Technology, USA
Jeffrey Hausdorff, Sackler School of Medicine, Tel Aviv University, Israel
Nicholas Stergiou, University of Nebraska, USA

S.8 ***Control of Balance during Walking in Humans and Robots***

Location: Giralda I-II

Chair: **John Jeka**, Temple University, USA

Participants: **Andy Ruina**, Cornell University, USA
Hendrik Reimann, Temple University, USA
Jessie Huisinga, University of Kansas Medical Center, USA
Manoj Srinivasan, Ohio State University, USA

S.9 ***Impact of hearing impairment on postural control in old age***

Location: Nervion I-II-III

Chair: **Karen Li**, Concordia University, Canada

Participants: **Jennifer Deal**, John Hopkins University, USA
Karen Li, Concordia University, Canada
Jennifer Campos, University of Toronto, Canada
Nicoleta Bugnariu, University of North Texas, USA

19:00 – 21:00 **Drinks & Honorary Member Presentations**

Location: Pool

Thursday, July 2, 2015

10:00 – 10:30 **Round Table with the ISPGR President**

10:30 – 11:30 **Keynote Presentation – Lena Ting,** Emory University, USA

Neuromechanics of gait and balance rehabilitation

Chair: **Shirley Rietdyk,** Purdue University, USA

11:30 – 13:30 **Poster Session 3 & Exhibitors** (refreshments provided)
Location: Giralda III-IV-V Hall-1, Hall-2

13:30 – 14:30 **Lunch & Exhibits**

14:30 – 16:30 **Oral Sessions 7-9**

O.7 Methods and Models

Location: Giralda I-II

Co-Chairs:
Sjoerd Bruijn, VU University Amsterdam, Netherlands
John Jeka, Temple University, USA

O.7.1 ***Kinematic validation of the Interactive Walkway against a gold-standard reference system***

Daphne Geerse, MOVE Research Institute Amsterdam, Netherlands

O.7.2 ***Where are the parameters? A sensitivity analysis of an inverted pendulum balance control model***

Tjitske Boonstra, Delft University of Technology, Netherlands

O.7.3 ***Mechanisms of interpersonal sway synchrony and stability***

Raymond Reynolds, University of Birmingham, United Kingdom

O.7.4 ***The human subthalamic nucleus recruits single neurons for kinematic control using different strategies for movements of upper vs. lower extremities***

Ariel Tankus, Tel Aviv Sourasky Medical Center and Tel Aviv University, Israel

O.7.5 ***Ankle trajectories for the quality and variability of semi-free-living gait in older adults, using a single ankle-worn inertial sensor***

Kejia Wang, UNSW Australia, Australia

O.7.6 ***Muscle activity during walking measured using FDG-PET and 3D MRI segmentations***

Vivian Weerdesteyn, Radboud University Medical Centre, Netherlands

O.7.7 ***Effect of Lab Environment and Segment Angular Velocity on the Accuracy of Orientation Data Issued from Inertial Measurement of Motion in a Clinical Biomechanical Evaluation Context***

Karina Lebel, Université de Sherbrooke, Canada

O.7.8 ***Muscle force prediction of the lower limb compared to surface EMG at different walking speeds in individual healthy subjects***

Ursula Trinler, University of Salford, United Kingdom

O.8 Sensorimotor dysfunction

Location: Santa Cruz

Co-Chairs:
Antonio Nardone, Fondazione Salvatore Maugeri (IRCCS) and University of Eastern Piedmont, Italy
Joyce Fung, McGill University, Canada

O.8.1 ***Relationship between postural sway and motion sickness in young and older adults during a simulated driving task***

Alison Novak, Toronto Rehabilitation Institute, Canada

O.8.2 ***The effect of recurrent low back on trunk neuromuscular performance during complex motion tracking tasks***

Seyed Javad Mousavi, University of Sydney, Australia

O.8.3 ***Further Study on Otolith Function and Head Stability During Gait***

Kazuo Ishikawa, Akita Graduate School of Medicine, Japan

O.8.4 ***Neuromodulation of the sense of upright to improve dynamic balance after stroke***

Dominic Pérennou, Academic Hospital Grenoble, France

O.8.5 ***Wearable sensor-based balance training in older cancer patients with chemotherapy-induced peripheral neuropathy: a randomized controlled trial***

Michael Schwenk, Robert-Bosch Hospital, Germany

O.8.6 ***Effects of implantable peroneal nerve stimulation on energy expenditure, gait quality, participation and user satisfaction in patients with post-stroke drop foot using an ankle-foot orthosis***

Frank Berenpas, Radboudumc Nijmegen, Netherlands

O.8.7 ***Standing slows the production of gaze shifts to double-step perturbations in the elderly***

Paul Stapley, University of Wollongong, Australia

O.8.8 ***Recovery rates of balance control during stance and gait tests after an acute unilateral peripheral vestibular deficit.***

John Allum, University Hospital Basel, Switzerland

O.9 Falls and fall prevention

Location: Nervion I-II-III

Co-Chairs:
Stephen Lord, Neuroscience Research Australia, Australia
Mirjam Pijnappels, VU University Amsterdam, Netherlands

O.9.1 ***What you see is what you step: The horizontal-vertical illusion increases toe clearance in older adults during stair ascent***

Richard Foster, Nottingham Trent University, United Kingdom

O.9.2 ***Gazing into thin air: dual-task costs of movement planning and execution during adaptive gait***

Toby Ellmers, Brunel University, United Kingdom

O.9.3 ***Reduced functional limits of stability during lateral balance perturbations in older adult non-fallers and fallers***

Masahiro Fujimoto, Ritsumeikan University, Japan

O.9.4 ***Reduction in older people's fall risk through home-based exergames targeting balance***

Kim Delbaere, University of New South Wales, Australia

O.9.5 ***Very fast muscle activations during adjustment of tripping responses***

Zrinka Potocanac, KU Leuven, Belgium

O.9.6 ***Fall risk reduction in chronic stroke survivors: Acquisition and retention of reactive adaptation to large-scale slip perturbations***

Tanvi Bhatt, University of Illinois at Chicago, United States

O.9.7 ***A comparison of accuracy of fall detection algorithms (threshold-based vs. machine-learning) using waist mounted tri-axial accelerometer data***

Omar Aziz, Simon Fraser University, Canada

O.9.8 ***Daily-life walking patterns from 1085 days of monitoring in older people with and without a history of falling***

Matthew Brodie, Neuroscience Research Australia, Australia

16:30 – 17:00 **Refreshment Break**

17:00 – 19:00 **Parallel Symposia 10-12**

Parallel Symposia

S.10

Location: Santa Cruz

From neurophysiology to cognitive psychology: How does anxiety influence the regulation of posture and gait?

Chair: **William Young**, Brunel University, UK

Participants: **Mark Carpenter,** University of British Columbia, Canada
Mark Hollands, Liverpool John Moores University, UK
Thomson Wong, Hong Kong University
William Young, Brunel University, UK

S.11

Location: Nervion I-II-III

The Quest to Apply VR Technology to Rehabilitation: Tribulations and Treasures

Chair: **Emily Keshner**, Temple University, USA

Co-Chair: **Joyce Fung**, McGill University, Canada

Participants: **Racheli Kizony**, University of Haifa, Israel
Anouk Lamontagne, McGill University, Canada
Christopher Rhea, University of North Carolina at Greensboro
Geoffrey Wright, Temple University, USA

S.12

Location: Giralda I-II

Advanced measures of gait; why, and how, should we (not?) calculate them?

Chair: **Sjoerd Bruijn**, VU University Amsterdam, The Netherlands

Participants: **Christine Wu**, University of Manitoba, Canada
Nicholas Stergiou, University of Nebraska, USA
Philippe Terrier, Clinique Romande de Réadaptation, Switzerland
Espen Ihlen, Norwegian University of Science and Technology, Norway

20:30 – 01:30 **Closing Gala Dinner**

~ End of Meeting ~

AWARDS

Promising Young Scientist Award Winner 2015

The Promising Young Scientist Award acknowledges superior research by a young investigator in Posture and/or Gait. The Awards Committee is pleased to announce this year's award recipient –

Melvyn Roerdink, MOVE Research Institute Amsterdam, VU University Amsterdam

So you think you can … walk?

Falling is a common, costly and impactful health problem. Most falls occur during walking, caused by trips, slips or misplaced steps following unsuccessful interactions with indoor and outdoor environmental contexts (e.g., obstacles, a puddle, uneven terrain). Major contributors to gait-related falls –gait adjustments during gait-environment interactions and associated attentional costs– are difficult to assess routinely, which hinders their prediction and prevention. In this presentation, I will discuss recent gait adaptability research using novel technologies introduced to evaluate to what extent a person is 'walk-able' and to help improve a person's 'walk-ability' by training gait-environment interactions.

Research and Innovation Award in memory of Aftab Patla

Sponsored by Northern Digital, Inc.

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RESEARCH-GRADE MOTION CAPTURE

The congress will offer two student poster presentation awards in honour of Dr Aftab Patla. One award will be for basic science and one for clinical science. Recipients will be chosen from a panel of researchers based on several criteria including:

Creativity and originality of research / clarity of presentation / level of understanding

The award will be announced at the Gala Dinner on Thursday, July 2, 20:30 – 1:30.

KEYNOTE SPEAKERS

Daniel Wolpert

University of Cambridge, United Kingdom

Daniel Wolpert read medical sciences at Cambridge and clinical medicine at Oxford. He completed a PhD in the Physiology Department at Oxford and was a postdoctoral fellow at MIT, before moving to the Institute of Neurology, UCL. In 2005 he took up the post of Professor of Engineering at the University of Cambridge and was made a Fellow of Trinity College. He was elected a Fellow of the Academy of Medical Sciences in 2004 and was awarded the Royal Society Francis Crick Prize Lecture (2005), the Minerva Foundation Golden Brain Award (2010) and gave the Fred Kavli Distinguished International Scientist Lecture at the Society for Neuroscience (2009). In 2012 he was elected a Fellow of the Royal Society (FRS) and made a Wellcome Trust Senior Investigator. In 2013 he was appointed to the Royal Society Noreen Murray Research Professorship in Neurobiology. His research interests are computational and experimental approaches to human sensorimotor control (***www.wolpertlab.com***).

Probabilistic models of sensorimotor control and decision making

The effortless ease with which humans move our arms, our eyes, even our lips when we speak masks the true complexity of the control processes involved. This is evident when we try to build machines to perform human control tasks. I will review our work on how humans learn to make skilled movements covering probabilistic models of learning, including Bayesian and structural learning as well as the role of context in activating motor memories. I will also review our work showing the intimate interactions between decision making and sensorimotor control processes. This includes the bidirectional flow of information between elements of decision formations such as accumulated evidence and motor processes such as reflex gains. Taken together these studies show that probabilistic models play a fundamental role in human sensorimotor control.

Karen Adolph

Infant Action Lab, USA

Karen Adolph is Professor of Psychology and Neuroscience at New York University. She received her B.A. from Sarah Lawrence College, her Ph.D. from Emory University, and completed a postdoctoral fellowship at the Albert Einstein College of Medicine. Adolph leads the Databrary.org project to enable video data sharing among developmental scientists. She is a Fellow of APA and APS and President of the International Society for Infant Studies. She received a Cattell Sabbatical Award, the APF Fantz Memorial Award, the APA Boyd McCandless Award, the ISIS Young Investigator Award, FIRST and MERIT awards from NICHD, and four teaching awards from NYU. She chaired the NIH study section on Motor Function and Speech Rehabilitation and is on the Advisory Board of the McDonnell Foundation and the editorial board of Developmental Psychobiology. Adolph's research examines effects of body growth, exploratory activity, environmental and social supports, and culture on perceptual-motor learning and development.

How Infants Learn To Walk (And How They Don't)

Typically, researchers represent the development of locomotion as a series of increasingly upright milestones and study locomotor development in terms of improvements in gait as infants crawl or walk on a treadmill or along a straight uniform path. However, the milestone and gait approaches to locomotor development have important empirical and conceptual flaws. I suggest several alternative ways to study how infants learn to walk: (1) Observing the development of natural locomotion in the everyday environment will provide insights into the phenomenon researchers ostensibly wish to explain and facilitate. (2) Examination of effects of functional changes in the body will inform on how infants learn to walk in the context of ongoing physical development. (3) Focus on infants' use of perceptual and social information will reveal

how infants guide locomotion through a cluttered natural environment. (4) Assessment of the developmental sequelae of independent mobility will situate locomotion in a larger developmental context. (5) Inclusion of a broader sample of infants will reflect how cultural differences in childrearing practices affect the development of locomotion. (6) Sharing videos and other forms of raw data will lead to greater transparency, allow for data reuse, and facilitate integrative analyses.

Amy Bastian

Kennedy Krieger Institute, USA

Dr. Amy Bastian is a neuroscientist and physical therapist who studies the neural control of human movement. She has a special interest in cerebellar motor disorders, stroke, motor learning, and walking control. She is the Director of the Motion Analysis Laboratory at the Kennedy Krieger Institute and Professor of Neuroscience at Johns Hopkins. Her research uses computerized movement tracking techniques and novel devices to control walking and reaching movements. She studies how humans with and without neurological damage control movement and learn new patterns.

Learning and relearning locomotor patterns

Human locomotor learning depends on a suite of brain mechanisms that are driven by different signals and operate on timescales ranging from minutes to years. Understanding these processes requires identifying how new walking patterns are normally acquired, retained, and generalized, as well as the effects of distinct brain lesions. The lecture will focus on normal and abnormal locomotor learning, and how we can use this information to improve rehabilitation for individuals with neurological damage.

James Lackner

Brandeis University, USA

James R. Lackner received his undergraduate and graduate training at the Massachusetts Institute of Technology. He is currently Director of the Ashton Graybiel Spatial Orientation Laboratory and Riklis Professor of Physiology at Brandeis University. His research interests concern human movement control and orientation in unusual force conditions, including weightless, high force, and rotating artificial gravity environments. Experiments in these different contexts have led to insights into how our bodies are dynamically tuned and adapted to the background acceleration of Earth gravity. A major recent interest has been adaptation of postural control to rotating environments and its implications for understanding mechanisms of fall recovery after perturbations of stance. This work is leading to development of non-parallel 2-leg models of balance control as well as haptic cueing techniques for stabilizing posture and enhancing postural recovery during falls. The role of the otolith organs in modulating the integration of semicircular signals during dynamic balancing is an ongoing research theme as well.

Experiments in Unusual Force Environments Unmask Our Postural Adaptations to Earth Gravity

This presentation will describe how experiments conducted on orientation and postural control in non-1 g and rotating environments provide insights into the dynamic sensory-motor adaptations of our bodies to the terrestrial force background of Earth gravity. We are not consciously aware of most of these adaptations because the central nervous system carries them out automatically. We become aware of them during exposure to non-1g accelerations because errors in the execution and appreciation of our movements result.

Lena Ting

Emory University, USA

Dr. Ting is a Professor in the W.H. Coulter Department of Biomedical Engineering at Emory University and Georgia Institute of Technology. She received a B.S. in Mechanical Engineering at the University of California at Berkeley, an M.S.E. in Biomechanical Engineering and Ph.D. in Mechanical Engineering from Stanford University. She received postdoctoral training in neurophysiology at the University of Paris V, and Oregon Health and Sciences University. Her research in neuromechanics focuses on the sensorimotor interactions between brain, body, and environment at the level of muscular coordination during balance and gait in humans and animals using methods from neurophysiology, rehabilitation, robotics, and biomechanics. She uses experimental and computational methods to understand the neural basis of the structure and variability of sensorimotor patterns and has recently developed collaborations to use such methods to understand of gait and balance deficits and mechanisms of rehabilitation in stroke, spinal cord injury, Parkinson's disease, and lower limb loss."

Neuromechanics of gait and balance rehabilitation

Understanding how neural and biomechanical interactions shape the way we move is critical in the study of whole body tasks such as gait and balance. Neuromechanical interactions define whether and how neural signals can influence motor function as well as how biomechanics may affect the structure of neuromotor organization. As there are no one-to-one relationships between neural signals and biomechanical variables, variations in neuromotor signals within and across individuals must be carefully interpreted. Depending on the context, variations in neuromotor signals can have no effect, or conversely, play a critical role in motor function. Using a neuromechanical approach to define motor deficits in neurological disorders may be particularly important for developing novel rehabilitation paradigms using adjuvant therapies, which enhance neural plasticity in combination with training to improve specific motor functions. I will give examples of novel gait and balance rehabilitation paradigms in individuals with stroke, spinal cord injury, and Parkinson's disease. Ultimately, neuromechanical approaches may help refine clinical testing to provide better specificity for diagnostic criteria and rehabilitation treatments, develop predictive models to identify individuals and subpopulations that stand to benefit the most from a given treatment, and facilitate the identification of physiological mechanisms of motor deficit and recovery.

SYMPOSIA ABSTRACTS

Symposium I Monday June 29, 17:00 - 19:00

Directing motor control research in the 21st century: Should investigations be guided by strong hypothesis-driven questions (YES) or open to discovery of unexpected findings (NO)? - A Yes/No debate

Chair and Discussant: **Stephen Prentice**, University of Waterloo, Canada

Michael Cinelli
Wilfrid Laurier University, Canada

The necessity of a hypothesis for scientific research

A hypothesis is a tentative statement about the relationship between two or more variables and it is a testable prediction about what the researcher expects to happen. The science community has long accepted hypothesis-driven approach to research. I believe this because the generation of a hypothesis is the most important stage of the scientific method as it demonstrates the researcher's knowledge of the area of research, it implies the researcher's theoretical viewpoint, and it provides insights into the design of the study. Some researchers may argue that their research is exploratory in nature and question the necessity of a hypothesis in science (motor control) research (Winter, 1987). These researchers allow their findings to "speak" to them and are more informative as they result from an unbiased approach to data analysis. However, this shotgun approach leaves one wondering about the direction or implications of the research as he or she collects the random pieces of results. On the other hand, hypothesis-driven research is an essential systematic way of thinking that begins with the collection of observations that are evaluated and assessed to determine possible causes of the problem. From here the researcher will create a list of possible explanations to explore (i.e., hypotheses) and then the controlled experiment(s) will emerge from the researcher's ability to think of ways to confirm or disprove these hypotheses (Popper, 1992). Hypothesis-driven research is not only based on scientific theories, but it is driven by best practices whereas exploratory research is driven more by hope and chance of discovery (Haufe, 2013). Exploratory research's haphazardness makes its serendipitous findings less credible. Research credibility is based on the theoretical framework in which discoveries were devised. Only hypothesis-based research maintains strong credibility through its empirical findings because it informs theories- the most reliable, rigorous, and comprehensive form of scientific knowledge (Schafersman, 1997). Therefore, it is prudent that research be driven by sound empirical questions rooted in theory (i.e., hypothesis-based) and not by advancements in technology or curiosity (exploratory).

Jacques Duysens
KU Leuven, Belgium

Why we should fight the tyranny of hypothesis testing

In the field of posture and gait research there is a vast majority of papers claiming that they aim to test one or more hypothesis while very few admit that they are exploratory in nature.

In contrast, in private conversation it is often admitted that studies were set up out of curiosity and/or to answer a given question, rather than to test a specific hypothesis. The strong bias towards published papers claiming to test specific hypothesis, leads to the suspicion that in reality some of these hypotheses are made up after termination of the experiments, rather than beforehand. In other cases the hypothesis is just a formulation of current knowledge and so obvious that nobody expects that it would be refuted. Rowbottom and Alexander (2012) took a close look at this phenomenon of fake hypotheses. They analyzed 100 papers from 2 biomechanics journals (Journal of Biomechanics and The Journal of Experimental Biology). They explored how often work was presented as testing a hypothesis, when the intent was different. They found that none of the papers stated exploration as an aim while 58% of papers claimed to be hypothesis-driven. Out of the latter group approximately one third (31%) were strongly suspected to contain, what they termed "presentational hypotheses" (e.g. hypotheses which "did not seem to have influenced the actual study"). They further

speculated that this practice of overemphasis on hypothesis formulation may be partly due to exploration being filtered out by the refereeing process. If researchers suspect that their chances of publication will be increased by presenting their work as "hypothesis-driven" they will do so. In reality some of these studies may have been made in the hope of finding something interesting, without requiring any hypotheses testing. Biomechanics experts may have adopted this 'hypothesis testing talk' to make their work appear manifestly scientific but one can question whether this practice has really benefitted the research reported. We agree with Rowbottom and Alexander (2012) that "presentational hypotheses are at best unnecessary" and we argue that science still benefits from 'fishing trips", provided one is able to identify those areas where interesting questions can be formulated and where careful examination might reveal unexpected new findings. Better a good question than a fake hypothesis.

Stephen Robinovitch
Simon Fraser University, Canada

The most useful science involves hypothesis testing

Should scientific investigations in posture and gait research be driven by strong hypothesis-driven questions? Yes - I believe the bulk of the work we do as scientists should be hypothesis-driven research. While many of us in the ISPGR community are involved in engineering - the development of new methods and technologies – the majority of us identify ourselves most strongly as scientists. True scientific breakthroughs, and indeed most scientific progress, occurs either in the laboratory or the field under carefully controlled conditions, where all the necessary precautions have been taken in the study design to examine the association between the independent and dependent variable, using established tests of statistical inference. Hypothesis testing allows us to answer scientific questions (with a quantifiable degree of certainty), and knowledge arises when the answer is sufficiently repeatable. While one may find it frustrating, there are important reasons why the Cochrane reviews and meta-analyses, which clinicians rely on so heavily for decision-making, only consider randomized controlled trials, and repeatable observations, as a basis for their recommendations [1].

Should investigations be open to discovery of unexpected findings? I also believe the answer to this question is also yes. The two questions are not mutually exclusive. The crucial thing is to recognize that hypothesis-driven research actually promotes the discovery of unexpected findings, since it establishes the conditions necessary to detect relationships between two variables. For example, today's news reported of a supposed breakthrough in the prevention of skin wrinkling in aged mice [2]. This was first observed, to the surprise of the UBC researcher team, in studies designed to test the effects of an enzyme on blood vessel development. I argue that the researchers would not have observed this finding, had they not started with a hypothesis-driven question that allowed them to examine the isolated effect of the enzyme through intervention and control groups.

So if we want to aim for scientific breakthroughs, we should direct our efforts to hypothesis testing. If we fear negative results, perhaps the study is not worth pursuing. The best experiments are those where the answer is interesting, regardless of whether it supports the hypothesis. Certainly, to broaden the impact of our scientific efforts, we must also engage in knowledge translation (KT) that is not hypothesis-driven. An important part of KT is listening to stakeholder communities (e.g., clinicians and patients) to identify important research questions and hypotheses.

Yuri Ivanenko
Fondazione Santa Lucia, Italy

The principles underlying the discovery of biological mechanisms

Philosophers have made numerous attempts to frame the principles that guide research and innovation (Silva 2007), from strongly hypothesis-driven guidance (Erren 2007) to exploratory research (Winter 1987).

Many of the best experiments were hypothesis driven and many of the exploratory (non-hypothesis driven) experiments resulted in major new knowledge. Nevertheless, while hypotheses and models allow one to formulate and test interesting questions, there is also a danger to produce a kind of 'data fitting' that supports the original hypothesis (Ajemian & Hogan 2010). The fact that the data support the hypothesis or the model does not necessarily imply that other models cannot. The alternative to 'hypothesis-driven' research is 'idea-driven' research, which does not necessarily require a very deterministic approach. As an example of the non-hypothesis driven approach, one may 'perturb the variable and see what changes result' or 'observe the particular and relate it to the general' (Winter 1987). Much depends on the ability of the individual scientist to make a synthesis of the results and to uncover the phenomenon. Unfortunately, the hypothesis driven research becomes a requirement in some scientific communities/journals. However, motor neuroscience remains at a descriptive stage due to the incredible complexity of the problem to be solved and one should be very cautious about assuming too much (Ajemian & Hogan 2010). It is of course important to have some hypotheses (or ideas) prior to performing experiments. Yet, it is also very important for the scientist to be open to change his/her mind completely rather than being stuck to the original hypothesis because, as very often is the case, the original hypothesis is likely wrong. While it may be useful to show that a given hypothesis is not supported, that in itself seldom advances the science. As we know from past discoveries, some of the suggestions based on the hypothesis may be completely revised as empirical data accumulate. This is best described by the neurophysiologist Victor Gurfinkel – 'a scientific truth is what we mistakenly believe today'. As a final point, all scientists would probably agree that we should be open to unexpected findings. Can we predict discoveries? The obvious answer is No.

Symposium II Monday June 29, 17:00 - 19:00

Balance implants or external prostheses or perturbation training: Which is the wave of the future?

Chair and Discussant: **John Allum**, University Hospital Basel, Switzerland

Herman Kingma
Maastricht University, Netherlands

Walking with a Vestibular Implant: Normalization of dynamic visual acuity in patients with bilateral vestibular loss

Background and aim:
Patients with a bilateral vestibular loss (BVL) lack a properly functioning vestibulo-ocular reflex (VOR), which impairs gaze stabilization. This results in an abnormal loss of visual acuity (VA) in dynamic situations. For instance, while walking, BVL patients' abilities to read signs or recognize faces is severely limited. Currently, it is still not possible to treat efficiently this handicap. Our group has provided promising results demonstrating that the VOR can be artificially restored with the Geneva-Maastricht Vestibular Implant (GM-VI). This study was designed to investigate whether this restoration results in an improvement of dynamic VA.

Methods:
Five BVL patients, unilaterally or bilaterally deaf, were fitted with the Geneva-Maastricht vestibular implant (GM-VI). This device consists in a modified cochlear implant (MED-EL, Innsbruck, Austria) providing extracochlear electrodes for "vestibular" stimulation. Motion sensors fixed to the patient's head, controlled the amplitude of electrical stimulation delivered through "vestibular" electrodes to the posterior or to the superior ampullary nerve. VA was determined using Sloan letters displayed on a computer screen in four conditions: (1) with the patient standing still (static), (2) while the patient was walking on a treadmill at constant speed with the GM-VI turned off (system OFF), (3) while the patient was walking on a treadmill at constant speed with the GM-VI turned on providing coherent motion information (system ONmotion), and (4) while the patient was walking on a treadmill at constant speed with the GM-VI turned on but providing aberrant motion information

(i.e., electrical noise; system ONnoise). VA values in each condition were normalized to those obtained in the static condition. A one-way repeated measures analysis of variance (ANOVA) was conducted to compare VA differences across conditions.

Results:
Group results are presented. The ANOVA analysis revealed a statistically significant difference between conditions ($F(3,12) = 30.04$, $p<0.0005$). Post hoc tests using the Bonferroni correction revealed a significant decrease ($p<0.05$) in VA in the system OFF and in the system ONnoise conditions when compared to the static and the system ONmotion There was no difference between either the system ONnoise and the system OFF conditions, or between the system ONmotion and the static conditions.

Conclusions:
In BVL patients, motion-modulated electrical stimulation of the vestibular nerve provided a significant improvement of the dynamic visual acuity while walking. This demonstrates that the GM-VI can significantly improve gaze stabilization by artificially restoring vestibular function. For the first time it offers a promising therapeutic alternative for patients with a BVL.

Kathleen Sienko
University of Michigan, USA

Sensory augmentation devices: balance aid or rehabilitation device?

Background:
Sensory augmentation is a technique of augmenting or replacing compromised sensory information through, for example, vibrotactile cues of body motion. Numerous studies in balance-impaired patient populations and older adults have demonstrated that real-time visual, vibrotactile, and auditory cues of body motion decrease trunk sway in a laboratory setting during static and dynamic standing tasks. This presentation will explore our findings and the findings of other researchers that support sensory augmentation as a balance aid and rehabilitation device.

Studies:
In one study, eight vestibulopathic subjects were given unpredictable random perturbations while standing on a moving horizontal platform. In trials when vibrotactile cues were provided, subjects' root-mean-square (RMS) tilt was significantly less than trials when the cues were absent. This effect was most apparent in the 0.3 Hz to 2.0 Hz frequency range. Two studies of vestibulopathic subjects' performance during the sensory organization tests (SOT) of computerized dynamic posturography showed essentially the same results. Namely, vibrotactile cues increased subjects' SOT scores and decreased their number of falls. The second of these studies showed that use of a vibrotactile feedback cue comprising tilt displacement and tilt velocity information was more effective compared to cues that relied only upon displacement or velocity. Despite the success of sensory augmentation technologies over the past ten years in improving standing balance for persons with balance deficits in laboratory settings, significant scientific questions remain unanswered. For example, given that the effects of sensory augmentation during locomotor tasks have been less compelling than results during standing balance, can sensory augmentation be used to provide meaningful cues during locomotor activities and thereby be an effective real-time balance aid? The use of medio-lateral (M/L) vibrotactile tilt cues during eyes-closed tandem walking in nine subjects with unilateral vestibular deficits significantly reduced their RMS M/L tilt when compared to trials for which no cues were provided. In another study involving 12 elderly community-dwelling subjects who had mild to moderate sensory deficits, M/L vibrotactile cues enabled these subjects to increase their DGI scores by three points, a difference that is both statistically and clinically significant. However, in some locomotor studies involving sensory augmentation, gait velocity and secondary task performance were observed to decrease, and subjects negatively altered their segmental control strategies when cues were provided following short training sessions. A further question is whether the carry-over effects of training with a sensory augmentation technology exceed the carry-over

effects of training alone, thereby supporting its use as a rehabilitation device. Preliminary results suggest that improvements in balance performance persist over time periods of hours to days following a small number of training sessions with a sensory augmentation device. Additional long-term clinical and home-based controlled training studies are currently in progress.

Conclusions:
Sensory augmentation may provide balance-impaired patients with additional sensory input to promote central compensation during a specific exercise/activity. Both in the clinic and at home, sensory augmentation technologies enable physical therapists to monitor patient compliance and progress over multiple sessions. Patient knowledge about balance performance can lead to enhanced exercise compliance and changes in postural control.

Clive Pai
University of Illinois, USA

Inevitable or preventable: Perturbation training may reduce community-dwelling older adults annual risk of falls

Introduction:
Falls often occur without any warning, even among the healthiest, causing devastating injuries or even death. Often without any warning sign or the presence of idopathological symptoms, falls can almost appear inevitable. Countless efforts and resources have been devoted to prevent such occurrences. Yet random search of the internet after a snow storm reveals that emergency room visits of local hospitals have tripled or quadrupled as result of incoming patients with injuries from falls. Would it not be desirable to "inoculate" older adults against falls once before the winter thereby reducing the likelihood of fall occurrence? This idea may not be too far fetched. The purpose of this randomized-controlled-trial (RCT) study was to determine the extent to which perturbation training can reduce the risk of falls among community-dwelling older adults.

Methods:
Two hundred and twelve community-dwelling older adults (> 65 years old) were randomly assigned to either a training group (N = 109) who then were repeatedly exposed to 24 unannounced slips during walking on a 7 m walkway, or to a control group (N = 103) who experienced merely one unannounced slip on the same walkway in the same protective laboratory environment. A motion capture system was used to determine the stability during walking (indicative of their proactive control) as well as during recovery following the slip onset (indicative of their reactive control). Outside of laboratory, we recorded their falls in the preceding year (through intake of their self-reported history during the initial session) and during the next 12 months (through falls-diary monitored with phone calls).

Results:
With this single session of repeated-slip exposure, training reduced older adults' annual risk of falls by 50% (from 34% to 15%, $p < 0.05$). Those who experienced merely a single slip were 2.3 times more likely to fall during the same 12-month follow-up period ($p < 0.05$) than those who experienced the 24 repeated slips. The training effect of repeated slips was especially prominent among those who had a history of falls. The reduction in risk of falls was associated with significant improvements in both proactive and reactive control of stability ($p < 0.01$) during the session of repeated-slip exposure. The retention of these improvements was especially remarkable, such that 12 months after the initial exposure to 24 slips, older adults' stability recorded during laboratory retest was still significantly greater than that of their corresponding first, novel slip.

Conclusions:
While earlier studies have revealed inter-task, inter-spatial, and remarkably, even inter-perturbation-type response generalization among young adults, the present study was the first to observe that a single session

of repeated-slip exposure could indeed improve community-dwelling older adults' resilience to postural disturbances in their everyday living. Hence, idiopathic falls no longer appear to be inevitable, either inside or outside of the laboratory environment, as these older adults significantly reduced their annual risk of falls.

John Allum
University Hospital Basel, Switzerland

Balance implants or external prostheses or perturbation training: A discussion on which is the wave of the future?

Background.
Balance impairments affect a large population of individuals especially the elderly, in addition to those with vestibular deficits, CNS disorders, peripheral neuropathies, and stroke. Recognizing the reduced quality of life, increased financial costs, and increased mortality risk associated with falls, a major scientific effort is underway to determine which new techniques holds the promise of significantly reducing fall risk: vestibular implants, wearable external sensory augmentation devices and balance perturbation training. The first two possibilities aim to replace the vestibular system, either directly or via sensory substitution as this system plays a crucial role in the control of balance. When vestibular function is deficient, essential tasks such as postural control and gaze stabilization are not performed normally. Furthermore, the quality of life of patients is significantly impaired. Balance perturbation training aims to induce adaptive control of stability in daily locomotion, its retention and generalization to other destabilizing postural disturbances.

The questions that need to be debated in this session are similar to those of cochlear implants three decades ago: which technique will improve life-quality most cost-effectively? Then the discussion was between cochlear implants or vibro-tactile feedback of sound. While an artificial vestibular system might be the appropriate solution for many persons with balance impairments, such systems are just on the cusp of clinical reality. A few patients with total vestibular loss have received implants very similar to cochlear implants, but with the additional capability of restoring vestibulo-ocular function with gyroscopes driving vestibular stimulation. Others consider that elderly fallers may be better served by external wearable aids which provide vibro-tactile feedback of body sway for balance rehabilitation as opposed to implants because the former provide persistent carry-over improvements in balance even weeks after an intense training program. It is debatable however whether such systems improve balance during gait, that is, not just for stance. Alternatively, it may prove more cost effective to reduce anxiety and provide training in fall-avoidance strategies during walking as a form of "inoculation" against future falls.

In this symposium we will bring together leaders in the field to share their research and views with the aim of sparking discussions and debate on the issues involved with each device. Ideally, new directions for future research will emerge to address several questions:

Questions
1) Which technique is likely to be more effective in reducing falls and why?
2) What are the advantages and disadvantages for the user and the training institution for each system?
3) Would it advantageous to combine systems, for example, vibro-tactile feedback stimulation during perturbation training?
4) Which systems achieve improvements just in stance or just in gait and why not both?
5) Of the two non-implant techniques which provides the greatest carry-over effect after training?
6) Is there an after-effect when the implant is switched off?
7) Can implants restore vestibulo-spinal as well as vestibulo-ocular function?
8) Can vibro-tactile feedback improve vestibulo-ocular function?

Symposium III Monday June 29, 17:00 - 19:00

Free-living activity monitoring in older persons - which outcomes are meaningful?

Co-Chair: **Kristin Taraldsen**, Norwegian University of Science and Technology, Norway
Co-Chair: **Jorunn Helbostad**, Norwegian University of Science and Technology, Norway
Discussant: **Malcolm Granat**, School of Health Sciences, University of Salford, UK

Stephen Lord
University of New South Wales, Australia

Remote monitoring by accelerometers reveals how clinical attributes of older people influence daily walking patterns

Impaired gait in older people is associated with disabilities in daily life and increased risk of falling. However, knowledge is still limited on what underpins the quantity, quality, and intensity of walks in daily life. This presentation will provide an overview of the use of free-living activity monitoring data to understand daily physical behavior in older people and provide an example of this work by presenting the findings from a recent study conducted by investigators at NeuRA, in Sydney, Australia.

In a study of remote monitoring, 24 participants (mean age: 82.0 ± 7.4) underwent a battery of health, psychological, sensorimotor, cognitive, and physiological tests and then wore a small pendent accelerometer in their homes for a period of several weeks. Gait measures extracted included gait domains of quantity, exposure, intensity and quality were investigated and compared for those with and without a history of falls.

We found day-to-day gait performances varied considerably. Participants completed more short walks relative to long walks, as approximated by a power law. Overall, walks ≤13 seconds in duration comprised 50% of exposure to walking-related falls. Daily-life cadence was bimodal and step-time variability followed a log-normal distribution. Fallers took significantly fewer steps per walk, had relatively more exposure from short walks and greater mode of step-time variability. Better functional mobility, reduced fear of falling and increased physiological capacity were associated with all three domains of the gait assessment (quantity, quality and intensity). Age and depressive symptoms were primarily correlated with reduced number of walks (quantity). Processing speed, executive functioning, and health factors were primarily associated with increased gait variability (quality).

In summary, the study findings indicate short walks constitute a large proportion of exposure to falls in older people. The study also confirms that older people at risk of falls and those with worse performance on clinical tests are more likely to undertake fewer walks of higher intensity and with greater variability in step timing in daily life.

Mirjam Pijnappels
VU University Amsterdam, Netherlands

Deriving gait quality measures from free-living activity monitoring

Ambulatory measurements of trunk accelerations can provide valuable information on the quality and amount of daily life activities and contribute to the identification of individuals at risk of falls. We investigated whether daily-life gait quality measures can add information to gait analyses measures obtained in the lab and how these quality measures can be used in fall risk prediction.

First, trunk accelerations of 18 older adults were recorded during walking for 4 minutes on a treadmill and for 1 week during daily life. Twenty-three fall-risk-related gait characteristics were estimated and compared between treadmill and daily-life measurements. Estimates from both settings were compared for systematic differences and correlations, which were assumed to indicate situational and personal fall risk factors, respectively. The

gait characteristics indicated less stable, less symmetric, and more variable gait during daily life than on the treadmill, while about half of the characteristics were correlated between conditions. These results suggest that daily-life gait analysis is sensitive to both physical capacity as well as behavioral and environmental determinants of fall risk.

Then, we investigated the predictive value for prospective falls over a follow-up period of 6 months of parameters on the amount and quality of gait in 169 older adults. We found that the predictive ability of commonly used questionnaires (area under the receiver operating curve (AUC) of 0.68) improved significantly by accelerometry-derived parameters of gait quality (local dynamic stability, intensity, smoothness), quantity (number of strides) and their interactions (AUC of 0.81).

As this fall risk prediction was based on median values of daily life gait quality characteristics, we further explored the added value of extreme values of gait characteristics (10th and 90th percentiles). It was found that particularly the extremes at the low-risk end of some characteristics were associated stronger with falling than the median values. These stronger associations were found for low variability, instability and entropy, and high regularity and symmetry. These low-risk values were suggested to reflect steady-state or 'high-quality' gait epochs. However, the use of extreme values of gait characteristics instead of their medians did not significantly improve the prediction models based on questionnaires, activity durations, and median values of gait characteristics.

Finally, we performed a cross-validation study on our prediction model based on factor analysis of clinically-used fall risk factors and daily-life trunk accelerometry and 1-year prospective fall incidences in 313 older adults. Using survival analysis with 10-fold cross validation, we obtained an AUC of 0.64-0.67 for time to first fall using principle components related to history of falls, fear of falling and depression. For time to second fall, we obtained an AUC of 0.69-0.78 using factor scores related to fear of falling and depression, history of falls and gait quality. These results suggest that accelerometry mainly contributes to the prediction of recurrent falls.

Silvia Del Din
Newcastle University, UK

Advantages and challenges in describing gait from free-living activity monitoring

Gait is emerging as a powerful tool to detect early disease and monitor progression across a number of diseases. Typically quantitative gait assessment has been limited to specialised laboratory facilities. However, measuring gait in home and community settings may provide a more accurate reflection of gait performance because: (1) it will not be confounded by attention which may be heightened during formal testing; and (2) it allows performance to be captured over time. Modern accelerometer-based monitors allow objective measurement of free-living ambulatory activity (macro level) as well as discrete gait characteristics (micro level). Although macro characteristics have been described in previous studies, quantifying micro gait characteristics in unsupervised environments presents considerable challenges. This presentation will address the feasibility and challenges of measuring discrete gait characteristics (micro level) during free-living activity using our own studies. It will compare gait characteristics evaluated from accelerometry-based free-living data collected over 7 days with data collected in the laboratory during scripted tests. The use of micro level gait outcomes as a measurement tool for characterising patient populations, discriminating disease and monitoring disease progression will also be discussed. This will be done by comparing data from healthy older adults with people with Parkinson's disease (PD). Our preliminary results suggest that micro level free-living data can discriminate between healthy older adults and people with PD better than laboratory based data. Although free-living quantification of gait behaviour remains a challenge due to sensor limitations and contextual recognition, our preliminary results are encouraging regarding the use of a single accelerometer-based monitor for application in large multi-centre clinical trials and in guiding clinical decision making.

Jeffrey Hausdorff
Tel Aviv Sourasky Medical Center, Israel

Can a body-fixed sensor reduce the uncertainty when it comes to the evaluation of mobility? Effects of aging and fall risk on transitions in daily living

Background:
Functional-performance based test like the Timed Up and Go test (TUG) and its subtasks have been associated with fall risk, future disability, nursing home admission and other poor outcomes. However, a single measurement in the laboratory may not fully reflect the subject's condition and everyday performance. To begin to validate an approach based on long-term, continuous monitoring, we investigated the sit-to-walk and walk-to-sit transitions performed spontaneously and naturally during daily living in four groups of subjects.

Methods:
30 young adults, 38 older adults, 33 elderly (idiopathic) fallers and 99 patients with Parkinson's disease (PD) were studied. After evaluating mobility and functional performance in the laboratory, participants wore a sensor that contained a 3D accelerometer and 3D gyroscope on their lower back for 3 days. We analyzed the sit-to-walk and walk-to-sit transitions using temporal measures (e.g., time to complete the transition, acceleration during the transition) and distribution-related features (e.g., cumulative distribution function applied to repeated measures). Machine learning algorithms assessed the feature set's ability to discriminate between the different cohorts.

Results:
More than five thousand transitions were analyzed. Significant differences were observed between the young and older adults ($p<0.044$) and between the fallers and older adults ($p<0.032$). Machine learning algorithms classified the young and older adults with an accuracy of about 98% and the fallers and the older adults at 88%, which was better than the results achieved using traditional laboratory assessments (~72%).

Many differences were also seen when comparing the transitions of the patients with PD to those of the older adults. When applying the AdaBoostM1 algorithm, for example, the accuracy, specificity and sensitivity using machine learning were 90.2, 76.3, and 91.0, respectively, based on 41 features extracted from the daily life transitions. In contrast, using conventional in-lab measures, accuracy, specificity and sensitivity using machine learning were only 80.7, 48.2, and 83.1, respectively.

Conclusions:
Features extracted from the multiple transitions recorded during daily living apparently reflect changes associated with aging, fall risk, and Parkinson's disease. Long-term monitoring of temporal features and their distributions may be help to provide a more complete and accurate assessment of the effects of aging, fall risk and neurodegenerative disease on daily functioning and mobility.

Symposium IV Tuesday June 30, 17:00 - 19:00

Near-Infrared Spectroscopy: Applications of Functional Neuroimaging during Gait and Posture

Chair: **Andrea Rosso**, University of Pittsburgh, USA

Patrick Sparto
University of Pittsburgh, USA

Understanding cortical responses during vestibular and balance function tests using NIRS

Mobility is an essential component of daily life. Because of the physical movement involved in sensori-motor processes related to mobility, neuroimaging tools such as fMRI or PET are limited in their ability to measure brain activity during upright movement. Functional near-infrared spectroscopy (fNIRS), a non-invasive technology that uses light to measure changes in the hemodynamic state of the brain (Obrig et al., 2003), is a

promising tool to investigate the brain activity during vestibular stimulation and control of standing balance and gait.

One of our studies investigated cortical changes in blood flow during bithermal caloric vestibular stimulation in young and older adults (Karim et al., 2013a). Activation of the vestibular cortical region (superior temporal gyrus) reflected the time course of the vestibular nystagmus. Warm stimulation produced greater activation in bilateral vestibular cortical regions compared with cool stimulation. In addition, older adults had stronger bilateral responses during the cool stimulation.

Another ongoing study is examining changes in brain activity in young and older adult subjects during earth-vertical axis rotation, a functional vestibular stimulation that is performed while subjects are seated upright. The temporal dynamics of the responses in the vestibular cortical region were consistent with the 0.05 Hz sinusoidal activation of right and left horizontal semicircular canals. The average activation was twice as large in older adults compared with young adults, while the oscillatory response was three times greater in older adults. These two previous studies confirm that vestibular stimulation reaches supratentorial regions in humans and can be measured non-invasively.

We have used fNIRS to understand sensory integration in young adults during upright standing (Karim et al., 2013b). Subjects stood quietly while the visual and somatosensory feedback modalities abruptly changed. There was minimal change in vestibular cortical responses when either vision or somatosensation was altered, as long as the other sensory modality was intact. However, a large increase in vestibular cortical activity occurred when both visual and somatosensory inputs were degraded.

In order to investigate how executive functions are engaged during postural tasks, we have used fNIRS to record activity in dorsolateral-prefrontal cortex (DLPFC) while young subjects performed lateral step initiation in response to visual cues that provided incongruent directional information (Huppert et al., 2012). Compared with a Simple Reaction Time (SRT) condition, greater activation of the DLPFC was found during Choice Reaction Time (CRT) conditions. In addition, incongruent cues led to greater activation in the DLPFC compared with congruent cues. We have performed a similar study in older adults. Our data show that older adults who preferentially show a more conservative step strategy have greater fNIRS activation of the frontal cortical regions compared with subjects who have a strategy that is similar to young adults. These balance studies illustrate that several regions are involved in the central control of balance. Furthermore, these studies lay the foundation for applying these techniques to study other balance and gait paradigms, as well as for using fNIRS in clinical populations with balance and vestibular disorders.

Hugh Nolan
Trinity College Dublin, Ireland

Cerebral Blood Perfusion during Orthostatic Challenge

Background:
The research areas of posture and cardiovascular control overlap most prominently in the investigation of orthostatic challenge. The effects of postural change on blood pressure and heart rate are relatively well-studied – the best-known contribution comes from the baroreflex, which helps maintain homeostasis by altering heart rate and system blood flow during orthostatic challenge. More specific cardiovascular components during postural change have been less studied – of particularly interest is cerebral blood perfusion, as the most common condition associated with orthostatic intolerance is orthostatic hypotension. This is the inability of the cardiovascular system to regulate blood pressure fast enough on, leading to a temporarily lowered blood supply to the upper torso and head, and a feeling of faintness. Relatively few studies have looked at the effects of orthostatic challenge on cerebral perfusion and how this relates to other cardiovascular measures. The Irish Longitudinal Study on Ageing, TILDA, recently began recording concurrent function near-infrared spectroscopy (fNIRS) and continuous blood pressure/heart rate information. Preliminary results from the on-going data collection are presented here, including data clustering classifications and initial analysis of relationships with cognitive tests and gait variables.

Methods:
The Irish Longitudinal Study on Ageing, TILDA, is a nationally representative study of over 8500 adults aged 50+ in Ireland. The study has multiple aspects including an in-depth interview section and a health assessment with cognitive, cardiovascular, gait and eye assessments. The study is currently in its third wave of data collection and has incorporated an fNIRS measurement during a supine to standing task, which captures both baseline and challenged cerebral perfusion. Number of records available at time of writing is N=1168. This can be compared with continuous blood pressure recordings to see specific components of cerebrovascular control. In this analysis, baseline-normalised timecourses are generated to create averages and compare orthostatic response between participants. Clustering methods are also applied to intra-subject correlations of the timepoints surrounding the stand, to objectively classify different response patterns. Both timepoint values and cluster membership can then be used as variables in the TILDA dataset as outcomes or predictors for analysis with a wide range of variables.

Results:
Averages of baseline-normalised time-series responses show the typical response time-course to peak, trough, and level out again, which has similarities to the time-course of the blood-pressure response. The cluster analysis output classifies responses into 4 types of response, primarily based on the steady-state perfusion value after stand: low, high or return to baseline, along with the response dynamics during standing. The cluster membership already delineates significant differences in measures such as gait speed and self-rated health. The values around 60s post-standing already show a weak negative relationship with cognitive scores on the Montreal Cognitive Assessment (MOCA).

Conclusion:
Preliminary data support some interesting hypotheses on the use of fNIRS during orthostatic challenge as a measure of health status and cognitive function. Further modelling of these responses with a larger dataset may determine which parameters are most relevant, along with demonstrating further novel relationships with other health and cognitive measures.

Andrea Rosso
University of Pittsburgh, USA

Prefrontal cortex contributions to community mobility

Mobility limitations affect between one quarter and one half of community-dwelling older adults and have long been recognized as important public health targets. Community mobility is an individual's movement that occurs outside the home; it is essential to completion of many instrumental activities of daily living, such as shopping and healthcare, and promotes physical function, social engagement, independent living, and quality of life in older adults. Community mobility occurs within complex environments and the interactions of an individual with the environment must be considered to fully understand how limitations in community mobility arise. Previous studies have indicated that lower integrity of specific brain regions, including prefronto-subcortical networks and the prefrontal cortex (PFC), are related to mobility impairments in older adults without neurologic disease. The PFC is involved in executive functions, including attention, speed of processing and planning, and is especially vulnerable to age-related atrophy and thinning. Atrophy and thinning of the PFC are associated with slower gait and shorter step length in older adults but PFC integrity has not been assessed in community mobility.

Because community mobility occurs in the context of environmental challenges, the relative importance of brain regions to achieve high performance may be different from those involved in maintenance of gait under sterile conditions as often studied in the lab. For example, the PFC is important for successful performance of complex walking tasks and modulation of PFC activity can improve dual-task performance, indicating that PFC integrity may be more important for walking with environmental challenges than under sterile conditions. The automaticity of walking decreases with age, leading to a greater dependence on attention for motor control. This leads to a greater need for recruitment of the PFC in older adults in order to perform as well as younger adults on motor tasks. The greater reliance on attention for motor control occurs as attentional capacity is

decreasing, leaving few resources for secondary tasks while walking. This may compound the impact of CNS impairments on community mobility, as succesful community mobility often requires individuals to plan, adapt, and complete other tasks while walking.Therefore, the PFC may be particularly relevant to negotiating environmental challenges, but traditional dual task experiments do not necessarily reflect the challenges that individuals experience in the real world.

We are using functional near-infrared spectroscopy (fNIRS) to record PFC activation while older adults negotiate real-world environmental challenges in the lab, including uneven surfaces and simulated street crossings. Results will be presented indicating how PFC activation is related to changes in mobility performance on these tasks, measured by gait speed and gait variability, compared to unchallenged walking. In addition, results of analyses comparing PFC activation and mobility performance with executive function and attention will be presented.

Anat Mirelman
Center for the Study of Movement, Cognition and Mobility, Israel

The contribution of frontal lobe activation to fall risk and freezing of gait in Parkinson's disease

Parkinson's disease (PD) is the second most common neurodegenerative disorder affecting 1-2% of the population over the age of 60. PD is classically characterized by progressive deterioration of both motor and non-motor symptoms heavily affecting the patients quality of life. Gait disturbances are the presenting symptom of 3.5-18.0% of the patients clinically diagnosed as having PD. Within 3 years of diagnosis, over 85% of people with clinically probable PD develop gait problems. This stems, in part, from the pathology of the basal ganglia and dopamine dysregulation that causes impaired execution of automatic and repetitive movements critical to walking.

Gait disturbances in PD can be classified as continuous or episodic. The continuous gait disturbances persist and are apparent all or most of the time, typically marked by slowness, small shuffling steps, longer double limb support, flexed posture, reduced arm swing, and short strides. In contrast, the episodic disturbances, such as freezing of Gait (FOG) and festination, occur occasionally and intermittently, emerging in an apparently random, inexplicable manner. FOG refers to a brief, paroxysmal absence or marked reduction of forward progression, despite the intention to walk. More than 70% of PD patients will develop FOG during the course of the disease. Although FOG is generally unpredictable, it occurs with increased likelihood in specific situations, e.g., during turns, gait initiation, and narrow spaces. These environmental constraints are often anticipated and require motor planning and information processing, an executive function task.

Recent studies have suggested that deficits in executive function contribute to fall risk and FOG in PD. To date, most findings provide only indirect evidence of the relationship between FOG and cognitive function. In this presentation, we will discuss a potential direct link between FOG and frontal lobe dysfunction as observed from studies using fNIRS technology. Evidence will be presented relating to differences in anticipated and unanticipated complex situations. In addition, we will explore evidence of changes in motor-cognitive function as a result of training that may improve fall risk and FOG in patients with PD and older adults.

Symposium V Tuesday June 30, 17:00 - 19:00

From Mathematical Theory to Practical Application: Using the Dynamical Systems Approachto Develop Clinical Assessments and Rehabilitative Techniques

Chair: **Joshua Liddy**, Purdue University, USA

Denise Cruise
Purdue University, USA

Analysis of Upright Human Stability Through the Use of a Novel Balance Board with Variable Torsional Stiffness and Time Delay

The ability to maintain upright stability declines with age and neurological disorders, such as multiple sclerosis or Parkinson's disease. Mathematical models of upright posture have demonstrated there are two underlying mechanisms of instability. The first is due to loss of muscle stiffness and/or neuromuscular feedback gain which results in a forward or backward leaning posture (Chagdes et al., submitted). The second is due to an increased combination of time-delay and neuromuscular feedback gain which leads to limit cycle oscillations (LCOs; Verdaasdonk et al., 2004). LCOs are self-sustained oscillations that result in deviations from upright posture.

We began with a dynamical systems approach to understand changes in stability through a mathematical model of a human standing upright on the board. The stability analysis confirmed that stance on the tunable board can be destabilized either by decreasing torsional board stiffness, leading to forward or backward leaning, or by increasing board time-delay, leading to limit cycle oscillations. Furthermore, the analysis indicates that for a person with a large neuromuscular time-delay, very little board time-delay is required to destabilize their upright posture. Conversely, a much larger board time-delay is required to destabilize a person with an inherently small neuromuscular time-delay. This demonstrates that the additional board time-delay required to destabilize a person's posture is indicative of that person's neuromuscular condition.

Current devices such as the Biodex Balance System SD® and the Neurocom® do not adjust torsional stiffness in a continuous manner. Thus, to explore the mechanisms of instability experimentally, we developed a single degree-of-freedom rotational balance board with adjustable torsional stiffness and time-delay. The geometry of the board was created so that it is inherently unstable, with dynamics similar to an inverted pendulum. At maximum stiffness, stance on the board is similar to stance on a rigid surface. Furthermore, we allow for the ability to provide an adjustable delay to torsional feedback. This novel board allowed us to test the afore-mentioned model predictions by simulating the issues with muscle stiffness and sensory processing delays typically observed in older individuals and individuals with neuromuscular disease. Human subject testing was performed with twelve young, healthy subjects on the board; this involved manipulating the torsional stiffness while the time delay was held constant. Four unique time delay values were tested.

This initial human testing on the balance board clearly demonstrated both types of postural instabilities: tipping at low stiffness values and limit cycle oscillations at large time delays. By analyzing the point at which instabilities occur, individual stability diagrams can be created. These charts help dictate what parameters allow a person to maintain upright posture, as well as accentuate what parameters lead to the two different instabilities.

This adjustable board enables a new class of balance detection and rehabilitation devices that are conscious of both stiffness and time-delay deficiencies in humans. We believe that this is a significant discovery that will lead to more effective diagnostics and more efficient rehabilitation plans that can be customized to each individual patient.

Brian Cone
University of North Carolina at Greensboro, USA

Recovery from an unexpected trip is related to gait dynamics

Background and aim:
Unexpected trips are a leading cause of falls and subsequent injuries. To reduce fall rates, researchers have developed trip-training programs designed to increase gait stability. Utilizing a dynamical systems framework, gait dynamics can be closely examined to determine how gait is altered to become more stable. This study focused on the dynamics of stride time, step length, and step width in a single 10 minute trip-training session to determine if gait dynamics can be altered to better adapt to a tripping perturbation.

Methods:
Twenty-eight young, healthy adults (23.1±3.7 years) walked on an ActiveStep treadmill that induced a

simulated trip every 50±10 steps for 10 minutes, resulting in 10 trips per participant. For this paper, only the first and last two trips were examined, which occurred during the first and last 100 steps, respectively. Full body kinematic data were recorded at 200 Hz. To quantify the influence of each trip, a variable called trip magnitude (TMag) was calculated by first determining the average stride time for the entire session and then determining the number of standard deviations (SD) the stride time directly after the trip fluctuated from the average stride time. A larger TMag value indicated that the trip highly influenced the participant's gait mechanics (i.e., less adaptive behavior). To quantify gait dynamics, Sample Entropy (SampEn) of the time series for stride time, step length, and step width was calculated for the first and last 100 steps. Differences in TMag and SampEn between the first and last 100 steps were examined using a MANOVA (α=.05). Pearson correlations were used to examine the relation between variables.

Results:
TMag significantly decreased ($p<.001$) from the first two trips (4.85±1.57 SD) to the last two trips (1.14±1.43 SD), suggesting an increase in participants' ability to adapt to the tripping perturbation during the trial. This increase in stability was paired with a near significant ($p=.088$) increase in SampEn of step width from the first 100 steps (1.21±0.23) to the last 100 steps (1.31±0.19). Although the correlation between TMag and SampEn of step width was not significant in the first 100 steps ($r=.161$, $p=.414$), we observed a significant negative correlation in the last 100 steps ($r=-.433$, $p=.021$). No significant findings were observed for stride time or step length ($p>.05$).

Conclusions:
The negative correlation we identified suggests that increased complexity (higher SampEn) is associated with more adaptive gait behavior (i.e., lower TMag). Since the correlation was only significant in the last 100 steps, the data suggest that some of the participants learned to control their gait in an adaptive manner by modifying the dynamics of step width by the end of the trial. Our findings provide details about how a trip-training program may allow gait mechanics to re-organize so that more adaptive and stable gait behavior emerges.

Michael Busa
University of Massachusetts Amherst, USA

Multiscale Entropy: A Tool for Understanding Changes in the Complexity of Human Standing

Over the last two decades the role of variability in physiological function has been a controversial topic in the literature. Specifically, much discussion has centered on the identification of methods that can distinguish functional from nonfunctional variability. Lipsitz and Goldberger formulated the loss of complexity hypothesis as a means to conceptualize how the disease and aging processes manifest in a breakdown of the physiological processes that underlie higher-level, integrated, biological outputs. This hypothesis suggests that as fluctuations in the underlying physiological function are impaired due to disease processes, there is a reduction in physiological complexity. Here, we define complex behavior as the output of a robust system of structural units (neurons, muscles and joints) and regulatory feedback loops that operate over a wide range of temporal and spatial scales. In order to gain insight into the health of the physiological structures that are coordinated in the control of quiet upright standing, we use multiscale entropy (MSE) to quantify the complexity of the postural center of pressure time series. MSE allows for the quantification of complexity across the diverse range of time scales at which these structures contribute to the control of postural fluctuations. Entropy analysis provides an estimation of the amount of information in a time series, and the information contained in biological fluctuations is thought to be brought about by the complex physiological interactions that produce/govern these processes. A comparatively low multiscale entropy value denotes biological processes that are more 'regular' in nature, indicating that these processes are under the control of a reduced set of functional interactions. Currently, MSE is the only technique that allows for the assessment of complexity over many time scales. Other techniques such as detrended fluctuation analysis and multifractal analysis examine the way that processes that happen at short time scales relate to those occurring at longer time scales. While

the relationship between the time scales is associated with certain features of a complex system, it cannot, provide a measure of the overall complexity contained in a system, as the nature of the fluctuations at any single time scale is not calculated. In this symposium I will present an overview of all the entropy techniques currently used in the human movement literature and discuss the ways in which they differ. Additionally, I will present examples of how MSE can be used to identify changes in complexity due to multiple sclerosis, adolescent idiopathic scoliosis, and artificially reduced sensory function in healthy young women. I will also discuss the interpretation of these results within the context of the loss of complexity hypothesis. Furthermore, the limitations of MSE analysis will be discussed, as these play an important role in the design of experiments that are able to utilize this technique. Finally, I will identify future directions that incorporate the multiscale approach within other entropy techniques

Vivien Marmelat
Universite Montpellier, France

Variability for stability: use of fractal auditory metronome to enhance gait dynamics

Background and aim
Inter-stride intervals (ISI) of healthy gait are characterized by fractal fluctuations, which become more random with aging and pathologies such as Parkinson's disease (Hausdorff et al., 2000). Auditory cueing is used in physiotherapy because it reduces stride variability. However ISI fluctuations become anti-persistent in the presence of periodic metronomes. Systems presenting fractal fluctuations tend to match their correlation structure when synchronizing (Hunt et al., 2014; Marmelat & Delignières, 2012). We examined whether auditory cues with fractal variations in inter-beat intervals (IBI) yield similar fractal ISI dynamics.

Methods
12 volunteers (28.08 years ± 5.82) walked on a treadmill with embedded single large force platform. They performed five trials of six minutes at their preferred walking speed, in each randomized conditions: self-paced, periodic metronome paced, and non-periodic metronome paced with anti-persistent, random or fractal fluctuations in IBI. Detrended Fluctuation Analysis (DFA) was used to estimate the fractal exponents (α) of ISI and IBI.

Results
ANOVA showed a significant effect of pacing conditions on αISI exponents ($F(5, 66) = 33.33$; $p<0.001$). αISI in self-paced condition differed with both αISI from periodic, anti-persistent and random metronomes, but was not significantly different with αISI from the fractal metronome. Moreover, the correlation between αISI and αIBI was only significant with the fractal metronome ($r10 = 0.90$).

Conclusions
We showed that using a fractal metronome preserves the fractal gait dynamics, while using isochronous, or non-isochronous including random or anti-persistent fluctuations modified ISI structure toward anti-persistence. Our results open up new perspectives to optimize rhythmic auditory cueing for gait stabilization by integrating fractal fluctuations in the IBI. Further research should focus on improving both linear measures such as stride length or walking speed, and non-linear features such as the fractal exponent. Further investigations are necessary to determine the carry-over impact of such non-linear pacing of gait.

Symposium VI Tuesday June 30, 17:00 - 19:00

Gazing from bench to beyond: visual control of gait in the real-world and methodological challenges

Chair: **Lynn Rochester**, Newcastle University, UK

Mark Hollands
Liverpool John Moores University, UK

What are the roles of eye movements during locomotion? Basic science and proposed mechanisms

Studies of where and when we look when we walk generally show that the predominant gaze behaviour during locomotion is fixation of environmental features lying in the current or future travel path. The extent to which walking individuals look ahead is heavily dependent on the specific nature of the walking task. When stepping onto small targets, the timing of the final fixation on the target with respect to the completion of the step onto it has shown to be an important predictor of accurate foot placement. Premature gaze transfer away from a target demonstrated by older adults has been shown to be causally linked to a loss in stepping accuracy and increased falls risk. However, the mechanism by which the central nervous system (CNS) benefits from stabilizing gaze on targets and other environmental features during walking remains unclear. In this review lecture I will present an argument that we need to understand these mechanisms in order to design effective intervention strategies to promote optimal gaze behaviour for safe locomotion. I will review evidence supporting various mechanisms by which gaze stabilization may aid in extracting useful visual information from the optic array. I will also present evidence that pointing the eyes at stable locations in space can supply the CNS with important non-visual information that can help identify target locations in three-dimensional space and aid in postural stabilization. This review lecture will draw on a wide body of literature ranging from Sports Psychology to primate neurophysiology and will summarise a working hypotheses relating to the mechanisms underpinning eye and stepping coordination that can be used to guide future research.

Rodrigo Vitorio
Sao Paulo State University, Brazil

Visual control of locomotion during real-world activities in people with Parkinson's disease

Vision can influence locomotion of people with Parkinson's disease (PD) in two distinct manners. Visual stimuli such as doorways can trigger movement disorders such as 'freezing' episodes in which the patient feels as if the feet are glued to the floor. Conversely, visual cues such as transverse lines placed on the ground can increase stride length and release freezing episodes. These paradoxical responses to visual information have motivated researchers to investigate the role of vision during locomotion in people with PD. Determining where, when, what and how visual information is acquired during real-world walking activities is critical to understand the visual control of locomotion in PD. This symposium presentation will cover studies using novel protocols involving mobile eye-trackers and alternatives such as liquid crystal glasses to examine the visual control of locomotion in people with PD. The first experiment to be presented was designed to investigate the contribution of optic flow to obstacle avoidance in PD. It was found that people with PD made more obstacle contacts than healthy controls only when optic flow was suppressed, suggesting that people with PD are more dependent on dynamic visual information for successful performance of obstacle avoidance. The second experiment investigated how people with PD visually sample the environment to improve gait while walking on a cued pathway and which piece of visual information (visual feedback from lower limbs or environmental information from cues) is critical for the benefits. Both people with PD and controls fixated close to 46% on visual cues necessary to accomplish the current step (on-line control), while 54% of fixations were focused on visual cues one or more steps ahead (feedforward control). Individuals with PD improved step length in all cued conditions, with and without visual feedback from lower limbs. These findings suggest that both people with PD and healthy individuals employ equal distribution of on-line and feedforward visual control of

gait while walking on visual cues. In addition, environmental information was demonstrated to be the critical visual information to achieve step length benefits with visual cues. The third experiment investigated how people with PD and healthy individuals synchronize gaze behavior and foot placement when required to step on single and multiple targets. When there was a single target in the travel path, both groups fixated the target until after heel contact on the target. However, when challenged with an additional target, both groups transferred their gaze from the first target prior to heel contact. Interestingly, only people with PD increased anterior-posterior absolute error (first target) when there was more than one target in the travel path. These findings suggest that people with PD are more dependent than healthy individuals on visual information in an on-line manner to guarantee accurate foot placement into an intended stepping location. Although these experiments and others in the literature provide insights into relevant aspects of visual control of locomotion in people with PD, much work remains to be done in this research area. As such, potential future directions will also be presented.

Rebecca Reed-Jones
University of Prince Edward Island, Canada

Eye tracking technology and its implications for designing visuo-motor training programmes for clinical populations

Eye tracking technology provides valuable information regarding eye movements and visual attention during locomotor activities. Since its inception in gait and posture research, eye tracking has facilitated the knowledge and understanding of the role of vision in the successful execution of a number of fundamental locomotor tasks (e.g. stepping, turning, steering, and obstacle avoidance). This research has led to the identification of specific visual behaviours that promote success and safety when executing these tasks. It has also led to the identification of visual behaviours associated with increased risk for unsuccessful execution in clinical populations who have trouble with locomotor activities (e.g. fall prone older adults and individuals with Parkinson's disease). However, the advantage of eye tracking technology in gait and posture research is that it can provide information beyond eye movement patterns; it also gives researchers insight into visual sampling and attention in the environment. These visual cognitive factors have significant implications when studying clinical populations. Mapping the differences in how clinical populations perceive their movement environment expands our current knowledge of the role of vision in locomotor activities. In addition, how these differences affect planning and execution of locomotor tasks in clinical populations provides an evidence base for intervention strategies. This talk will discuss the current state of knowledge on the role of vision in the safe and successful execution of fundamental aspects of locomotion (i.e. turning, steering, and stepping characteristics). It will also discuss the importance of incorporating visuo-motor measures in fall prevention programmes for older adults and the assessment and training of clinical populations such as individuals with Parkinson's disease and athletes with concussions.

Sam Stuart
Newcastle University, UK

Real-world eye tracking: what are the methodological considerations?

Eye movements are required to gather information about our environment when performing real-world activities such as walking, obstacle crossing etc. Saccadic eye movements (fast eye movements to areas of interest) form the basis of visual exploration and provide a 'window to the mind', as they offer a quantifiable method to study the influence of visuo-cognition on behavioural outcomes.

Advancements in eye-tracking technology have made the measurement of visual exploration during real-world activities possible and have led to growing interest in the deterioration of visual exploration across the ageing process and in pathology such as Parkinson's disease. This progress is vital as visual exploration is a critical feature of accurate locomotor control, which is affected in PD, and can result in a loss of independence,

reduced mobility and increased falls risk. Mobile eye-trackers currently provide the most comprehensive measurement of visual exploration but many methodological challenges remain and need to be resolved to ensure the collection of highly robust and reliable data. In addition, there is currently no single measurement or outcome that has been identified as the 'gold standard' indicator of relevant processes, limiting study comparability.

Present limitations range from general mobile eye-tracking problems, such as variable temporal resolutions, inaccurate calibration or incomplete data collection due to blinking or flickers (pupil detection errors), to a lack of accuracy and reliability of eye-tracking measurement particularly during real-world activities. Broader considerations also exist regarding the interpretation of visual exploration data with relation to behavioural outcomes. For example, many previous studies have not considered or controlled for saccadic eye movement mediators/potential confounders such as cognitive function (i.e. attention) or basic visual functions (i.e. visual acuity, contrast sensitivity). In addition, studies have often excluded participants on the basis of impaired cognition and vision, greatly limiting the generalisability of the findings.

In response to some of these methodological issues, we have developed a protocol to determine mobile eye-tracker accuracy and reliability, and have explored the association between saccadic frequency during gait and cognitive and visual measures in both older adults and pathology (Parkinson's disease). To aid in the development of robust protocols, recommendations will be proposed for future quantification of visual exploration during real-world activity research, including the use of task appropriate devices with adequate temporal resolution, reporting of the reliability and validity of any device used and the routine assessment of other mediating factors including cognition and vision.

The aims of this presentation will be to (i) outline the reliability of saccadic measurement using mobile eye-tracking, and (ii) highlight current methodological challenges.

Symposium VII Wednesday July 1, 17:00 - 19:00

Structure of Variability as a Window into what Matters during Mobility

Chair: **Young-Hui Chang**, Georgia Institute of Technology, USA

Young-Hui Chang
Georgia Institute of Technology, USA

The motor and the brake during propulsion in human walking with and without lower limb loss

In recent years, the idea of 'good' and 'bad' variability during movement control has provoked increased scrutiny over the role of variability in human gait. The ability to distinguish between good and bad variability requires knowledge about the system of elements composing movement and their relationship to the task-level performance goal. A particular challenge to understanding the role of variability in gait, however, is that we do not have adequate knowledge about what the performance goals of locomotion are. Using the framework of the uncontrolled manifold approach, we have tested several potential biomechanical parameters that may serve as locomotor task variables controlled by the nervous system. Over the past several years, we have used hopping and running locomotion as a test bed to study the control of the legs during locomotion in healthy adults. We have found that the limb-level dynamics (leg length, leg orientation and leg force) associated with a well-known biomechanical template (spring-mass model) are stabilized through the variance structure exhibited in the joint dynamics. We have recently extended this approach to study the control of limb forces during walking in persons with and without a unilateral transtibial amputation. In subjects with intact legs (n=8), we find that the variance structure of joint torques stabilizes limb force in the leading limb during the double-support phase, but destabilizes the trailing limb during double-support phase. This destabilization of trailing limb force is associated with the modulation of limb push-off force

during terminal stance phase and stabilization of power output of the trailing leg, which may contribute to more consistent center of mass redirection during step-to-step transitions. We used a modified uncontrolled manifold analysis to further distinguish the influence of independent joint variance vs. joint covariance on the overall torque variance structure projected into the limb force task space. We observed that trailing limb push-off force is modulated from stride to stride primarily through the independent control of ankle torque timing and not through adjustments in ankle torque magnitude. Furthermore, we observed that knee torque covaries with ankle torque such that the knee attenuates the effect of the ankle on push-off force. In this way, trailing limb propulsive force appears to be modulated through the independent adjustment of ankle torque acting as a 'motor' and the covariance of knee torque acting as a 'brake'. A matched group of subjects with unilateral transtibial amputation (n=8) exhibited the same ability to modulate trailing limb force through adjustments in the timing of their prosthetic ankle torque trajectories. We observed a significant deficit, however, in their ability to covary knee torque with their prosthetic ankle torque. Thus, persons with transtibial limb loss appear to have the motor, but no brake when modulating propulsive forces on their amputated leg during gait.

Jeffrey Hausdorff
Sackler School of Medicine, Tel Aviv University, Israel

Gait variability: a window into understanding instability and fall risk

The stride-to-stride fluctuations in walking offers a complementary way of quantifying locomotion and its changes with aging and disease as well as a means of monitoring the effects of therapeutic interventions and rehabilitation. Previous work has suggested that measures of gait variability may be more closely related to falls, a serious consequence of many gait disorders, than are measures based on the mean values of other walking parameters. Thus, stride-to-stride fluctuations in walking can provide insights and pave the way for expanded research into the control of gait and the practical application of measures of gait variability in the clinical setting. This presentation reviews some of the cross-sectional and prospective studies that have examined the relationship between gait variability and falls and summarizes the mechanisms that likely link variability in the gait pattern for a loss of balance and falls, focusing on recent imaging studies.

Nicholas Stergiou
University of Nebraska, USA

A Perspective on Human Movement Variability: Implications for Health and Pathology

This talk describes innovations in the exploration of variability and their potential importance in understanding human movement. Far from being a source of error, evidence supports the presence of an optimal state of variability for healthy and functional movement. Deviations from this state can lead to biological systems that are either overly rigid and robotic or noisy and unstable. Both situations result in systems that are less adaptable to perturbations, such as those associated with unhealthy pathological states.

Symposium VIII Wednesday July 1, 17:00 - 19:00

Control of Balance during Walking in Humans and Robots

Chair: **John Jeka**, Temple University, USA

Andy Ruina
Cornell University, USA

Point-mass models explain a lot about balance of human and robotic walking

Background and aim:
Point-mass models are ubiquitous in discussions of robotic and animal locomotion and balance on wheels (e.e., bicycles) or feet (walking, running). Why?: 1) One should understand simple models before complex ones, 2) The mechanics of the center-of-mass (CoM) motion is the same as for a point mass, and 3) For walking people and bicyclists the CoM seems high and the total moment-of-inertia about the CoM seems small, so a point-mass model seems to be a good approximation. Thus, many approaches to balance are tied to point-mass, or at least CoM concepts, e.g.: Zero Moment Point, Inverted Pendulum, Linear Inverted Pendulum, Spring Loaded Inverted Pendulum, Margin of Stability, Extrapolated Center of Mass, etc.

In contrast, imagine a more detailed model of, say, a walking robot or person consisting of many links that can move in complex ways. Assume perfect sensing and infinitely fast computing. How well could such a thing balance? Might a point mass model of the same system not just be an approximation of such a "full" model, but make a controller that balances almost as well?

The aim here is to compare the balance, that is the ability to avoid falling, of a fully informed complex model with the ability of the same mechanism to avoid falling based only on a point mass model. Consider a 3-D point-mass walking controller. It models the dynamical state of the robot using only the position and velocity of one point, and the entire control is described by 3 numbers per step (push off amount & heel-strike location). Our hypothesis is that such a controller can avoid falling almost as well as can an imagined controller based on a "full model" with full sensing and infinite computation.

That is, the point-mass models are not just vaguely good practice models for balance, but are actually almost as good as the best possible models. The surprise is that we can neglect the effects of ankle torques and of upper body motions; exactly the effects that matter for standing balance are essentially irrelevant for robust prevention of falls when walking.

Methods:
1) Simple experiments on people; 2) Scaling rules for human shaped things; and 3) Comparison of robustness of a fully-optimized (maximized basin of non-falling) complex model with a point mass model.

Results:
1) A person who is able to step can recover from far larger perturbations than one who can only use ankle torques or arbitrary non-stepping body motions (e.g., arm and leg swing or trunk bending; 2) mechanics constrains that the largest control authority comes from stepping; and 3) The point mass model recovers from almost the same set of disturbances as does the optimized embedding model.

Conclusions:
The ubiquity and utility of point mass models is not accidental, they are really very good.

Hendrik Reimann
Temple University, USA

Anticipatory mechanisms for the control of balance during locomotion

Walking upright is an activity that humans do seemingly effortless and without conscious control. While the legs move cyclically, the upper body remains mostly stable during gait. This stability, however, is the result of a highly sophisticated control process.

Even more so than during quiet, upright stance, the walking body is mechanically highly unstable. The gravitational torques acting on the joints are continuously changing. The large movements in the legs generate complex patterns of interaction torques in the upper body. Yet the amount of movement in the upper body is very small. This means that the destabilizing effects of gravity and interaction torques are largely cancelled out by forces from upper body muscles. We analyze the effects of these torques by calculating the accelerations that gravity, movement-dependent torques and muscle torques at different sites along the body induce in a given joint. Flexion of the hip during a leg swing, for instance, induces an acceleration at the upper body, which is cancelled out by local muscle torques.

This cancellation of destabilizing torques by active muscle forces is instantaneous, as first pointed out by Winter and colleagues (Winter (1995), Gait & Posture, 3, 193–214): there is no phase shift between the unbalancing accelerations from gravitational and interaction torques and the balancing accelerations from muscle torques. This rules out the possibility of a feedback system generating the balancing muscle torques. Instead, the movement generation system must employ an anticipatory mechanism that predicts the unbalancing torques so they can be matched by balancing torques of equal magnitude, which cancel each other out to generate the negligible net movement we observe in the upper body during locomotion. This prediction mechanism, which can be understood as an internal model of the forward dynamics of the walking body, is essential for keeping balance during locomotion.

To function properly, the state of such an internal model must be kept aligned with the configuration of the body as a movement progresses. How does this updating process work? Likely candidates to play a role are the visual, vestibular and proprioceptive systems. To assess its contribution to balancing the upper body, we perturb relevant sensory systems during locomotion and measure the resulting changes in the joint configuration and muscle torques. We find that the anticipatory mechanism is surprisingly robust against erroneous sensor data. Furthermore, there is little evidence for these effects propagating down from the upper to the lower body. Instead, we observe a tight coupling in the control of all body segments, with the effects of sensory perturbations appearing simultaneously across the whole body.

Jessie Huisinga
University of Kansas Medical Center, USA

Postural control measures to classify balance during walking

Walking is a motor task that requires both forward movement toward a goal and the maintenance of upright posture. Thus, to appropriately classify clinically important movement deficits in pathological populations, it is of great interest to utilize methods which help to identify postural control deficits which occur during walking.

The mechanics surrounding feed-forward and feed-back postural control systems cannot be quantified and effectively gauged through the use of observation and timing based clinical tests alone. Measures of postural sway, often obtained using a force platform or similar device, rely on the inverted pendulum model of sway where the body is modeled as one rigid body with the center of mass motion represented as the center of pressure time series. The same assumptions may be used to assess the relationship between foot placement and postural control during walking. Margin of Stability is a measure which illustrates one's ability to regulate center of mass motion from footfall to footfall based on extrapolated center of mass and base of support

changes during gait. When examined in pathological populations, lower margin of stability during single leg stance is indicative of reduced postural stability during gait since the extrapolated center of mass is closer to the stability limits imposed by the base of support.

Measuring acceleration of the trunk segment during walking allows for investigation of trunk motion which is responsible for regulating and attenuating gait-related oscillations to achieve stabilization necessary the head's perception of sensorimotor information. Identifying changes which occur at the trunk, specifically, are vital since any alterations in the control of trunk oscillation might be associated with poor balance control during gait. In a population with sensory motor delays, increased variability of trunk acceleration indicated greater divergence of the movement pattern in the medial-lateral direction compared to healthy controls which was thought to be reflected in increased step width and the greater need for more active control of step-to-step motion in the medial-lateral direction. Assessment of the acceleration time series using variables typically evaluated in center of pressure time series may also be used to classify postural control during gait. Similar to stabilograms produced from center of pressure sway during standing, acceleration time series obtained from a sensor on the lower back can be used to produce stabilograms to represent motion in all three planes. Using this analysis in subjects with multiple sclerosis, for example, it was found that compared to healthy controls, subjects demonstrated reduced mean acceleration of the trunk in sagittal plane and transverse plane motion at heel contact, mid-stance, and toe off as well as altered variability of acceleration at these points across multiple gait cycles.

Identifying the postural control changes during gait which may contribute to falls or may indicate disease progression is of great importance for clinicians. By considering postural control outcomes which are traditionally employed during quiet standing, it seems that specific mechanisms of "balance during walking" may be highlighted.

Manoj Srinivasan
Ohio State University, USA

Human walking control: system identification with human data and optimal feedback control with simple biped models

Here, we present two complementary approaches to understanding human locomotion control: (1) system identification of walking dynamics with human data, which we compare with (2) optimal feedback control with simple biped models.

Given that the natural step-to-step variability likely explores the neighborhood of the periodic walking motion, it may have dynamical information about the control system employed. Using data from hundreds of human walking steps, we obtain the local linear dynamical models that best explain the deterministic part of the observed variability: we use a mathematical construction we call the "factorized Poincare map" to represent the local linear dynamics. This local linear model, derived entirely from steady human data, enables us to make predictions about how humans will respond to small perturbations, which we compare with results from external perturbation experiments. For instance, by fitting linear models, we find the variability in the lateral foot placement can largely be explained by the lateral position and velocity deviation of the center of mass on the previous step, suggesting lateral stabilization by foot placement, as has previously been argued by other authors.

Next, we compare the experimentally inferred dynamics with the normative theory that humans minimize the cost of recovery from perturbations — 'optimal feedback control'. We consider two simple three-dimensional biped models, (1) biped with point-mass body and (2) biped with a three-dimensional rigid body for its upper body. The legs are massless and telescoping in both bipeds (but with a leg swing cost), and in the biped with a 3D rigid upper body, the hips can also exert 3D moments. For each biped, we first compute the optimal periodic trajectory, which is hypothesized to be the 'target' steady state trajectory for the feedback control. Then,

we compute the optimal recovery strategy (trajectory and control actions) for sufficiently many state perturbations at various phases along each step. The optimal recovery strategy depends somewhat on the assumptions made regarding the target steady state (whether we allow lane preservation, phase resetting, or changes in average speed) and on how long one is allowed to get back to steady state after a perturbation (two, three, four, or infinitely many steps). Depending partly on these assumptions, the optimal recovery strategy for the point-mass model explains some features in the human data: for instance, sideways perturbations during a stance phase are recovered from optimally by using a mixture of mostly sideways foot placement and some push-off modulation. While the point-mass body explains a few qualitative and quantitative features observed in human data, we consider the biped with the 3D rigid upper body so as to capture the substantial coupling with forward and sideways control, for instance, a step length change in response to a sideways perturbation.

Symposium IX Wednesday July 1, 17:00 - 19:00

Impact of hearing impairment on postural control in old age

Chair: **Karen Li**, Concordia University, Canada

Jennifer Deal
John Hopkins University, USA

Relationship between Hearing Impairment and Physic al Function and Falls in Older Adults: Recent Insights from Two Observational Epidemiologic Studies

Hearing impairment (HI) is prevalent in older adults and may be a risk factor for functional decline and falls in this population. Here we present results assessing the relationship of HI with physical function and falls in two prospective, observational epidemiologic studies in older adults: the Atherosclerosis Risk in Communities Neurocognitive Study (ARIC -NCS) and the Health Aging and Body Composition (Health ABC) study.

In ARIC-NCS, hearing was measured using audiometric testing in a pilot study of 253 men and women from Washington County, Maryland (mean age 77 years). A pure-tone average (PTA) was calculated in the better-hearing ear using thresholds from 0.5-4 kilohertz. HI was defined as a PTA > 25 decibels (dB). Physical function was measured using the Short Physical Performance Battery (SPPB), a performance-based measure of lower extremity function based on the ability and time to complete three tasks: chair stands, balance and 4-meter walk. Falls frequency within the past 6 months was assessed by self-report at the time of hearing assessment.

Mean cross-sectional differences in SPPB performance (both total score and its components) and the log odds of falls by HI status were modeled using tobit and logistic regression, respectively. After adjustment for demographic and cardiovascular factors, audiometric HI was associated with lower (poorer) SPPB performance (mean difference in SPPB score comparing participants with HI to participants without HI was -0.77 points, p=0.037) and slower speed to complete 5 chair stands (p=0.025). The odds ratio of >1 fall associated with HI was 2.46 (95% CI: 0.41, 1.61); power to detect a statistically significant result was limited by the small number of events (N=14).

In the Health ABC Study, longitudinal associations of HI with incident frailty and self-reported falls were estimated in 2,000 participants (34% Black race; mean age 74 years; from Memphis, Tennessee or Pittsburgh, Pennsylvania). Audiometric hearing was assessed in Year 5 and the PTA in the better-hearing ear was categorized according to clinical cutpoints: no HI (≤25 dB), mild HI (26-40 dB), and moderate or severe HI (>40 dB). Frailty, assessed at Years 1, 4, 6, 8, 10 and 11, was defined as gait speed < 0.60 m/s and/or inability to rise from a chair without using arms. Falls were assessed annually by self-report. Associations between HI and incident frailty and incident falls were modeled using discrete-time Cox proportional hazards models and generalized estimating equations (GEE) models, respectively. Compared to participants with no HI, participants with moderate or severe HI (PTA >40 dB) had an increased hazard of incident frailty over 11 years (HR: 1.63, 95% CI:

1.26, 2.12). In women only, HI that was moderate or severe was also associated with a greater annual percent increase in the odds of self-report falling (11.6% versus 3.5%, p <.001).

In epidemiologic studies of older adults, HI is associated with poorer lower extremity mobility function and with risk of incident frailty and falls. A randomized clinical trial, currently being planned within the ARIC-NCS study, will determine whether hearing rehabilitation may postpone functional decline in older adults.

Karen Li
Concordia University, Canada

The effects of age, auditory noise, and cognitive load on postural recovery in young, old, and hearing-impaired adults

Epidemiological research indicates a link between age-normative hearing loss and mobility decline, independent of vestibular impairment. The present work tests the model of Cognitive Compensation, which assumes that both age-related hearing loss and mobility decline involve increasing levels of cognitive resource allocation. As such, we argue that a possible explanatory mechanism linking losses in hearing and in postural control is competition for scarce cognitive capacity. We predict that as compared to healthy young adults, older adults with normal hearing should show greater performance decrements when performing a listening task and a postural recovery task simultaneously, compared to single-task performance. Further, we predict that older adults with mild to moderate hearing loss should show disproportionate performance decrements under challenging dual-task conditions and when auditory noise is present. We tested these predictions using a dual-task paradigm. Healthy young adults (YA; n = 29), older adults (OA; n = 25) and older adults with mild to moderate (25-45 dB average pure tone thresholds for .5, 1, 2, 3 kHz) hearing loss (OAH; n = 10) completed auditory working memory (n-back) and balance (recovery from a forward platform perturbation) tasks singly and concurrently under noisy and quiet conditions. The auditory noise was background multi-talker babble. We set the intensity levels of the auditory stimuli according to each individual's average pure-tone thresholds (+50 dB HL), and held the signal-to-noise ratios constant across individuals (SNR: -6 dB). The balance task involved trials containing 0, 1, or 2 forward translations (50 mm, up to 150 mm/s) at unpredictable times. Kinematic, kinetic, and EMG data were collected simultaneously to quantify postural recovery. Analysis of the cognitive accuracy data revealed a significant 3-way interaction of Cognitive Load, Noise, and Group. Further analyses of the accuracy data revealed that under quiet conditions, cognitive accuracy was comparable across all conditions. By contrast, accuracy under noisy conditions was disproportionately worsened by dual tasking in the OAH group but not in the other two groups. Analysis of kinematic data revealed that A-P sway (CoM total displacement) increased significantly as a function of cognitive load across all groups, and that cognitive load affected the YA group differentially more than the older groups. Furthermore, the presence of background noise caused an increase in sway in YA, but not in either of the older groups. The OAH group exhibited substantially less sway overall compared to the other groups, suggesting a more rigid and less adaptive postural recovery strategy. Together, the results support the contention that age-related hearing loss results in competition for cognitive capacity and negatively affects postural stability.

Jennifer Campos
University of Toronto, Canada

Age-related hearing loss and gait adaptations: Evidence from a dual-task experiment in a virtual environment

Epidemiological aging research links hearing loss with cognitive decline, slower walking, and falls risk. For instance, individuals with even mild hearing loss are three times more likely to fall than age-matched peers with normal hearing. However, the precise mechanism through which hearing loss affects safe mobility is currently poorly understood. A candidate explanation for these links is that both hearing and motor performance involve the recruitment of cognitive capacity. In order to examine this possibility we employed

a "listening while walking" dual-task paradigm with three groups of participants: healthy younger adults, healthy older adults, and older adults with age-related hearing loss. An immersive Virtual Reality laboratory allowed participants to walk on a treadmill within a realistic urban cityscape simulating a busy street crossing while engaging in a multi-talker listening task. Specifically, participants each completed three conditions: a) listening task alone; b) walking task alone; c) listening while walking. During the listening only condition, three sentences (1 target, 2 maskers) were presented simultaneously to the left, center, and right side of the participant and they were asked to verbally reproduce parts of the target sentence. Listening accuracy was recorded. Cognitive load was manipulated by informing participants before each block of trials whether the target would either a) always be presented from the center location (high certainty = lower cognitive load), or b) that it could be presented from any one of the three locations (low certainty = higher cognitive load). During the walking only condition, participants were simply asked to walk across the street. Gait parameters associated with walking stability were measured using a motion capture system. During the listening while walking task, participants performed both the listening and walking task concurrently (under both conditions of certainty). When comparing the data from healthy younger and older adults with normal hearing, results demonstrated that listening task accuracy was negatively affected by age (older adults were less accurate), uncertainty of target location (uncertain locations were less accurate), and concurrent task load (dual-task listening was less accurate than single-task listening). The task load manipulation and the certainty manipulation had a disproportionately more negative effect on the word recognition accuracy of older compared to younger adults. Correlations were significant between average pure-tone thresholds and word recognition accuracy in the dual-task condition only. Conversely, kinematic parameters of walking stability suggested that, during more challenging conditions, older adults prioritize their physical safety and task performance, potentially due to reductions in cognitive capacity. Data collection for the older adults with hearing loss is ongoing. Overall, the results of this study provide early experimental evidence to explain the link between age-related hearing loss and reduced mobility. Given that hearing loss affects more than half of adults over the age of 65, better understanding the hearing-mobility link during complex, real-world challenges could help to identify those at risk of falling and provide more ecologically valid methods of intervention.

Nicoleta Bugnariu
University of North Texas, USA

The effect of different types of hearing aids on postural control

Hearing loss affects a large percentage of older adults and may compromise their postural control and increase the risk of falls. Nevertheless, the delay between first noticing a hearing problem and seeking help is often more than ten years and only a fraction of those who might benefit receive hearing aids. A barrier in defining the relationship between hearing loss and balance impairments, and consequently the potential benefits of hearing aid on postural control, has been the disconnect that exists between audiology findings obtained in soundproof booths, and the impact of these findings in the real world where patients need to maintain balance and walk in noisy environments.

We developed a method to evaluate the interaction between hearing function and balance/movement by integrating standardized audiology tests in realistic, ecologically valid virtual environments (VE) in which patients perform functional activities. Subsequently we tested the effectiveness of different types of hearing aids at improving not only speech recognition, but also measures of postural control. Adults 51 to 80 years old, newly diagnosed with hearing loss, without vestibular or other neurologic impairments and age-matched controls participated. Patients were tested at the time of hearing loss diagnosis and after a two months accommodation and use of their hearing aids. Patients randomly received one of the three types of hearing aids: 1) regular hearing aid ear level with noise reduction (HA), 2) hearing aid interfaced with mini-microphones (HAM), and 3) hearing aid interfaced with wireless remote adaptive digital microphone with frequency modulator (HAFM). We systematically manipulated characteristics of auditory stimuli, physical and cognitive challenges present in VE, and measured the effects on balance and gait. Outcome measures included:

standing center of pressure sway, performance on dual task involving cognitive decisions, performance on auditory task, and self-selected gait speed on flat and uneven terrain. Testing conditions: no HA, HA, HAM, HAFM; auditory task: listening only or repeating back sentences. ANOVA were conducted for each dependent variable with respect to: group, condition of HA and condition of auditory task. Center of pressure sway variability in M/L direction was increased ($p<.05$) in participants with hearing loss vs. controls when subjects had to perform a dual standing/cognitive task. All types of hearing aids decreased sway in conditions of repeating back sentences. Without HAs, self- selected gait speed was lower ($p<.05$) in individuals with hearing loss vs. controls, as long as they attended to the auditory task. Use of HAM and HAFM, but not of regular HA significantly increased self-selected gait speed ($p<.01$). When auditory inputs are reduced/conflicting, perception of the environment is incomplete and the cognitive resources allocated to effortful listening are increased, potentially leading to maladaptive balance responses. Use of hearing aids, especially HAM and HAFM, significantly improve not only speech recognition but also measures of balance and gait. While laboratory audiology tests focus on sound localization and speech recognition, perhaps outcome measures such as balance /gait while conducting a conversation are more meaningful for assessing the impact of hearing loss/hearing aids on level of function and participation.

Symposium X Thursday July 2, 17:00 - 19:00

From neurophysiology to cognitive psychology: How does anxiety influence the regulation of posture and gait?

Chair: **William Young**, Brunel University, UK

Co-Chair: **Mark Carpenter**, UBC

Mark Carpenter
University of British Columbia, Canada

The neurophysiological basis for fear and anxiety effects on posture and gait

Fear and anxiety are commonly experienced by older adults and those with movement disorders. Strong associations between fear of falling and falls have been previously established, and a growing body of evidence supports a direct relationship between anxiety, arousal, fear and human balance control and gait. In a series of studies we have experimentally manipulated fear, anxiety and arousal using real and virtual elevated surfaces, affective pictures and sounds, and the threat of perturbation in order to identify the neurophysiological mechanisms that may mediate anxiety-related changes in static and dynamic balance and gait. Potential neural mechanisms that have been investigated include changes in muscle spindle sensitivity, cutaneous and vestibulo-spinal reflex gain, 1b reflex pathways, motor cortical excitability and cortical processing of sensory information. In general, the results support a strong neurophysiological basis for the observed changes in balance and gait with increased fear, anxiety and arousal. These changes are likely related to strong neural links that are known to exist between areas of the brain and brainstem controlling elements of fear, vigilance and arousal and the sensory-motor areas that contribute to human balance and gait.

Mark Hollands
Liverpool John Moores University, UK

Using gaze tracking to elucidate the interplay between, anxiety, attention and falls

In order for pedestrians to safely navigate our cluttered environment they must visually identify and hazards and safe paths and adapt gait appropriately. Therefore, looking in the right places at the right times is crucial for safe locomotion. We have previously shown that older adults, particularly those who have a high risk of falling, tend to spend less time previewing upcoming hazards while walking and tend to look away prematurely from targets for safe foot placement to view future hazards. I will present evidence from a series of laboratory studies that this maladaptive gaze behaviour contributes towards falls risk and is causally linked to

anxiety and/or fear of falling. I will also provide evidence that age- and anxiety-related differences in attentional processing may be the key to understanding these changes in behaviour. Finally I will discuss how these findings may fit in with the concept of generalized anxiety-related stiffening strategies representing attempts to minimize 'unnecessary' destabilizing movements which paradoxically lead to increased falls risk.

Thomson Wong
Hong Kong University

The relationships among fear of falling, conscious motor processing, balance ability and risk of falling in older adults: Implications for rehabilitation

Walking is the most common fall-related activity in older adults (Lai et al., 2009). Healthy adults are mostly capable of walking and executing a wide range of movement skills automatically, but may use conscious motor processing to ensure the effectiveness of their movements when encountering difficulties. Owing to fear of falling or an awareness of movement difficulties, older adults may try to consciously monitor and control their movements during walking to ensure that the movements are performed correctly. Conscious motor processing utilizes knowledge and strategies that are explicitly processed in working memory (Baddeley, 1994). The process of switching from automatic motor processing to conscious explicit motor processing has been called "reinvestment" (Masters, 1992). Masters (1992) defined reinvestment as "an inward focus of attention in which an attempt is made to perform the skill by consciously processing explicit knowledge of how it works". Masters et al. (2005) subsequently developed a Movement Specific Reinvestment Scale (MSRS), which measures an individual's propensity for 'reinvestment'. The scale assesses two separate factors (i) movement self-consciousness and (ii) conscious motor processing. Higher scores represent a greater propensity for conscious motor processing. Our research team initially found that high fear of falling in older adults was associated with poor balance and high propensity to reinvest (Wong & Masters, 2005). Subsequently, we discovered that older fallers have a higher propensity to consciously process their movements (i.e., reinvest) than age-matched non-fallers (Wong et al., 2008). Conscious control of movements by internal focus of attention may lead to movement disruption, possibly by constraining or interfering with automatic motor control mechanisms (Wulf et al., 2001; McNevin et al., 2003). Focusing internally may not only have the effect of disrupting natural motor coordination but may also reduce the allocation of or interfere with the attention to negotiating the environment, further increasing the risk of falling of the older adults. Additionally, older fallers were also found to have higher tendency to divide their attention between the external environment and internal mechanisms of their movements, especially under stress, while older non-fallers focus externally during walking (Wong et al., 2009). Efforts to attend both internal and external information by the older fallers may overload resources in the working memory (Baddeley, 1994) which may in return influence negatively on movement control. This talk summarizes the novel evidence of the relationships among fear of falling, conscious motor processing (i.e., reinvestment), balance ability and risk of falling in older adults. Potential practical implications and rehabilitation methods to ameliorate the predisposition to reinvest during gait training of the older fallers by Physiotherapists are discussed. The utilization of the theory of reinvestment in different disease groups for people with movement difficulties, for example Stroke and Parkinson's diseases, are also reviewed.

William Young
Brunel University, London, UK

How can fear of falling influence fall-risk in older adults? Applying psychological theories to practical observations.

It is widely reported that fear of falling (FOF) has a profound effect on balance performance in older adults. However, the mechanisms by which FOF influences postural stability are poorly understood. Many researchers have investigated neurophysiological and behavioral responses to perceived threat, mostly by raising the height of a support surface. These researchers have consistently shown that behavioral correlates of FOF are indicative of a conservative 'stiffening strategy'. Anxiety-related changes in visual behavior whilst walking have

also been reported; where anxious OA will fixate a stepping target earlier during their approach towards it and for longer durations, whilst fixating subsequent stepping constraints on fewer occasions and for shorter durations compared to OA with low self-reported anxiety. It seems likely that anxiety-related shifts towards stiffening strategies represent attempts to minimize 'unnecessary' destabilizing movements even when, in the instance of visual search, they are needed for feedforward movement planning during adaptive gait.

There is a clear need for researchers to identify commonalities between the wide-ranging anxiety-related adaptations observed during posture and gait tasks, and to conceptualize these adaptations within existing or new theoretical frameworks. Of particular importance is the presentation of possible mechanisms responsible for anxiety-related decline in dual-task performance (i.e., rationalize anxiety-related reductions in the efficiency of attentional processing). For instance, older adults with FOF may try to consciously monitor and control their movements during walking to ensure that movements are performed correctly. Focusing internally may interfere with the attention allocated towards negotiating the environment, impacting on the efficiency of attentional processing and potentially disrupting the capacity for switching attention between tasks. This perspective can be interpreted with reference to extant psychological frameworks such as Attentional Control Theory (ACT). The broad aim of this symposium is to evaluate the applicability of these theories in conceptualizing anxiety-related changes to psychological and motor function and to discuss opportunities that this theoretical platform might provide in terms of future basic and applied sciences.

Symposium XI Thursday July 2, 17:00 - 19:00

The Quest to Apply VR Technology to Rehabilitation: Tribulations and Treasures

Chair: **Emily Keshner,** Temple University, USA

Co-Chair: **Joyce Fung**, McGill University, Canada

Racheli Kizony
University of Haifa, Israel

The design and implementation of virtual reality systems and environments for neurological rehabilitation

Background:
Using virtual reality (VR) technology for neurological rehabilitation is widely accepted by clinicians. In order to maximize the potential of these technologies for rehabilitation, the process of designing, adapting and implementing VR technology should accommodate clinical goals that are guided by theories, models and treatment techniques used in rehabilitation (e.g., motor learning, neurodevelopmental approach). The purpose of this presentation is to demonstrate the process and clinical reasoning behind the design and clinical implementation of virtual reality for neurological rehabilitation. This will be demonstrated via 1) A Kinect-based tele-rehabilitation system developed for the treatment of the weak upper extremity post-stroke and, 2) A high-end VR system running a virtual environment designed to assess executive functions during the performance of complex daily tasks (i.e. walking and shopping).

Methods:
The Kinect-based tele-rehabilitation system (ReAbility-online; http://www.gertnerinst.org.il/e/health_society/ReAbility_online/) is composed of evaluation and treatment modes. The treatment mode includes instructional demo routines used to teach the required movements and games to train purposeful movements of the upper extremity. The games were designed to implement key rehabilitation principles; adjusting the difficulty levels from motor and cognitive aspects and providing knowledge of results and knowledge of performance types of feedback.

The virtual environment designed to assess executive functions during the performance of complex daily tasks (i.e. the Multiple Errands Test) is a simulation of a small shopping mall. The simulation runs in the CAREN™

(Computer Assisted Rehabilitation Environment) Integrated Reality System and is projected onto a wall-mounted monitor. The person walks on a self-paced treadmill (VGait; Motek Medical B.V.) facing the monitor and navigating through the simulation with a joystick. The scene is shown to advance in accordance with the speed of the treadmill. In addition, 20 passive markers are placed on anatomical landmarks and are detected by 12 VICON cameras (www.vicon.com). The markers are detected by CAREN to activate the self-paced treadmill and to enable interaction with the 3D objects (e.g. items for purchase). Data from the simulation, treadmill and markers are recorded and synchronized via CAREN.

Results:
Our feasibility studies, including a small RCT, demonstrated the potential of using the Kinect system for improving function of the weak upper extremity post-stroke. To date, the system is used in a tele-rehabilitation service. An initial retrospective study of 28 adults with neurological impairments, who received at least 10 sessions, showed that the service was provided for people aged between 35-78 years. In addition, clients had mild to moderate impairments of their upper extremity with low frequencies of hand use for daily activities. Results from a focus group of 8 clients and two spouses showed that both clients and spouses reported high levels of compliance and satisfaction with the service. The design of the shopping mall simulation allows multidimensional assessment of performance of complex daily activities and provides an opportunity to explore the complexity of cognitive as well as motor strategies used by individuals to accomplish functional tasks such as shopping.

Conclusions:
Challenges arising throughout the described processes will be discussed.

Anouk Lamontagne
McGill University, Canada

Manipulating visual and auditory information with virtual reality to improve mobility post-stroke

Background:
Mobility in stroke survivors is deficient, often characterized by gait asymmetry, slow walking speed and a reduced ability to adapt to contextual and environmental demands. Together, these walking dysfunctions compromise ambulation in complex community environments. An altered perception and utilization of visual and auditory cues, as they provide information about self-motion and the environment, may further alter community ambulation abilities in stroke survivors. The overarching goals of our projects are to examine how changing visual and auditory cues modify locomotion and to design virtual reality (VR) technology-based in interventions that manipulate visual and auditory cues to improve mobility in stroke survivors.

Methods:
In a first project, we examined the ability of stroke participants with and without visual-perceptual deficits to i) perceive moving obstacles approaching from different directions and ii) avoid these same obstacles during locomotion. In a second project, we are investigating the impact of manipulating biological visual and auditory cues, presented in the form of virtual pedestrians, on walking speed and gait characteristics of healthy and stroke participants.

Results:
Results from the first project showed that stroke participants with visual-perceptual deficits, compared to those without visual-perceptual deficits, presented with a delayed detection and a delayed onset of avoidance strategies in response to obstacles approaching from the contralesional side and from head-on. In the second project, preliminary findings show that healthy participants can modify their walking speed and temporal distance parameters in response to changes in walking speed presented by the visual avatars, the footstep sounds, and more profoundly by the combination of both visual and auditory cues. We expect that participants with chronic stroke can also respond to these cues and we are in the process of verifying that.

Conclusions:
VR technology can be used to study perceptuo-motor factors involved in the control of obstacle avoidance during locomotion. There is emerging evidence of manipulating visual and auditory information to increase gait speed. The presence of a residual capacity for locomotor adaptation in the stroke participants will provide the basis for intervention strategies that incorporate visual and auditory cues to improve mobility.

Christopher Rhea
University of North Carolina at Greensboro

Using virtual reality stimuli to develop fractal gait characteristics

Background:
Aging, disease, and injury often leads to a reduced ability to ambulate through the environment. A functional consequence for this reduced ambulatory ability is an increased fall rate, often leading to injury. Clinical rehabilitation programs frequently rely on subjective metrics to assess gait and balance ability. While these metrics are certainly useful, including metrics that objectively measure functional ability could enhance rehabilitation programs. Over the past two decades, metrics rooted in dynamical systems theory have been used to quantify differences in gait patterns between healthy and pathological populations. Collectively, these findings suggest that fractal patterns are a fundamental characteristic in the gait of healthy adults, and these fractal patterns typically weaken with aging, disease, or injury. Importantly, fractal patterns are thought to reflect the adaptive, functional ability of the actor.

Methods:
A weakened fractal patterns may indicate less functional gait control, and ultimately a higher risk of falling. Fractal patterns are attractive because their strength can be quantified across a continuum. Therefore, assessing fractal gait patterns in pathological populations may represent a way to objectively measure functional gait ability. Further, these novel techniques could be used to redevelop fractal gait characteristics so that functional ability can re-emerge in pathological populations. This presentation will focus on our recent studies examining how virtual reality (VR) stimuli can be used to develop fractal gait characteristics.

Results:
Study one showed that fractal gait characteristics can be prescribed with a simple visual stimulus. Study two showed that the newly formed fractal gait characteristics are retained in the short-term and that a VR stimulus showing a discrete timing cue was superior to a continuous timing cue for the retention of fractal gait characteristics. Study three showed that an avatar exhibiting fractal gait patterns was not an optimal VR stimulus to change gait characteristics, a finding explained by study four that used eye-tracking to determine where on the avatar participants were focusing. Study five is currently underway and is examining how long the newly formed fractal gait patterns are retained after a single 10 minute training session. Study six is examining how learning new fractal gait patterns during treadmill training transfers to overground walking and study seven is investigating the feasibility of using our VR fractal gait training intervention to enhance functional ability in lower-limb amputees.

Conclusions:
Limitations of solely relying on VR for fractal gait training will be discussed, as well as the role of feedback in developing and retaining new fractal gait patterns.

Geoffrey Wright
Temple University, USA

Using commercial technology to create a portable VR balance device to assess mTBI symptoms

Background:
Mild traumatic brain injury following a head impact or blast exposure can cause diffuse injury to the brain, which can affect sensorimotor, cognitive, and emotional processes. Among the most common sensorimotor symptoms of mTBI is balance impairment. Using postural control as a biomarker of brain injury may help improve identification of individuals with sub-acute symptoms which may be used to guide rehabilitation and clinical decision-making. Commonly used assessments of balance following mTBI include the sensory organization test (SOT) or the balance error scoring system (BESS) test. However, these tests may not be sensitive to visual-vestibular processing issues, which are thought to underlie unremitting or lingering symptoms that do not spontaneously resolve. Our current project involves demonstrating validity and reliability of a novel low-cost, portable virtual reality-based balance screening device that employs established principles of sensorimotor reweighting and visual-vestibular integration. The goal is to determine if it can replace existing tools that are either prohibitively expensive or lack reliability or sensitivity.

Methods:
Healthy adults with no known musculoskeletal or neurological injury (n=23; 14 males, 9 females; 22.8+4.1 years) were tested to establish healthy norms. Individuals with mTBI (n=6; 3 males, 3 females; 23.0+4.4 years) were compared to the healthy norms. The new VR-based balance assessment system consists of a Wii balance board (WBB), a large screen television, and a custom-designed software interface used to collect and process data. Subjects performed six upright postural tasks (3 visual conditions either standing directly on the WBB or on foam placed on the WBB) three times each. Subjects viewed a VR scene displayed on a 60" television. The 3 visual conditions were Static Scene, Dark Scene, and Dynamic Scene (Roll at 60 deg/s). The WBB recorded COP at 100Hz for 30 sec. Dependent variables included COP velocity, SD, RMS, and sway area. Subjects also performed the sensory organization test (SOT), and balance error scoring system (BESS) test, which can be used as criterion-measures for intraclass correlations with the new device.

Results:
Preliminary data on healthy subjects validates effectiveness of the device to reduce postural stability as sensory input reliability and availability decreased. Additionally, our results reveal that individuals with mTBI have significantly worse balance scores on the new VR-device ($p<0.05$). This highlights its sensitivity to balance disturbance even if statistical power is low. Comparison of the new device to SOT and BESS shows good criterion validity, however, the VR-based device was more sensitive. At 2- and 6-week follow-up, SOT and BESS showed a possible learning effect in the healthy cohort, while the VR-based device was stable. COP sway area, velocity, and standard deviation of medial-lateral and anterior-posterior sway were all sensitive dependent variables.

Conclusions:
Technology is constantly driving the development of more affordable and assessable inventions, while reducing training time and expertise to use. This study helps demonstrate that our new VR-based assessment tool is a valid measure for detecting balance related changes in neurologically impaired individuals and can potentially replace expensive equipment, while increasing objectivity beyond standard clinical tests.

Symposium XII Thursday July 2, 17:00 - 19:00

Advanced measures of gait; why, and how, should we (not?) calculate them?

Chair: **Sjoerd Bruijn**, VU University Amsterdam, The Netherlands

Christine Wu
University of Manitoba, Canada

Using Advanced Dynamics Measures to Characterize Human Gait - Advantages and Cautions

Transient stability (short-term stability) and Lyapunov's stability (long-term stability) are fundamentally different from a nonlinear system viewpoint. The transient stability is often measured by the centre of mass, center of pressure, zero moment point, etc. Such measures are conceptually intuitive and computational less costly. The lack of invariance is the main limitation, and limits the predictability. On the other hand, the long-term stability is measured by Lyapunov functions, Lyapunov exponents, Floquet numbers, etc. Such measures are invariant and characterize inherent features of the dynamic systems. I will discuss the two types stabilities focusing on the invariant property, its importance and how such a property imposing conditions on how we calculate and interpret such measures. Entropies are (almost) invariant measures of fundamental features of dynamic systems, but they are perceived not indicating the stability directly. I'll then discuss the entropies (Sample Entropy, Fuzzy Entropy and Permutation Entropy), especially the two extended one developed by my group (Quantized Dynamic Entropy and Quantization-based approximation of Sample Entropy), in term of how they characterize the nonlinear system complexities, and how such complexities may indicate the system stability. Often we are interested in the transient stability, and some of the measures meant for the long-term stability have been borrowed. I'll discuss the indication of such a migration and cautions.

Overall I`ll talk about the dynamic measures from the nonlinear systems viewpoint using the examples of passive dynamic walking models and human gait (active healthy young adults versus healthy community-dwelling older adults, and regular walking versus walking while performing a secondary task (dual-tasking)). The question I`m interested in is that if we keep the measures theoretically rigorous, we are restricted to applications, how much we can `loosen up`, but still get meaningful results in predicting the stability of human locomotion.

Nicholas Stergiou
University of Nebraska, USA

A Perspective on Human Movement Variability: Implications for Health and Pathology

This talk describes innovations in the exploration of variability and their potential importance in understanding human movement. Far from being a source of error, evidence supports the presence of an optimal state of variability for healthy and functional movement. Deviations from this state can lead to biological systems that are either overly rigid and robotic or noisy and unstable. Both situations result in systems that are less adaptable to perturbations, such as those associated with unhealthy pathological states.

Philippe Terrier
Clinique Romande de Réadaptation, Switzerland

Assessment of gait characteristics in patients with chronic pain using accelerometry under free-living conditions

A poor gait quality can be induced by various conditions and pathologies. It is characterized by slow speed, abnormal kinematics, increased energy cost, high stride-to-stride variability, and high falling risk. These gait deficits greatly reduce the patient's ability to move around, thereby compromising their participation in activities of daily life, and degrading quality of life. Kinematic and kinetic analyses made in a gait laboratory are the gold standard for evaluating gait quality; however, these analyses occur in artificial environments and with very limited numbers of gait cycles. Thus, there is a need to assess gait quality in real life conditions outside the lab. Two recent developments might help fulfill this need. First, new wearable motion sensors with high storage capabilities can record body acceleration over more than 1 week at high frequency (50–100 Hz). Second, recent advances in nonlinear signal processing have brought new indexes that can assess gait quality using acceleration signals measured at the trunk level.

The goal of this presentation is to describe an ongoing study that aims, inter alia, to implement long-term gait quality monitoring in a clinical context, based on those recent advances. We sought to assess the validity

of several nonlinear indexes in a study of about 70 patients with chronic pain induced by musculoskeletal problems. Among them, 20% had lower-limb injuries. The patients were hospitalized an average of 4 weeks in our rehabilitation clinic. The aim of the therapeutic program was to improve functional status and the patients' chances of returning to work. Each participant wore an activity monitor for a divided 3-week period: one week at home, 10 days before hospitalization; one week at the clinic during hospitalization; and one week at home 90 days following hospitalization. The controls comprised 80 healthy individuals who were assessed over 1 week. The accelerometer was an ActiGraph wGT3X, a popular, lightweight (19 g) activity monitor that allows continuous recording of 3D acceleration up to 100 Hz. An algorithm based on spectral analysis detected periods of walking. For each day, 5 walking periods of 2 minutes were randomly selected. For the gait quality index, we tested many different parameters derived from the trunk acceleration signal, but I will focus on local dynamic stability (divergence exponent method) and recurrence quantification analysis (RQA), particularly the determinism (DET).

To characterize the validity and reliability of the indexes, we first assessed the intra-individual variability (within and between days) in the control subjects. Second, we tested the ability of the indexes to discriminate between the healthy controls and the patients, and between the patients with and without lower limbs injuries. Third, in the patients, we compared the 3 divided weeks to detect potential effects of the rehabilitation. Here, I will present the current results and discuss the necessity of such empirical validations in addition to theoretical and experimental studies.

Espen Ihlen
Norwegian University of Science and Technology, Norway

Gait stability and variability measures in accelerometry data

A large number of variability and stability measures have been suggested for accelerometry data of daily life walking. However, many of these measures are statistical quantities such as standard deviation, coefficient of variation, entropies or local dynamical stability, that were not developed explicitly for gait analysis. The current presentation illustrates how variability and stability measures can be modified to be more suitable for analysis of daily life walking. An example of modification of local dynamic stability is used to illustrate how gait stability measures can be modified. In this example, new measures of the local divergence of small perturbations are considered within each stride cycle that are better able to define subtle stability characteristics in daily-life walking compared to the local dynamical stability. The presentation also emphasizes the importance of variability and stability measures in early detection and prediction of functional decline and impairments. Currently, there are few studies that compare new and existing measures of daily-life walking in their ability to discriminate between groups and predict outcomes of clinical importance. An example of the performance of local divergence measures is used to differentiate between daily-life walking of fallers and non-fallers in community dwelling older persons. The performance of the local divergence measures are compared with existing gait stability and variability measures by a data mining procedure called partial least square (PLS) regression. PLS regression finds latent structures for a large set of noisy and collinear gait variability and stability measures which can be used to compare the influence of each measure in early prediction of outcomes and discrimination between groups. The presentation ends with further promising possibilities to compare and select amongst existing gait variability and stability measures of daily-life walking in different clinical applications.

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Authors and Presenters

All authors (lead and additional) and presenters are listed here for easy cross-referencing to their respective abstract. The list of full abstracts is available as a download from the ISPGR website (***www.ispgr.org***).

Interpreting the presentation numbers:

The first section of the number represents the type of presentation as follows:

K = Keynote presentation
O = Oral presentation
S = Symposium presentation
P1 = Poster Session 1
P2 = Poster Session 2
P3 = Poster Session 3

The second section represents the session number for Oral and Symposium presentations or the subject theme for posters.

The third section indicates the order of presentation for Oral and Symposium presentations or Poster number.

Poster Themes:

A Activity monitoring
B Adaptation, learning, plasticity & compensation
C Aging
D Biomechanics
E Brain imaging/activation during posture & gait
F Cognitive impairments
G Cognitive, attentional, and emotional influences
H Coordination of posture and gait, Devices to improve posture and gait
I Development of posture and gait
J Developmental disorders
K Devices to improve posture and gait
L Effect of medication on posture and gait
M Ergonomics
N Exercise and physical activity
O Falls and fall prevention
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Q Modeling
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U Sensorimotor control, Visual function & disorders
V Tools and methods for posture and gait analysis
W Vestibular function and disorders

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Fouaz Ayachi[1], **Hung Nguyen** [1], **Catherine Lavigne Pelletier**[1], **Margaux Blamoutier**[1], **Patrick Boissy**[2], **Etienne Goubault**[1], **Christian Duval**[1]
[1]University of Quebec at Montreal, [2]University of Sherbrooke

P1-A-2 Validation of the Actigraph GT3X+ activity monitor in individuals with recent stroke
Vince DePaul[1], **Cynthia Campos**[2], **Shajicaa Sivakumaran**[2], **Svetlana Knorr** [2], **Avril Mansfield**[2], **Kara Patterson**[2]
[1]Toronto Rehab-UHN, [2]Toronto Rehabilitation Institute - UHN

P1-A-3 Do Postural Sway Measures tell us something about Quality and Quantity of Physical Activity Performed at Home? A Smartphone-based Study on Community-Dwelling Older People
Sabato Mellone[1], **Marco Colpo**[2], **Stefania Bandinelli**[2], **Lorenzo Chiari**[1]
[1]University of Bologna, [2]Azienda Sanitaria Firenze, Florence, Italy

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Mariana Stehlíková[1], **Ondrej Cakrt**[1], **Igor Bodlák**[2], **Jaroslav Jerabek**[1]
[1]2nd Faculty of Medicine, Charles University in Prague, [2]Princip a.s.

B Adaptation, learning, plasticity and compensation

P1-B-5 Using transcranial magnetic stimulation to probe effects of visual motion adaptation on primary visual cortex (V1) excitability in Bilateral Vestibular Failure patients
Hena Ahmad[1]
[1]Imperial College London

P1-B-6 Adaptation to perturbations reduces difficulty to maintain balance during unpredictable gait perturbations in healthy individuals
Cyril Duclos[1], **Gabrielle Blanc**[2], **Lucie Dubreucq**[2], **Aurélie Méreu**[2]
[1]Université de Montréal, School of rehabilitation, [2]Centre for Interdisciplinary Research in Rehabilitation (CRIR-IRGLM)

P1-B-7 Kinematic and kinetic analysis of human grounded running with and without heel contact
Takahiro Iwami[1], **Reiko Sasaki**[1], **Naomichi Ogihara**[1]
[1]Keio University

P1-B-8 Assessing Variances After A Freezing of Gait Intervention: A Dual Motor-Cognitive Task in a Virtual Environment
Isabelle Killane[1], **Conor Fearon**[2], **Conor McDonnell**[1], **Kristian Sons**[3], **Richard Reilly**[1]
[1]Trinity College Dublin, [2]The Mater Hospital, [3]Deutsches Forschungszentrum für Künstliche Intelligenz GmbH, DFKI

P1-B-9 Postural control during cascade ball juggling: Effects of expertise and support basis
Sérgio Rodrigues[1], **Paula Polastri**[1], **Stefane Aguiar**[2], **Marcelo Mesaros**[1], **Fabio Barbieri**[1]
[1]Univ Estadual Paulista - UNESP, [2]Cruzeiro do Sul University

C Aging

P1-C-10 The effect of age on improvements in balance control after acute unilateral peripheral vestibular loss
John Allum[1], **Alijda Scheltinga**[1], **Dionne Timmermans**[1], **Flurin Honegger**[1]
[1]University Hospital Basel

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Bård Bogen[1], **Mona Aaslund**[1], **Anette Hylen Ranhoff**[1], **Rolf Moe-Nilssen**[1]
[1]University of Bergen

P1-C-12 Reliability, measurement error and minimum detectable change of TUG and usual gait speed in community-dwelling adults aged 50 years and over
Orna Donoghue[1], **George Savva**[2], **Rose Anne Kenny**[1]
[1]Trinity College Dublin, [2]University of East Anglia

P1-C-13 Sedentary behaviour, physical activity and physical function in older people. The Generation 100 study
Jorunn Helbostad[1], **Sebastien Chastin**[2], **Thorlene Egerton**[1], **Kristin Taraldsen**[1], **Dorthe Stensvold**[1], **Beatrix Vereijken**[1]
[1]Norwegian University of Science and Technology, [2]Caledonian University

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Linda Maclean[1], **Elizabeth Williams**[2], **Faustina Hwang**[3], **Tim Adlam**[4], **Laura Brown**[5], **Hassan Khadra**[6], **Claire Timon**[7], **Arlene Astell**[2]
[1]University of Glasgow, [2]University of Sheffield, [3]University of Reading, [4]University of Bath, [5]University of Manchester, [6]Oxford Technologies Limited, [7]University College Dublin

P1-C-15 Effects of aging on arm swing and trunk rotation during walking
Anat Mirelman[1], **Hagar Bernad-Elazari**[1], **Tomer Nobel**[2], **Avner**

Thaler[1], Meir Plotnik[3], Nir Giladi[1], Jeffrey Hausdorff[1]
[1]Tel Aviv Sourasky Medical Center, [2]Ben Gurion University, [3]Sheba Medical Center

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***Caterina Rosano[1]*, Stephanie Studenski[2], Howard Aizenstein[1], Anne Newman[1], Kristine Yaffe[3], Joe Verghese[4], Andrea Rosso[1]**
[1]University of Pittsburgh, [2]National Institutes of Health, [3]University of California, San Francisco, [4]Albert Einstein College of Medicine

P1-C-17 Age-related changes in self-estimation of step-over ability in older adults: A three-year follow-up study
***Ryota Sakurai[1]*, Takahiro Higuchi[2], Yoshinori Fujiwara[1], Kuniyasu Imanaka[2]**
[1]Tokyo Metropolitan Institute of Gerontology, [2]Tokyo Metropolitan University

P1-C-18 Gender and walking speed affect models of gait - The Generation 100 study
***Beatrix Vereijken[1]*, Per Bendik Wik[1], Pernille Thingstad[1], Jorunn Helbostad[1]**
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P1-C-19 Cholinergic dysfunction: a common substrate for gait disturbances among fallers in older adults and people affected by Parkinson?s disease
***Elisa Pelosin[1]*, Carla Ogliastro[2], Andrea Ravaschio[2], Anat Mirelman[3], Jeffrey Hausdorff[3], Giovanni Abbruzzese[2], Laura Avanzino[2]**
[1]DINOGMI c/o Clinica Neurologica, [2]University of Genoa, [3]Tel Aviv Sourasky Medical Center

D Biomechanics

P1-D-20 Adaptability of gait post-stroke requires symmetry of single support time
***Sultan Alharbi[1]*, Kristen Hollands [1], Richard Jones[1]**
[1]University of Salford

P1-D-21 The EMG Signal Processing for Estimation of Lower Limb Joint Angle Using ANN
***Junghwa Hong[1]*, Taekyeong Lee[1], Heesuk Roh[1], Jaemin Kim[1], Soonmoon Jung[1]**
[1]Korea University

P1-D-22 Evaluation of sagittal spinal parameters during gait before and after high tibial osteotomy in patients with knee osteoarthritis
***Yoon Hyuk Kim [1]*, Ahreum Han[1], Ariunzaya Dorj[1], Kyungsoo Kim[1]**
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P1-D-23 Inverse dynamics without force plates
***Hendrik Reimann[1]*, Elizabeth Thompson[1], Peter Agada[1], John Jeka[1]**
[1]Temple University

P1-D-24 Biomechanical analysis of friction requirement at shoe-floor interface during straight walking and turning
***Takeshi Yamaguchi[1]*, Akito Suzuki[1], Hironari Higuchi[1], Kei Masani[2], Kazuo Hokkirigawa[1]**
[1]Tohoku University, [2]Toronto Rehabilitation Institute ? University Health Network

E Brain imaging/activation during posture and gait

P1-E-25 Self-recognition of one's own fall evoked the right dominant cortical and brainstem activity
***Tomoaki Atomi[1]*, Madoika Noriuchi[2], Kentaro Oba[3], Yoriko Atomi[4], Yoshiaki Kikuchi[2]**
[1]Teikyo University of Science, [2]Graduate School of Tokyo Metropolitan University, [3]Tohoku University, [4]Tokyo University of Agriculture and Technology

P1-E-26 The neural mechanisms underlying walking in complex situations in healthy older adults and patients with Parkinson's disease: insights from an fMRI study
***Inbal Maidan[1]*, Keren Rosenberg-Katz [1], Yael Jacob[1], Nir Giladi[1], Judith Deutsch[2], Jeffery Housdorff[1], Anat Mirelman[1]**
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P1-E-27 Functional Brain Imaging of Multisensory Integration during Computerized Dynamic Posturography in Older Adults Using Functional Near-infrared Spectroscopy (fNIRS)
***Patrick Sparto[1]*, James Lin[1], Joseph Furman[1], Theodore Huppert[1]**
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P1-E-28 Suthalamic activity during the initiation of gait in human
***Marie-Laure Welter[1]*, Adele Demain[1], Jean-Eudes Le Douget[1], Xavier Drevelle[1], Antoine Collomb-Clerc[1], Sara Fernandez-Vidal[1], Eric Bardinet[1], Brian Lau[1], Carine Karachi[1]**
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F Cognitive impairments

P1-F-29 Physical Fitness in Older People with Mild Cognitive Impairment and Dementia
***Karin Hesseberg[1]*, Hege Bentzen[2], Anette Hylen Ranhoff[3], Knut Engedal[4]**
[1]Oslo and Akershus University College/Diakonhjemmet hospital, [2]Oslo and Akershus University College, [3]Diakonhjemmet Hospital, Oslo. Kavli Research Centre for Geriatrics and Dementia, Haraldsplass Hospi, [4]Norwegian Centre for aging and health, Vestfold ho

P1-F-30 Limited importance of rigidity and bradykinesia for gait and balance in patients with mild Alzheimer disease.
***Gro Tangen[1]*, Anne Marit Mengshoel[2]**
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G Cognitive, attentional, and emotional influences

P1-G-31 The relationship between movement reinvestment, balance confidence, and balance performance in healthy older adults
Allan Adkin[1], Kimberly Caporicci[1], Larkin Lamarche[1], Kimberley Gammage[1]
[1]Brock University

P1-G-32 Controlling perceptual interference and balance in older adults: How does cognitive function relate to balance performance at different ages?
April Chambers[1], J Richard Jennings[1], Patrick Sparto[1], Joseph Furman[1], Mark Redfern[1]
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P1-G-33 Does anxiety influence the ability to utilize sensory feedback while walking in PD?
Kaylena Ehgoetz Martens[1], Colin Ellard[2], Quincy Almeida[3]
[1]University of Waterloo/ MDRC, [2]University of Waterloo, [3]Wilfrid Laurier University/ Movement Disorders Research and Rehabilitation Centre

P1-G-34 Dual-task cost in four domains of gait- a comparison between elderly with mild to moderate Parkinson's disease and healthy controls.
Niklas Löfgren[1], David Conradsson[1], Erika Franzén[1]
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P1-G-35 Tai Chi training reduces dual task gait variability, a potential mediator of fall risk, in healthy older adults: cross-sectional and randomized trial studies
Peter Wayne[1], Jeffrey Hausdorff[2], Brian Gow[1], Lewis Lipsitz[1], Vera Novak[3], Eric Macklin[4], Chung-Kang Peng[3], Brad Manor[1]
[1]Harvard Medical School, [2]Tel Aviv Sourasky Medical Center and Tel Aviv University, [3]Beth Israel Deaconess Medical Center, Harvard Medical School, [4]Massachussets General Hospital, Harvard Medical School

H Coordination of posture and gait, Devices to improve posture and gait

P1-H-36 Does the passability of apertures change when walking between people versus objects?
Amy Hackney[1], Michael Cinelli [2], James Frank[1]
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P1-H-37 How do children age 7 complete a combined motor and cognitive task?
Dorelle Hinton[1], Lori Ann Vallis[1]
[1]University of Guelph

P1-H-38 Verticality perception during standing and sitting
Klaus Jahn[1], Christian Prawitz[1], Jeannine Bergmann[1], Carmen Krewer[2], Charlotte Selge[1], Stanislav Bardins[1], Paul MacNeilage[1], Aram Keywan[1], Friedemann Müller[2], Eberhard Koenig[2]
[1]University of Munich, [2]Schoen Klinik Bad Aibling

P1-H-39 Impaired Interlimb Coordination after Concussion
Martina Mancini[1], Clayton Swanson[1], Jim Chesnutt[1], Laurie King[1]
[1]Oregon Health & Science University

P1-H-40 KNEE FLEXION LIMITATIONS INFLUENCE LOWER LIMB INTERSEGMENTAL COORDINATION DURING OBSTACLE CLEARANCE
Emily McIntosh[1], Stephen Prentice[1]
[1]University of Waterloo

P1-H-41 ASSOCIATION BETWEEN BALANCE AND GAIT ABNORMALITIES IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE
Antonio Nardone[1], Simone Guglielmetti[2], Margherita Grasso[2], Chiara Giordano[2], Paola Morlino[3], Bruno Balbi[2], Marco Schieppati[4]
[1]Fondazione Salvatore Maugeri (IRCCS) and University of Eastern Piedmont, [2]Fondazione Salvatore Maugeri (IRCCS), [3]Università di Pavia, [4]University of Pavia and Fondazione Salvatore Maugeri (IRCCS)

P1-H-42 Attentional demands during treadmill walking: dynamic gait stability and associated neural correlates
Samir Sangani[1], Taichi Kurayama[2], Joyce Fung[3]
[1]Jewish Rehabilitation Hospital, [2]Chiba University, [3]McGill University

P1-H-43 Does postural configuration affect saccadic reaction time during reaching?
Alexander Stamenkovic[1], Rebecca Robins[2], Paul Stapley[1], Mark Hollands[2]
[1]University of Wollongong, [2]Liverpool John Moores University

P1-H-44 Changes of smoothness at the center of mass and foot by walking speeds
Gyerae Tack[1], Jinseung Choi[1], Dongwon Kang[1], Jeongwoo Seo[1], Juyoung Kim[1]
[1]Konkuk University

P1-H-45 Timing of turn to sit Timed Up and Go Subtasks in Parkinson's Disease
Aner Weiss[1], Talia Herman[1], Anat Mirelman[1], David Bennett[2], Aron Buchman[2], Jeffrey Hausdorff[1], Giladi Nir[1]
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P1-H-46 THE NEURAL ORIGIN OF SWITCHES IN COORDINATION OF ARM AND LEG MOVEMENTS DURING WALKING
Nadia Dominici[1], Andreas Daffertshofer[2]
[1]Vrije Universiteit, [2]VU University of Amsterdam

P1-H-47 Effects of speed of walking on the accuracy of foot placement control
Jeanine Blaakmeer[1], Ulrike Hammerbeck[2], Susanne van der Veen[2], Vivian Weerdesteyn[1], Kristen Hollands[2]
[1]Radboud University Nijmegen, [2]University of Salford

P1-H-48 Reactive stepping ability in healthy adults as a control comparison for stroke survivors.
Susanne van der Veen[1], Ulrike Hammerbeck[1], Jeaninne Blaakmeer[2], Kristen Hollands[1]
[1]University of Salford, [2]Radboud University

P1-H-107 Therapeutic Effects of Robot-Assisted Gait Training in people with Stroke
***Chien-Hung Lai*[1]**
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I Development of posture and gait

P1-I-51 Cognitive and sensorimotor interference while walking : a study in adolescent girls
***Christine Assaiante*[1], Fabien CIGNETTI[1], Marianne JOVER[2], Marianne VAUGOYEAU[1]**
[1]CNRS, [2]AMU

P1-I-52 The effect of age and coordination on gait propulsion strategy in primary school aged children
***Stephanie Parkinson*[1], Jilllian Lye[1], Jenny Downs[2], Susan Morris[1]**
[1]Curtin University, [2]University of Western Australia

J Developmental disorders

P1-J-53 Change in standing postural control and physical functions with 6-months physical exercise in children with mild developmental disorders
***Tadamitsu Matsuda*[1], Osamu Nitta[2], Makiko Furuya[3], Shigeki Miyajima[4], Yasushi Kusumoto[5], Nozomi Nagaoka[6]**
[1]Uekusa Gakuen University, [2]Tokyo Metropolitan University, [3]Kyoto University, [4]Ryotokuji University, [5]Tokyo Technology University, [6]Higashi Oomiya Hospital

K Devices to improve posture and gait

P1-K-54 The Immediate and Long term effects of Hart walker in an adult with cerebral palsy
***Satsuki Amimoto*[1], Noboru Sekiya [2], Hiroto Hayashi[3], Kazutaka Irie[4]**
[1]Showa University Fijigaoka Rehabilitation Hospital, [2]Showa University, [3]Hanahana home care center, [4]Hart walker Japan

P1-K-55 Differential influence of postural remediation insoles on the postural Maddox rod test
***Géraldine Constantin*[1], Virginie Salaün[1], Imen Frikha[1], Marc Janin[2]**
[1]Cabinet Paramédical, [2]Applied Podiatry College

P1-K-56 The effects of vibrotactile cuing on recovery performance from treadmill-induced trip in healthy young adults
***Beom-Chan Lee*[1], Timothy Thrasher[1], Charles Layne[1]**
[1]University of Houston

P1-K-57 Influence of Insole Types, with or without Anterior Bar Stimulation, on Postural Control.
***Sophie Loureau*[1], Marc JANIN[2]**
[1]Cabinet Paramédical, [2]Applied Podiatry College

P1-K-58 The Effects of Attractive vs. Repulsive Instructional Cuing on Balance Performance
***Jaehong Lee*[1], Kathleen Sienko[1], Catherine Kinnaird[1], Wendy Carender[1], Bernard Martin[1]**
[1]University of Michigan

P1-K-59 Influence of vibrating lower-leg tendon for gait in patients with diabetic neuropathy
***Hiroshi Takemura*[1], Takayuki Shina[2], Yoshinori Kondo[2], Yuka Iijima[2], Hiroshi Tsubo[2], Yoshiyuki Midorikawa[2], Yusuke Fujino[3], Hiroshi Mizoguchi[2], Takeshi Yamakoshi[2]**
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P1-K-60 Balancing a book on the head may improve postural control
***Fredrik Tjernström*[1], Eva-Maj Malmstrom[2]**
[1]Dept. OtoRhinoLaryngology, Head and Neck Surgery, [2]Department of Neurology and Rehabilitation Medicine

L Effect of medication on posture and gait

P1-L-61 Pre- and unplanned walking turns in Parkinson´s disease - effects of anti-parkinson medication
***David Conradsson*[1], Caroline Paquette[2], Niklas Löfgren[1], Erika Franzén[1]**
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P1-L-62 Balance deficits that are selectively dopa-responsive in Parkinson's disease
***Shannon Lefaivre*[1], Kaylena Ehgoetz Martens[1], Eric Beck[1], Frederico Faria[1], Quincy Almeida[1]**
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M Ergonomics

P1-M-63 Implicit Cues and Explicit Motivations Modify Occupational Handling Strategies and Postures
***Harsha Bandaralage*[1], Dustin McCubbing[1], Jon Doan[1]**
[1]University of Lethbridge

N Exercise and physical activity

P1-N-64 Gait, muscle strength, and body balance in healthy older adults: differences between younger old and oldest old
Silvia Aranda-Garcia[1], Antoni Planas[2], Joan Prat-Subirana[2], Rosa Angulo-Barroso[3]
[1]EUSES, School of Health and Sport Science, UdG, [2]INEFC-Lleida , [3]CSUN (California, USA) and INEFC-Barcelona

P1-N-65 Validation of a new sport specific trunk function and balance assessment for para-kayak athletes
Anna Bjerkefors [1], Jordan Squair[2], Johanna Rosén[3], Olga Tarassova[3], Mark Carpenter[2]
[1]The Swedish School of Sport and Health Sciences, [2]University of British Columbia, [3]The Swedish School of Sport Sciences

P1-N-66 Sagittal Knee Kinematics During Flamenco Dancing - preliminary studies
Wanda Forczek[1], Alfonso Vargas-Macías[2]
[1]University of Physical Education, [2]Performing Arts Research Group, San Antonio Catholic University, Murcia, Spain

P1-N-67 Long-term Tai Chi Training May Improve Dual-task Standing and Cognition in Older Adults
Azizah Jor'dan[1], Brad Manor[1], Jeffrey Hausdorff[2], Matthew Lough[1], Vera Novak[3], Peter Wayne[4]
[1]Harvard Medical School/Hebrew SeniorLife, [2]Tel Aviv Sourasky Medical School, [3]Harvard Medical School/Beth Israel Deaconess Medical Center, [4]Harvard Medical School/Brigham and Women's Hospital

P1-N-68 Effect of a walking exercise on crouch gait in children with cerebral palsy: a kinematic analysis
Audrey Parent[1], Annie Pouliot-Laforte[2], Maxime Raison[1], Pierre Marois[3], Désirée Maltais[4], Christine Detrembleur[5], Laurent Ballaz[2]
[1]École Polytechnique de Montréal, [2]Université du Québec à Montréal, [3]Sainte-Justine Hospital, [4]Laval University, [5]Catholic University of Louvain

P1-N-69 Effectiveness of an exercise program for hip fracture patients - the EVA-HIP randomized controlled trial
Pernille Thingstad[1], Kristin Taraldsen[1], Ingvild Saltvedt[1], Olav Sletvold[1], Jorunn Helbostad[1]
[1]Norwegian University of Science and Technology

O Falls and fall prevention

P1-O-70 Sleep quality is associated with dual-task walking among community dwelling older adults:
Maayan Agmon[1], Tamar Shochat[1], Rachel Kizony[1]
[1]University of Haifa

P1-O-71 Toe clearance profiles distinguish fallers with incident Parkinson's disease when classified by fall type rather than fall frequency.
Lisa Alcock[1], Brook Galna[1], Sue Lord[1], Lynn Rochester[1]
[1]Newcastle University Institute for Ageing, Newcastle University

P1-O-72 The effect of treadmill training with and without virtual reality on postural control and gait in elderly fallers
Esther Bekkers[1], Kim Dockx[2], Elke Heremans[2], Sabine Verschueren[2], Anat Mirelman[3], Jeffrey Hausdorff[3], Alice Nieuwboer[2]
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P1-O-73 Reduced power Progressive Addition Lenses provide good stair ambulation safety in older people whilst providing adequate spot-reading ability
John Buckley[1], Richard Foster[2], John Hotchkiss[1], David Elliott[1]
[1]University of Bradford, [2]Nottingham Trent University

P1-O-74 Exploratory study on a sensor-based fall risk assessment tool
Lorenzo Chiari[1], Luca Palmerini[2], Sabato Mellone[2], Luca Cattelani[2], Marco Colpo[3], Stefania Bandinelli[3], Pierpaolo Chiari[2]
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P1-O-75 Similar Virtual Reality Games Elicit Different Challenges for Balance Training
Aijse de Vries[1], Jaap van Dieën[2], Ilse Jonkers[1], Sabine Verschueren[1]
[1]KU Leuven, [2]VU Amsterdam

P1-O-76 Psychometric properties of the Spring Scale Test - a clinical instrument to assess balance in the elderly
Joyce Fung[1], Elizabeth Dannenbaum[2], Claire Perez[2]
[1]McGill University, [2]Jewish Rehabilitation Hospital

P1-O-77 Accelerometer based free-living data: does macro gait behaviour differ between fallers and non-fallers with and without Parkinson's disease?
Silvia Del Din[1], Alan Godfrey[1], Brook Galna[1], Kim Dockx[2], Elisa Pelosin[3], Miriam Reelick[4], Anat Mirelman[5], Jeffrey Hausdorff[6], Lynn Rochester[1]
[1]Newcastle University, [2]KU Leuven, [3]University of Genova, [4]Radboud University Medical Center, [5]Tel Aviv Sourasky Medical Center, [6]Tel Aviv Sourasky Medical Center and Tel Aviv University

P1-O-78 Functional Reach performance and fall prediction in a cohort of 1102 elderly - the TREND study
Sandra Hasmann[1], Sebastian Kormeier[2], Markus Hobert[2], Katrin Maier[2], Sebastian Heinzel[2], Janet van Uem[2], Daniela Berg[2], Walter Maetzler[2]
[1]University Hospital of Tuebingen, [2]University Hospital of Tübingen

P1-O-79 Falls in the real world are related to obstacle crossing behaviors in a lab setting for young adults
Michel Heijnen[1], Shirley Rietdyk[1]
[1]Purdue University

P1-O-80 Can a five week visual training task improve balance in older adults?
Russell Kennedy[1], Michael Cinelli[2], Kristine Dalton[3]
[1]Wilfrid Laurier University , [2]Wilfrid Laurier University, [3]University of Waterloo

P1-O-81 Impaired modulation of reactive balance responses post stroke: Response to varying magnitudes of unpredictable perturbations.
Prakruti Patel[1], **Tanvi Bhatt**[1]
[1]University of Illinois at Chicago

P1-O-82 A Quantitative Evaluation of the Stay Well At Home Multifactorial Fall Risk Reduction Program
Debra Rose[1], **Elizabeth White**[1], **Ingrid Tanner**[1], **Kathleen Wilson**[1]
[1]California State University, Fullerton

P1-O-83 Daily-life gait quality as outcome measure to evaluate interventions: How many subjects are required to detect relevant changes?
Kimberley van Schooten[1], **Mirjam Pijnappels**[1], **Jaap van Dieën**[1]
[1]VU University Amsterdam

P1-O-84 The impact of falls on functional recovery after discharge from in-patient stroke rehabilitation
Jennifer Wong[1], **Dina Brooks**[1], **Elizabeth Inness**[2], **Avril Mansfield**[2]
[1]University of Toronto, [2]Toronto Rehabilitation Institute - UHN

P1-O-85 Large Trials on Falls Prevention in Parkinsons Disease: Outcomes of Hospital, Outpatient and Home Based Physiotherapy
Meg Morris[1], **Robert Iansek**[2], **Hylton Menz**[1], **Jennifer McGinley**[3], **Anna Murphy**[4], **Jennifer Watts**[5], **Clarissa Martin**[2], **Mary Danoudis**[1]
[1]La Trobe University, [2]Monash University, [3]The University of Melbourne, [4]Kingston Centre, [5]Deakin University

P Habilitation & rehabilitation

P1-P-86 The Effect of Lead-limb and Seat-height on Transition From Sitting to Upright in Healthy Individuals
Gareth Jones[1], **Darren James**[2], **Michael Thacker**[1], **David Green**[3]
[1]Guy's & St Thomas' NHS Foundation Trust, [2]London South Bank University, [3]King's College London

P1-P-87 Balance function in patients who had undergone allogeneic hematopoietic stem cell transplantation
Shinichiro Morishita[1], **Katsuji Kaida**[2], **Osamu Aoki**[3], **Shinya Yamauchi**[1], **Tatsushi Wakasugi**[1], **Orie Saino**[1], **Kazuhiro Ikegame**[2], **Norihiko Kodama** [2], **Hiroyasu Ogawa**[2], **Kazuhisa Domen**[4]
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P1-P-88 The virtual physiotherapist system utilizing IMU sensors.
Adam Switonski[1], **Henryk Josiński**[2], **Romualda Mucha**[2], **Konrad Wojciechowski**[2]
[1]Polish-Japanese Academy of Information Technology, [2]Polish-Japanese Institute of Information Technology

Q Modeling

P1-Q-89 Estimation of Smartphone Orientation Worn on the Thigh during Physical Activity
Michael Del Rosario[1], **Lauren Kark**[2], **Kejia Wang**[2], **Sylvain Hirth**[3], **Nigel Lovell**[2], **Stephen Lord**[4], **Stephen Redmond**[2]
[1]University of New South Wales, [2]University of New South Wales, Australia, [3]École Polytechnique Fédérale de Lausanne, [4]Neuroscience Research Australia

P1-Q-90 Impulse-momentum analysis shows that walking on a split-belt treadmill was energetically optimal after adaptation
Myunghyun Lee[1], **Montakan Thajchayapong**[2], **Young-Hui Chang**[2], **Sukyung Park**[1]
[1]KAIST, [2]Georgia Institute of Technology

R Neurological diseases

P1-R-91 Pronounced Lateral Postural Instability in Persons with Progressive Supranuclear Palsy: A Comparison with Parkinson's Disease
Shinichi Amano[1], **Jared Skinner**[2], **Hyo Keun Lee**[2], **Elizabeth Stegemöller** [3], **Nawaz Hack**[2], **Nikolaus McFarland**[2], **Chris Hass**[2]
[1]Ohio University, [2]University of Florida, [3]Iowa State University

P1-R-92 Gaze behaviour in freezers may relieve processing demands
Eric Beck[1], **Kaylena Ehgoetz Martens**[2], **Quincy Almeida**[1]
[1]Wilfrid Laurier University, [2]University of Waterloo

P1-R-93 Transcranial direct current stimulation to enhance dual-task gait training in Parkinson's disease: a pilot, randomized, double-blind, sham-controlled trial
Sandra Brauer[1], **Robyn Lamont**[1], **Siobhan Schabrun**[2]
[1]University of Queensland, [2]University of Western Sydney

P1-R-94 Self-assessment of gait symmetry in individuals with unilateral stroke: A pilot study
Vince DePaul[1], **Felicia Chow**[2], **Krystyna Thomas**[2], **Patricia Chan**[2], **Lisa Azuma**[2], **Vivien Poon**[3], **Avril Mansfield**[3], **Kara Patterson**[3]
[1]Toronto Rehab-UHN, [2]University of Toronto, [3]Toronto Rehabilitation Institute - UHN

P1-R-95 FREEZING OF GAIT OR AXIAL RIGIDITY? UNDERSTANDING THE COORDINATIVE NATURE OF EN BLOC TURNING IN PD
Frederico Faria[1], **Jessica Pinkerton**[2], **Janele Tacuyan**[2], **Quincy Ameida**[2]
[1]Visa, [2]Wilfrid Laurier University/MDRRC

P1-R-96 Sensor-based gait parameters correlate to clinical scores and dual task performance in Parkinson?s disease
Heiko Gaßner[1], **Johannes Schlachetzki**[1], **Jens Barth**[2], **Julia Goßler**[1], **Samuel Reinfelder**[3], **Simon Steib**[3], **Klaus Pfeifer**[3], **Jürgen Winkler**[1], **Björn Eskofier**[3], **Jochen Klucken**[1]

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P1-R-97 PreAtaxia: Changes in the control of posture and gait in pre-clinical degenerative cerebellar ataxia
***Winfried Ilg*[1], Zofia Fleszar[1], Cornelia Schatton[1], Martin Giese[1], Ludger Schoels[1], Matthis Synofzik[1]**
[1]Hertie Institute for Clinical Brain Research

P1-R-98 An Stimulation Algorithm to Treat Gait Impairment for Individuals with Parkinson?s Disease Following Deep Brain Stimulation (DBS) of the Subthalamic nucleus (STN).
***Sukhvinder Kalsi-Ryan*[1], Marina Picillo[1], Samantha Smith[1], Anthony Lang[1], Michael Fehlings[1], Alfonso Fasano[1]**
[1]University Health Network

P1-R-99 Acute effects of a novel treadmill device on gait and postural control in patients with Parkinson's disease
***Sarah Klamroth*[1], Simon Steib[1], Heiko Gassner[2], Jürgen Winkler[2], Björn Eskofier[1], Jochen Klucken[2], Klaus Pfeifer[1]**
[1]Friedrich-Alexander University of Erlangen-Nürnberg , [2]Universitätsklinikum Erlangen, Friedrich-Alexander University of Erlangen-Nürnberg

P1-R-100 Presence of multiple obstacles affects gait safety in healthy elderly and people with Parkinson's disease
***Diego Orcioli-Silva*[1], Fabio Barbieri[1], Rodrigo Vitório[1], Lucas Simieli[1], Paulo Santos[1], Francielle Hernandes[1], Claudia Teixeira-Arroyo[1], Lilian Gobbi[1]**
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P1-R-101 The Impact of Segmental Trunk Support on Posture and Reaching in Children with Cerebral Palsy: A Kinematic and Electromyographic Study
***Jaya Rachwani*[1], Victor Santamaria[1], Sandra Saavedra[2], Marjorie Woollacott[1]**
[1]University of Oregon, [2]University of Hartford

P1-R-102 Resistance Training versus Balance Training to improve postural control in patients with Parkinson?s Disease
***Christian Schlenstedt*[1], Steffen Paschen[1], Annika Kruse[1], Jan Raethjen[1], Burkhard Weisser[1], Günther Deuschl[1]**
[1]University Kiel

P1-R-103 Test-retest reliability of dual task performance measures in patients with Parkinson's disease
***Carolien Strouwen*[1], Esther Molenaar[2], Liesbeth Münks[1], Samyra Keus[2], Bastiaan Bloem[2], Alice Nieuwboer[1]**
[1]KU Leuven, [2]Radboud University Medical Centre

P1-R-104 STN-DBS reduces freezing of gait in Parkinson's disease in the VANTAGE prospective, multi-center trial
***Claudia Stummer*[1], Michael Barbe[2], Nic Van Dyck[3], Roshini Jain[3], Lilly Chen[3], Thomas Brücke[4], Fernando Seijo[5], Esther Suarez San Martin[5], Claire Haegelen[6], Marc Verin[6], Martin Amarell[2], Steven Gill[7], Alan Whone[7], Mauro Porta[8], Domenico Servello[8], Franço**
[1]1Radboud university medical centre, Donders Institute for Brain, Cognition and Behaviour, Department of Neurology, Nijmegen, The Netherlands, [2]Department of Neurology, Univ. Hospital, [3]Boston Scientific Corporation, [4]Wilhelminenspital, [5]Hosp. Central de

S Orthopedic diseases and injuries

P1-S-105 Younger total knee replacement patients demonstrate symmetrical heel strike transients and knee joint moments during level walking
***Brian Street*[1], William Gage[2]**
[1]California State University, Bakersfield, [2]York University

T Proprioceptive function and disorders

P1-T-106 Cerebral network subtending proprioceptive processing in children from 7 to 10 years
***Aurélie FONTAN*[1], Fabien CIGNETTI[1], Bruno NAZARIAN[1], Jean-Luc ANTON[1], Marianne VAUGOYEAU[1], Christine ASSAIANTE[1]**
[1]CNRS, AMU

U Sensorimotor control, Visual function and disorders

P1-U-108 Hypersensitivity to visual cues during quiet standing in persons with Mal de debarquement: Preliminary report from a case-control study
***Shinichi Amano*[1], Leatha Clark[1], S. Lee Hong[1], James Thomas[1], Timothy Law Sr.[1], Brian Clark[1]**
[1]Ohio University

P1-U-109 The Effect of a Visual Manipulation on Navigating a Virtual Reality Environment in Older and Younger Adults
***Carmen Baker*[1], Michael Cinelli[1], Jennifer Campos[2]**
[1]Wilfrid Laurier University, [2]Toronto Rehabilitation Institute

P1-U-110 Assessment of interhemispheric interactions between shoulder and trunk muscle representations of the primary motor cortex
***Dorothy Barthelemy* [1], Loyda Jean-Charles[1], Jean-François Nepveu[1], Numa Dancause[1]**
[1]Université de Montréal

P1-U-111 A differential games approach to analyse the influence of moving obstacles on locomotor avoidance strategies post stroke
***Anuja Darekar*[1], Valery Goussev[2], Bradford McFadyen[3], Anouk Lamontagne[1], Joyce Fung[1]**
[1]McGill University, [2]Jewish Rehabilitation Hospital, [3]Université Laval

P1-U-112 Associations between measures of structural brain connectivity and the sit-to-stand-to-sit performance in individuals with non-specific low back pain and healthy controls: a diffusion MRI based network analysis
***Nina Goossens*[1], Simon Brumagne[1], Lotte Janssens[1], Hadi Hosseini[2], Karen Caeyenberghs[3], Madelon Pijnenburg[1]**
[1]KU Leuven, [2]Stanford University, [3]University of Ghent

P1-U-113 Mild Head Impacts Induce Immediate Increase in Trunk Motion during Treadmill Walking
***Lei Ma*[1], Keisuke Kawata[1], Sungjae Hwang[1], Lori Moore[1], Ryan Tierney[1], John Jeka[1]**
[1]Temple University

P1-U-114 Coordination in Self-Paced Tapping of Upper and Lower Limbs with Four Touch Pad Device
Yoshimasa Matsushima[1], **Toshiya Urushihata**[1]
[1]Tsukuba International University

P1-U-115 Comparison of Postural Control in Participants with Chronic Fatigue Syndrome and Fibromyalgia Syndrome
Omid Rasouli[1], **Egil Fors**[2], **Ottar Vasseljen**[3], **Havard Loras**[1], **Ann-Katrin Stensdotter**[1]
[1] Sør-Trøndelag University College (HiST), Faculty of Health Education and Social Work, [2]2Norwegian University of Science and Technology, [3]Norwegian University of Science and Technology

P1-U-116 Humans Continuously Optimize Energetic Cost During Walking
Jessica Selinger[1], **Max Donelan**[1]
[1]Simon Fraser University

P1-U-117 Effects of subsensory electrical noise applied to the legs on postural sway in older adults
Diana Toledo[1], **José Barela**[2], **André Kohn**[1]
[1]University of Sao Paulo, [2]Cruzeiro do Sul University

P1-U-118 Effect of dominant and non-dominant sides on the cervical joint position sense in healthy adults
Toshiya Urushihata[1], **Yoshimasa MATSUSHIMA**[1]
[1]Tsukuba International University

P1-U-119 Using postural sway to identify adults with high functioning autism
Susan Morris[1], **Alex Kwang Leng Goh**[1], **Tan Tan**[1], **Chris Foster**[1], **Torbjorn Falkmer**[1], **Simon Rosalie**[1]
[1]Curtin University

V Tools and methods for posture and gait analysis

P1-V-120 Can a single lower trunk body-fixed sensor differentiate between straight line walking and stair descent and ascent?
Marina Brozgol[1], **Aner Weiss**[1], **Jeffrey Hausdorff**[1], **Nachum Vaisman**[1]
[1]Sourasky Medical Center

P1-V-121 Impact of vision on left and right foot Centre of Pressure Relationship during a postural task on a passive frontal and sagittal plan unstable platform. Contribution of cross-correlation study.
Denis Ducommun[1], **Maurice Ouaknine**[2], **Nicolas Vuillerme**[3]
[1]AGIM laboratory, Grenoble.ITO, Labége, [2]Univ. Grenoble-Alpes, AGIM Laboratory, La Tronche (France).ITO, Labége, [3]Univ. Grenoble-Alpes, AGIM Laboratory, La Tronche (France).Institut Universitaire de France

P1-V-122 Self- selected gait speed - over ground versus self-paced treadmill walking, a solution for a paradox
Yoav Gimmon[1], **Tamar Azrad**[2], **Moshe Bondi**[2], **Yotam Bahat**[2], **Meir Plotnik**[2], **Gabriel Zeilig**[2], **Rivka Inzelberg**[2], **Itzhak Siev-Ner**[2]
[1]Ben-Gurion University of the Negev, Israel, [2]Sheba Medical Center

P1-V-123 Effects of Variations in Electrical Parameters on Bradykinesia of Patients after Subthalamic Deep Brain Stimulation
Mandar Jog[1], **Stephanie Tran**[2], **Greydon Gilmore**[1], **Kristina Ognjanovic**[1], **Kenneth McIsaac**[1], **Mehdi Delrobaei** [3]
[1], [2]Western University, [3]London Health Sciences Center

P1-V-124 Validity, reliability, and clinical utility of an open access Wii Balance Board-based posturography
Emily Keshner[1], **ROBERTO LLORENS**[2], **Enrique Noé**[3], **Jorge Latorre**[2]
[1]Temple University, [2]Universitat Politècnica de València, [3]Fundación Hospitales NISA

P1-V-125 Portrait of the accuracy of Inertial Measurement of Motion for Clinical Biomechanical Evaluation: An analysis of the effect of segment, joint and task on the accuracy of the orientation data.
Karina Lebel[1], **Patrick Boissy**[1], **Christian Duval**[2]
[1]Université de Sherbrooke, [2]Université du Québec à Montréal

P1-V-126 Inter- and intra-person variability of plantar pressures during walking
Camille Marini[1], **Maximilien Fournier**[1]
[1]FeetMe

P1-V-127 Validation of a new algorithm for detection of step durations in short episodes of gait using a single accelerometer in healthy elderly and patients with Parkinson´s Disease.
María Encarnación Micó Amigo[1], **Idsart Kingma**[2], **Erik Ainsworth**[3], **Janet van Uem**[4], **Martijn Niessen**[5], **Walter Mätzler**[4], **Rob van Lummel**[6], **Jaap van Dieen**[2]
[1]MOVE Research Institute Amsterdam / McRoberst B.V., [2]MOVE Research Institute Amsterdam, VU University Amsterdam, [3]McRoberts B.V., [4]Center of Neurology, University of Tübingen, [5]McRoberst B.V., [6]McRoberst B.V. / VU University Amsterdam

P1-V-128 FOUR FUNCTIONAL TESTS IN HV SUBJECTS USING A WEARABLE INERTIAL SENSOR
Erika Nerozzi[1], **Claudio Tentoni**[1]
[1]School of Biotechnology, Pharmacy and Motor Sciences University of Bologna

P1-V-129 Recommendations for a Core Outcome Set for Measuring Standing Balance in Adult Populations: A Consensus-Based Approach
Kathryn Sibley[1], **Tracey Howe**[2], **Sarah Lamb**[3], **Stephen Lord**[4],

Brian Maki[5], Deborah Rose[6], Vicky Scott[7], Liza Stathokostas[8], Sharon Straus[5], Susan Jaglal[5]
[1]University of Manitoba, [2]Glasgow Caledonian University, [3]University of Oxford, [4]University of New South Wales, [5]University of Toronto, [6]California State University, Fullerton, [7]University of British Columbia, [8]Western University

P1-V-130 Agreement in Measures of Gait Between an Inertial Measurement System and a 3D Motion Analysis System.
***Elise Vonstad[1]*, Marit Olsen[2], Beate Gjesdal[2], Arve Opheim[2], Linda Rennie[2]**
[1]Sunnaas Rehabilitation Hospital, [2]Sunnaas Hospital

P1-V-131 Middle- and high-frequency power spectrum display method for stabilometry
***Masahiko Yamamoto[1]*, Tomoe Yoshida[1], Fuyuko Ikemiyagi[1]**
[1]Toho University

P1-V-132 Postural control in healthy subjects using visual feedback
***Tomoe Yoshida[1]*, Fuyuko Ikemiyagi[2], Toshitake Tanaka[2], Masahiko Yamamoto[2], Mitsuya Suzuki[2]**
[1]Toho University Sakura Medical Center, [2]Toho University

W Vestibular function and disorders

P1-W-133 Medio-lateral Head on Trunk Stability Depends on the Vestibular System
***Eric Anson[1]*, Yuri Agrawal[2], Tim Kiemel[3], John Carey[2], John Jeka[4]**
[1]Johns Hopkins Medical Institutes, [2]JHMI, [3]UMD, [4]Temple University

P1-W-134 Psychological factors, not vestibular impairment, are associated with impaired balance, gait and falls in people with dizziness aged 50 years and over
***Jasmine Menant[1]*, Americo Migliaccio[1], Stephen Lord[1]**

[1]Neuroscience Research Australia
P1-W-135 Postural instability and bone quality in the elderly with vestibular disorders
***Toshihisa Murofushi[1]*, Yukiko Tsuda[1], Eriko Yoshimura[1]**
[1]Teikyo University School of Medicine

P1-W-136 First Trial Reaction in peripheral vestibulopathy: the effect of compensation
***NICOLAS PEREZ-FERNANDEZ[1]*, Jorge De Abajo[1]**
[1]UNIVERSITY OF NAVARRA-OTOLARYNGOLOGY

P1-W-137 Interactions of position and forces on the gait cycle in bilateral vestibulopathy
***Klaus Jahn[1]*, Julian Decker[1], Cauchy Pradhan[1], Roman Schniepp[1]**
[1]University of Munich

Poster Session 2

Tuesday, June 30, 11:30 – 13:30

A Activity Monitoring

P2-A-1 Defining ambulatory bouts in free-living activity: Impact of brief stationary periods on walking bout metrics
***Gillian Barry[1]*, Alan Godfrey[2], Brook Galna[2], Sue Lord[2], Lynn Rochester[2]**
[1]Newcastle University/Northumbria University, [2]Newcastle University

P2-A-2 The Use Of Multiple Inertial Sensors & EMD Approach For The Auto Segmentation Of Daily Living Activities
***Christian Duval[1]*, Fouaz Ayachi[2], Hung Nguyen[2], Catherine Lavigne-Pelletier[2], Margaux Blamoutier[2], Patrick Boissy[3], Étienne Goubault[2]**
[1]Universié du Québec à Montréal, [2]Université du Québec à Montréal, [3]Université de Sherbrooke

P2-A-3 Auto detection and segmentation of physical activities during a Timed-Up-and-Go (TUG) task in healthy older adults using multiple inertial sensors
***Hung Nguyen[1]*, Fouaz Ayachi[1], Catherine Lavigine-Pelletier[1], Etienne Goubault[1], Margaux Blamoutier[1], Fariborz Rahimi[2], Patrick Boissy[3], Mandar Jog[4], Christian Duval[1]**
[1]University of Quebec at Montreal, [2]University of Bonah, [3]University of Sherbrooke, [4]London Health Sciences Center University Hospital

P2-A-4 UADL: A SMARTPHONE APPLICATION FOR UBIQUITOUS ACTIVITY OF DAILY LIVING MONITORING WITH REAL-TIME PARAMETER COMPUTATION
***Carlo Tacconi[1]*, Sabato Mellone[2], Lorenzo Chiari[3]**
[1]University of Bologna HST-ICIR and mHealth Technologies s.r.l., [2]University of Bologna and mHealth Technologies s.r.l., [3]University of Bologna HST-ICIR

B Adaptation, learning, plasticity and compensation

P2-B-10 Rapid postural changes in patients with cerebellar degeneration
***Mariana Stehlíková[1]*, Krystof Slabý[1], Ondrej Cakrt[1]**
[1]2nd Faculty of Medicine, Charles University in Prague

P2-B-5 Role of Hand Contact in Continually Challenged Postural Equilibrium
***Jernej Camernik[1]*, Luka Peternel[1], Jan Babic[1]**
[1]Jozef Stefan Institute

P2-B-6 Previous Experiences and Central Set Development to Complex Moving Environments: Would Dancers Make Good Seafairors?
***Carolyn Duncan[1]*, Tony Ingram[2], Avril Mansfield[3], Jeannette Byrne[4], William McIlroy[5]**
[1]Toronto Rehabilitation Institute/Memorial University, [2]Dalhousie University, [3]Toronto Rehabilitation Institute/Sunnybrook Research Institute, [4]Memorial University of Newfoundland, [5]University of Waterloo/Toronto Rehabilitation Institute

P2-B-7 Locomotor adaptation is modulated by observing the actions of others.
Diego Kaski[1], **Mitesh Patel**[1], **Mohammed Riyaz**[1], **Maroof Ahmed**[1], **David Buckwell**[1], **Karen Bunday**[2], **Qadeer Arshad**[1], **Ed Roberts**[1], **Adolfo Bronstein**[1]
[1]Imperial College London, [2]Institute of Neurology

P2-B-8 Adaptive modulation of pendular energy-saving mechanism during bipedal locomotion on a split-belt treadmill
Naoki Kitagawa[1], **Kei Tsunoda**[1], **Naomichi Ogihara**[1]
[1]Keio University

P2-B-9 On-line Balance Control and Adaptation in the Context of a Virtual Force Field Illusion
Olivier Martin[1], **Andreas Pusch**[2], **Sabine COQUILLART**[3]
[1]Gipsa-Lab/CNRS, [2]GIPSA-lab, [3]INRIA, Univ. Grenoble, LIG, CNRS

C Aging

P2-C-11 Factors associated with the increased perceptual reliance on the visual reference frame with age
Catherine Agathos[1], **Delphine Bernardin**[2], **Delphine Huchet**[2], **Anne-Catherine Scherlen**[2], **Christine Assaiante**[3], **Brice Isableu**[4]
[1]Paris-Sud University, [2]Essilor International, [3]Aix-Marseille University, National Centre for Scientific Research (CNRS), [4]University of Paris-Sud

P2-C-12 Subjective visual and haptic vertical in young and elderly
Ondrej Cakrt[1], **Krystof Slaby**[1], **Pavel Kolar**[1], **Jaroslav Jerabek**[1]
[1]2nd Faculty of Medicine, Charles University in Prague and Motol University Hospital, Czech Republic

P2-C-13 Simulation of a real world task to study motor, cognitive and metabolic aspects of performance of complex daily tasks in young and older adults: comparison with real world performance
Rachel Kizony[1], **Zeilig Gabi**[2], **Patrice (Tamar) Weiss**[1], **Ilanit Baum-Cohen**[1], **Einat Kodesh**[1], **Moshe Bondi**[2], **Igor Mintz**[2], **Michal Kafri**[1]
[1]University of Haifa, [2]Sheba Medical center

P2-C-14 Effects of ageing on the attentional demands of step adjustments to perturbations in visually cued walking
Masood Mazaheri[1], **Wouter Hoogkamer** [2], **Zrinka Potocanac**[2], **Sabine Verschueren**[2], **Melvyn Roerdink**[3], **Peter Beek** [3], **Lieke Peper** [3], **Jaak Duysens** [4]
[1]MOVE Research Institute Amsterdam, Faculty of Human Movement Sciences, VU University Amsterdam, [2]KU-Leuven, [3]MOVE Research Institute Amsterdam / VU University Amsterdam, [4]KU Leuven

P2-C-15 GAZE BEHAVIOR AND POSTURAL CONTROL PERFORMANCE IN YOUNG ADULTS AND ELDERLY
Paula Polastri[1], **Matheus Brito**[2], **Gisele Gotardi**[2], **Fabio Barbieri**[2], **Sergio Rodrigues**[2]
[1]Sao Paulo State University, [2]Univ Estadual Paulista

P2-C-16 Aging, Central Nervous System and Mobility: Findings and Strategies to Prevent or Improve Late Life Gait Decline from a 3 Year Conference Series
Caterina Rosano[1], **Wen Chen**[2], **David Bennett**[3], **Richard Camicioli**[4], **Luigi Ferrucci**[5], **Jack Guralnik**[6], **Jeffrey Hausdorff**[7], **Jeffrey Kaye**[8], **Lenore Launer**[9], **Lewis Lipsitz**[10], **Anne Newman**[1], **Joe Verghese**[11], **Neil Alexander**[12], **Farzaneh Sorond**[13], **Sandra Black**[14], **Michel**
[1]University of Pittsburgh, [2]National Institutes of Health, [3]Rush University Medical Center, [4]University of Alberta, Edmonton, [5]National Institute on Aging, [6]University of Maryland, [7]Harvard Medical School, [8]Oregan Health and Science University, [9]National

P2-C-17 "Standing Tall" - an engaging home-based exercise program using iPad technology for preventing falls in older people
Trinidad Valenzuela[1], **Ashley Woodbury**[2], **Thomas Davies**[2], **Jonathan Yeong**[2], **Stephen Lord**[3], **Kim Delbaere**[3]
[1]University of New South Wales; Neuroscience Research Australia, [2]Neuroscience Research Australia, [3]Neuroscience Research Australia; University of New South Wales

P2-C-18 Sub-threshold plantar vibrations enhance the multiscale complexity of postural sway in older adults
Brad Manor[1], **Junhong Zhou**[1], **Justine Lo**[2], **Lewis Lipsitz**[1]
[1]Harvard Medical School, [2]Institute for Aging Research

D Biomechanics

P2-D-19 Question on the cross-correlation function
Pierre-Marie Gagey[1], **Sarah RECOULES**[2], **Alexandre GÉLY**[2]
[1]Institut de Posturologie Paris, [2]Institut de Posturologie

P2-D-20 Effect of step length on upper body dynamics using an inverted double pendulum model
Toyoyuki Honjo[1], **Takahiro Tanaka**[1], **Masahiro Fujimoto**[1], **Tadao Isaka**[1]
[1]Ritsumeikan University

P2-D-21 Does perturbation training improve control of quiet standing in individuals with chronic stroke?
Alison Schinkel-Ivy[1], **Jonathan Singer**[2], **Anthony Aqui**[1], **George Mochizuki**[3], **Avril Mansfield**[4]
[1]Toronto Rehabilitation Institute - University Health Network, [2]University of Manitoba, Canadian Partnership for Stroke Recovery, Sunnybrook Research Institute, [3]Canadian Partnership for Stroke Recovery, Sunnybrook Research Institute, Toronto Rehabilitati

P2-D-22 Effect of walking speed and turning angle on required coefficient of friction during turning
Takeshi Yamaguchi[1], **Akito Suzuki**[1], **Hironari Higuchi**[1], **Kazuo Hokkirigawa**[1]
[1]Tohoku University

E Brain imaging/activation during posture and gait

P2-E-23 White matter abnormalities in dizzy patients: A retrospective cohort multi-centre study
Hena Ahmad[1], Niccolò Cerchiai[2]
[1]Imperial College London, [2]Pisa University Hospital, Pisa, Italy.

P2-E-24 Brain metabolic pattern during gait with freezing in Parkinson's disease
Arnaud Delval[1], Céline Tard[2], Pierre Lenfant[3], Kathy Dujardin[4], Claude Hossein-Focher[4], Luc Defebvre[2], renaud lopes[2], Florence Lejeune[5], caroline moreau[2]
[1]Clinical Neurophysiology, [2]université de Lille, U1171, [3]université de Lille , [4]université de Lille, [5]université de rennes

P2-E-25 Different motor cortical processing between voluntary and postural tasks in both young and old adults
Selma Papegaaij[1], Wolfgang Taube[2], Helco van Keeken[1], Egbert Otten[1], Tibor Hortobágyi[1]
[1]University of Groningen, University Medical Center Groningen, [2]University of Fribourg

P2-E-26 fNIRS imaging of step initiation in older adults
Patrick Sparto[1], Helmet Karim[1], Joseph Furman[1], Mark Redfern[1], J. Richard Jennings[1], Theodore Huppert[1]
[1]University of Pittsburgh

F Cognitive impairments

P2-F-27 Dual-Task Timed Up and Go Test as Part of Memory Assessment - A pilot study
Anna Cristina Åberg[1], Anna Grundström[2], Ylva Cedervall[2]
[1]Dalarna University, [2]Uppsala University

P2-F-28 Vestibular training intervention for individuals with post-concussion syndrome
Alyssa Prangley[1], Michael Cinelli[1], Matthew Aggerholm[2]
[1]Wilfrid Laurier University, [2]Vestibular and Orthopaedic Rehabilitation

G Cognitive, attentional, and emotional influences

P2-G-29 Emotional exposure duration and its influence on gait initiation
Daniëlle Bouman[1], John Stins[2], Peter Beek[2]
[1]MOVE Research Institution, [2]MOVE research institute Amsterdam

P2-G-30 Increased threat influences the conscious perception of postural sway
Taylor Cleworth[1], Mark Carpenter[2]
[1]UBC, [2]University of British Columbia

P2-G-31 Attentional demand of balance in persons with low back pain: Effect of dual-tasking on balance response following perturbation
Yasaman Etemadi[1], Mahyar Salavati[1], Amir Arabloo[1]
[1]University of Social Welfare and Rehabilitation Sciences

P2-G-32 A novel dual task balance test with cognitive cues for the postural control
Uffe Laessoe[1], Bo Grarup[1]
[1]University College North Denmark

P2-G-33 Balance recovery while performing cognitive and manual tasks: evidence for participation of high processing levels in reactive postural responses
Luis Teixeira[1], Catarina Folha[1], Daniel Coelho[1]
[1]University of São Paulo

P2-G-34 Threat-induced changes in attentional processing during static and anticipatory postural control tasks
Martin Zaback[1], Mark Carpenter[2], Allan Adkin[1]
[1]Brock University, [2]University of British Columbia

H Coordination of posture and gait, Devices to improve posture and gait

P2-H-35 Reactive postural responses as a function of feet orientation and magnitude of perturbation
Nametala Azzi[1], Daniel Coelho[1], Luis Teixeira[1]
[1]University of São Paulo

P2-H-36 Is altered upper body control during gait in people with Parkinson's disease simply due to altered lower limb mechanics?
Christopher Buckley[1], Lynn Rochester[2], Brook Galna[2], Claudia Mazzà[1]
[1]University of Sheffield, [2]Newcastle University

P2-H-37 Timing Parameters of Gait Coordination, the Effect of Age and Walking Speed
Yoav Gimmon[1], Ilan Kurz[1], Meir Plotnik[2], Raziel Riemer[1], Hisham Rashed[1], Amir Shapiro[1], Ronen Debi[3], Itshak Melzer[1]
[1]Ben-Gurion University of the Negev, Israel, [2]Center of Advanced Technologies in Rehabilitation, Sheba Medical Center, Tel Hashomer, Israel, [3]Orthopedic department, Barzilai Medical Center, Ashkelon, Israel

P2-H-38 Gait initiation: the frontal-plane control
Jean-Louis Honeine[1], Manh-Cuong Do[2], Marco Schieppati[3]
[1]University of Pavia - Fondazione Salvatore Maugeri, I.R.C.S.S., Istituto di Pavia, [2]Université Paris-Sud, [3]University of Pavia

P2-H-39 Deliberately light interpersonal touch facilitates trunk stability during locomotion in cerebral palsy
Leif Johannsen[1]
[1]Technische Universität München

P2-H-40 An Investigation of the Relationship between Steering Control and Hearing during Goal-Directed Locomotion
Sin-Tung Lau[1], Jennifer Campos[2], Michael Cinelli[3]
[1]Wilfrid Laurier University; Toronto Rehabilitation Institute - University Health Network, [2]Toronto Rehabilitation Institute-University Health Network, [3]Wilfrid Laurier University

P2-H-41 Further study of a Balance Geometry underlying obstacle crossing
Bradford McFadyen[1], Louis-Philippe Dugas[1], Laurent Bouyer[1]
[1]Laval University

P2-H-42 Skating Visual Flow Improves Postural Perturbation Response: Potential of Skating as Neurorehabilitation
Brittany Mercier[1]
[1]University of Lethbridge

P2-H-43 Changes of motor-control strategies in precision jump under varying distance constraints
David Pagnon[1], Olivier Martin[2]
[1]Gipsa-Lab/CNRS, [2]Gipsa-Lab

P2-H-44 Muscle fatigue affects similarly obstacle crossing step of people with Parkinson's disease and neurological healthy individuals, independent of physical activity level
Paulo Cezar Santos[1], Fabio Barbieri[2], Diego Orcioli-Silva[1], Lucas Simieli[1], Victor Beretta[1], Vinicius Alota Pereira[1], Stephannie Beretta[1], Lilian Teresa Gobbi[1]
[1]Univ Estadual Paulista at Rio Claro - UNESP - Rio Claro, [2]Univ Estadual Paulista at Bauru - UNESP - Bauru

P2-H-45 Trunk muscle synergies suggest an initiatory rather than stabilising role of predictive postural control during goal-directed reaching
Alexander Stamenkovic[1], Pauline Hilt[2], Paul Stapley[1]
[1]University of Wollongong, [2]Université de Bourgogne

P2-H-46 Differences in temporal gait dynamics due to walking speeds and dual task
Gyerae Tack[1], Jinseung Choi[1], Seungtae Yang[1], Dehyeok Kim[1], Jeongwoo Seo[1]
[1]Konkuk University

P2-H-47 Asymmetries in reactive and anticipatory balance control are of similar magnitude in Parkinson's disease patients.
Joost van Kordelaar[1], Tjitske Boonstra[1], Denise Engelhart[1], Jeroen van Vugt[2], Herman van der Kooij[1]
[1]University of Twente, [2]Medical Spectrum Twente

P2-H-48 Energetic tradeoffs of foot-to-ground clearance during swing phase of walking
Amy Wu[1], Arthur Kuo[1]
[1]University of Michigan

P2-H-49 Is virtual reality a viable tool for examining the affordance of aperture crossing when walking through two people versus two poles?
Amy Hackney[1], Michael Cinelli[2], William Warren[3], James Frank[1]
[1]University of Waterloo, [2]Wilfrid Laurier University, [3]Brown University

P2-H-50 Determination of gravicorder parameters for evaluation of dizziness symptoms in vertigo follow-up
Fujita Nobuya[1]
[1]Nara Medical University

I Development of posture and gait

P2-I-51 Bouts of Steps: The Organization of Infant Walking
Whitney Cole[1], Scott Robinson[2], Karen Adolph[2]
[1]Max Planck Institute for Human Development, [2]New York University

P2-I-52 Stability of gait in children evaluated by inclination angle between CoM and CoP
Akira Sawatome[1], Mitsunori Tada[2], Hiroshi Takemura[3], Makiko Kouchi[2], Masaaki Mochimaru[2]
[1]Graduate School of Science and Technology,Tokyo University of Science, [2]National Institute of Advanced Industrial Science and Technology, [3]Tokyo University of Science

J Developmental disorders

P2-J-53 Virtual reality gait training to enhance cognitive and motor function in children with Attention Deficit Hyperactivity Disorder: Preliminary results
Shirley Shema[1], Karen Geva Dayan[1], Michael Rotstein[1], Marina Brozgol[1], Yael Leitner[1], Jeffrey Hausdorff[1], Anat Mirelman[1]
[1]Tel Aviv Sourasky Medical Center

K Devices to improve posture and gait

P2-K-54 Modular Haptic Belt for Augmented Balance Feedback
Jan Anlauff[1], Joyce Fung[1], Jeremy Cooperstock[1]
[1]McGill University

P2-K-55 Effect of foot orthoses on single-leg squat balance performance in adults with patellofemoral pain
Anna Hatton[1], Gimhani Ratnayaka[1], Kay Crossley[1], François Hug[1], Natalie Collins[2]
[1]The University of Queensland, [2]The University of Melbourne

P2-K-56 Assessment of guidance modality on weight-shifting balance exercises in individuals with Parkinson's disease
Beom-Chan Lee[1], Stanley Fisher[2], Charles Layne[1], Timothy Thrasher[1]
[1]University of Houston, [2]Houston Methodist Research Institute

P2-K-57 "Anchoring" reduces postural sway: effects of different points of haptic contact and support surface
Mayara Pestana[1], Stephanie Pacheco[2], Fabio Barbieri[3], Renato Moraes[4], Fernanda Magre[2], Thais Costa[2], Eliane Mauerberg-deCastro[2]
[1]Univ. Julio de Mesquita Filho - UNESP , [2]Univ. Julio de Mesquita Filho - UNESP - Rio Claro - Brazil, [3]Univ. Julio de Mesquita Filho - UNESP - Bauru - Brazil, [4]University of São Paulo (USP), Ribeirão Preto, São Paulo, Brazil

P2-K-58 Balance telerehabilitation: considering user preferences for the design of a cell phone balance trainer
Wendy Carender[1], Kathleen Sienko[1], Catherine Kinnaird[1], Geeta Peethambaran[1], Gabrielle Fantich[1], Susan Whitney[2]
[1]University of Michigan, [2]University of Pittsburgh

L Effect of medication on posture and gait

P2-L-59 Influence of STN-DBS stimulation frequency on gait performance in Parkinson?s disease.
Brian Day[1], Amy Peters[1], Irene Di Giulio[1], Eirini Kalliolia[1], Dejan Georgiev[1], Patricia Limousin[1]
[1]University College London

P2-L-60 Effect of fampyra on walking and mobility in patients with multiple sclerosis with different disability levels
Klara Novotna[1], Jana Lizrova Preiningerova[1], Lukas Sobisek[2], Eva Havrdova[1]
[1]Charles University in Prague, 1st Faculty of Medicine and General University Hospital in Prague , [2]Department of Statistics and Probability, University of Economics in Prague, Czech Republic

M Ergonomics

P2-M-61 Effect of a Forward Sloping Seat on the Strain Sustained by the Postural Chain
Alain Hamaoui[1], Myriam Hassaïne[1]
[1]University JF Champollion

N Exercise and physical activity

P2-N-62 A virtual reality based dance training paradigm to increase physical activitylocomotor-balance control and physical activity in community dwelling chronic stroke survivors
Tanvi Bhatt[1], Savitha Subramanium[1]
[1]University of Illinois at Chicago

P2-N-63 Clustered Physical Activity Attenuates Expression of Motor Symptoms in Parkinson Disease Independent from Nigrostriatal Dopaminergic Degeneration
Nicolaas Bohnen[1], Jonathan Snider[2], Vikas Kotagal[2], Robert Koeppe[2], Roger Albin[2], Kirk Frey[2], Martijn Muller[2]
[1]University of Michigan & VAMC, [2]University of Michigan

P2-N-64 Older people who feel fatigue have restricted ability to accumulate physical activity
Jorunn Helbostad[1], Sebastien Chastin[2], Thorlene Egerton[3]
[1]Norwegian University of Science and Technology, [2]Institute of Applied Health Research, Glasgow Caledonian University, [3]Norwegian University of Science and Technology (NTNU)

P2-N-65 What discharge factors predict ambulation activity outcomes in the first six months after stroke?
Niruthikha Mahendran[1], Suzanne Kuys[2], Sandra Brauer[1]
[1]University of Queensland, [2]School of Allied Health Sciences, Griffith Health Institute, Griffith University and The Prince Char

P2-N-66 Effectiveness of exergaming for improving balance in people with mild cognitive impairment: a randomized controlled trial
Michael Schwenk[1], Marwan Sabbagh[2], Ivy Lin[3], Pharah Morgan[3], Gurtej Grewal[3], Jane Mohler[3], Bijan Najafi[3]
[1]Robert-Bosch Hospital , [2]Banner Sun Health Research Institute, [3]University of Arizona

P2-N-67 Neuromuscular and Physiological Variables Evolve Independently when Running Immediately After Cycling.
Paul Stapley[1], Romuald Lepers[2], Gregory Peoples[1], Alexander Stamenkovic[1], Joel Walsh[1]
[1]University of Wollongong, [2]Université de Bourgogne

O Falls and fall prevention

P2-O-68 Practicing without instructions- Dual-task learning among older adults:
Maayan Agmon[1], Rachel Kizony[1]
[1]University of Haifa

P2-O-69 Effect of light touch on standing balance among individuals with incomplete spinal cord injury.
Tarun Arora[1], Kristin Musselman[2], Joel Lanovaz[1], Alison Oates[1]
[1]University of Saskatchewan, [2]Toronto Rehabilitation Institute

P2-O-70 Obesity increases stepping reaction and movement times
Felix Berrigan[1], Pierre-Michel Bernier[1]
[1]Université de Sherbrooke

P2-O-71 Obstacle avoidance performance and foot placement accuracy are impaired among community-dwelling older adults with low executive function
Maria Joana Caetano[1], Jasmine Menant[1], Daniel Schoene[1], Paulo Henrique Pelicioni[2], Stephen Lord[1]
[1]Neuroscience Research Australia, [2]Universidade Estadual Paulista

P2-O-72 Instrumented Timed Up and Go test discriminates between community-dwelling fallers: the InCHIANTI-FARSEEING study
Marco Colpo[1], Petula Iacopozzi[2], Sabato Mellone[3], Lorenzo Chiari[3], Stefania Bandinelli[2]
[1]Università degli Studi di Firenze - Azienda Sanitaria di Firenze, [2]Azienda Sanitaria di Firenze, [3]Università degli Studi di Bologna

P2-O-73 Effect of planning time and practice on the obstacle avoidance strategies of older adults
Melissa Gurney[1], Joshua Fisher[1], Michael Bijman[1], Lori Ann Vallis[1]
[1]University of Guelph

P2-O-74 The effect of a cholinesterase inhibitor on balance in Parkinson's disease
Amie Hiller[1], Martina Mancini[2], Fay Horak[2], Seth Kareus[3], Bernadette Schoneburg[4], John Nutt[2]
[1]OHSU/ Portland Veterans Health Care System, [2]Oregon Health Sciences University, [3]Neurological Associates, [4]North Shore Medical Group

P2-O-75 Physical activity and different concepts of fall risk estimation in older people - results of the ActiFE-Ulm study
Jochen Klenk[1], Ngaire Kerse[2], Kilian Rapp[1], Thorsten Nikolaus[3], Clemens Becker[1], Dietrich Rothenbacher[4], Richard Peter[4], Michael Denkinger[3]
[1]Robert-Bosch Hospital, [2]University of Auckland, [3]Agaplesion Bethesda Clinic, [4]Ulm University

P2-O-76 The association between excessive daytime sleepiness and gait parameters in community-dwelling elderly people
Sho Nakakubo[1], Takehiko Doi[1], Kota Tsutsumimoto[1], Ryo Hotta[1], Hyuma Makizako[1], Rei Ono[2], Hiroyuki Shimada[1], Takao Suzuki[1]
[1]National Center for Geriatrics and Gerontology, [2]Kobe University Graduate School of Health Sciences

P2-O-77 Relationship between gaze behavior and failure to cross a stationary, visible obstacle
Samuel Pontecorvo[1], Michel Hiejnen[1], Brittney Muir[1], Shirley Rietdyk[1]
[1]Purdue University

P2-O-78 Combining inhibition and choice reaction time in a step test as powerful predictor for falls in older people
Daniel Schoene[1], Kim Delbaere[2], Stephen Lord[2]
[1]Friedrich- Alexander University Erlangen-Nuremberg, [2]Neuroscience Research Australia

P2-O-79 Anticipatory Postural Adjustment in Choice Reaction Step Initiation
Ruopeng Sun[1], John Shea[1]
[1]Indiana University Bloomington

P2-O-80 Daily-life trunk accelerometry aids prediction of recurrent falls in older adults
Kimberley van Schooten[1], Mirjam Pijnappels[1], Sietse Rispens[1], Petra Elders[1], Paul Lips[2], Jaap van Dieën[1]
[1]VU University Amsterdam, [2]VU medical centre Amsterdam

P Habilitation & rehabilitation

P2-P-81 Gait initiation of individuals with stroke before and after gait training with body weight support on treadmill and over the ground
Ana Barela[1], Gabriela Gama[2], Melissa Celestino[2], Dinah Santana[2], Jose Barela[2]
[1]Cruzeiro do Sul University, [2]Universidade Cruzeiro do Sul

P2-P-82 Effect of ankle-foot orthosis on kinematics and ground reaction forces of level walking in healthy subjects
Mizuki Kato[1], Arinori Kamono[1], Naoki Kitagawa[2], Naomichi Ogihara[1]
[1]Keio University, [2]Showa University

P2-P-83 Feasibility of a Virtual Reality Remote Tele-Rehabilitation training for Parkinson's Disease- a case report
Anat Mirelman[1], Ziv Sberlo[1], Shirley Shema[1], Eran Gazit[1], Pablo Bezalel[1], Nir Giladi[1], Jeffrey Hausdorff[1]
[1]Tel Aviv Sourasky Medical Center

P2-P-84 Development of exergames for the training and evaluation of coordination and dynamic stability in cerebellar ataxia
Cornelia Schatton[1], Jan-Marco Moritz[1], Adrian Bauer[1], Martin Giese[1], Matthis Synofzik[1], Winfried Ilg[1]
[1]Hertie Institute for clinical brain research

P2-P-85 Attentional requirements of postural control in people with spinal cord injury: the effect of dual task
Cynthia Tse[1], Mark Carpenter[2], Teresa Liu-Ambrose[1], Amanda Chisholm[1], Tania Lam[1]
[1], [2]University of British Columbia

P2-P-86 Cell phone telerehabilitation device for home-based balance training
Jaehong Lee[1], Kathleen Sienko[1], Tian Bao[1]
[1]University of Michigan

P2-P-87 Evaluating a conceptual progression framework by grouping balance exercises based on difficulty
Tian Bao[1], Kathleen Sienko[1], Brooke Klatt[2], Wendy Carender[1], Catherine Kinnaird[1], Susan Whitney[2]
[1]University of Michigan, [2]University of Pittsburgh

Q Modeling

P2-Q-88 Interpersonal competition dynamics in a ballgame: Modeling of a 1-on-1 game and two opposing cognitive systems.
Keisuke Fujii[1], Yuji Yamamoto[1]
[1]Nagoya University

P2-Q-89 An attempt to model postural sway as a relaxation oscillator.
Maurice Ouaknine[1], Denis Ducommun[1], Nicolas Vuillerme[1]
[1]University of Grenoble-Alpes

R Neurological diseases

P2-R-90 Longitudinal balance changes in patients with relapsing-remitting multiple sclerosis: Disease progression and confirming subjective assessments
John Allum[1], Dionne Timmermans[1], Oliver Findling[1], Alijda Scheltinga[1], Oezguer Yaldizli[1]
[1]University Hospital Basel

P2-R-91 Effects of disease severity and medication state on postural control asymmetry of challenging postural tasks in people with Parkinson's disease
Fabio Barbieri[1], André Baptista[2], Vinicius Pereira[2], Ellen Lirani-Silva[2], Lucas Simieli[2], Diego Orcioli-Silva[2], Victor Beretta[2], Mayara Pestana[2], Lilian Teresa Gobbi[2]
[1]Univ. Estadual Paulista - UNESP - Bauru - Brazil, [2]Univ. Estadual Paulista - UNESP - Rio Claro - Brazil

P2-R-92 Freezing of gait in Parkinson's disease and the role of postural control impairments
Aniek Bengevoord[1], Griet Vervoort[1], Wim Vandenberghe[1], Bastiaan Bloem[2], Alice Nieuwboer[1]
[1]KU Leuven, [2]Radboud University Nijmegen

P2-R-93 Locomotor deficits and their relation to balance confidence and perceived motor functioning in people with Parkinson's Disease
Carolin Curtze[1], Martina Mancini[1], Patricia Carlson-Kuhta[1], John Nutt[1], Fay Horak[1]
[1]Oregon Health & Science University

P2-R-94 Continuous Monitoring of Mobility in Huntington Disease Patients Using Inertial Sensors
Mahmoud El-Gohary[1], Fay Horak[1], James McNames[1], Ravi Ramachandran[2], Katie Stenson[2], Anna Legedza[2], Martyn Botfield[2], Arthur Lenahan[3], Penelope Hogarth[3]
[1]APDM Inc., [2]Vertex Pharmaceuticals, [3]OHSU

P2-R-95 Accelerometer Cut Points for Physical Activity Assessment of Older Adults with Parkinson's Disease
Erika Franzén[1], Martin Benka Wallén[1], Hakan Nero[1], Agneta Ståhle[1], Maria Hagströmer[1]
[1]Karolinska Institutet

P2-R-96 Effect of Deep Brain Stimulation on Gait in Parkinson's Disease
Greydon Gilmore[1], Mehdi Delrobaei[1], Kristina Ognjanovic[1], Stephanie Tran[1], Tyler Stratton[1], Mandar Jog[1]
[1]Western University

P2-R-97 Static sway in prodromal Parkinson´s Disease: Longitudinal data from seven converters
Sandra Hasmann[1], Markus Hobert[2], Sinja Maier[2], Katrin Maier[2], Janet van Uem[2], Daniela Berg[2], Walter Maetzler[2]
[1]University Hospital of Tuebingen, [2]University Hospital of Tübingen

P2-R-98 Establishing Disease Severity of Cervical Spondylotic Myelopathy through Novel Sensitive Gait Assessments
Sukhvinder Kalsi-Ryan[1], Alex Laliberte[1], Spyridon Karadimas[1], Florentina Teoderascu[1], Eric Massicotte[1], Mohamad Shamji[1], Michael Fehlings[1]
[1]University Health Network

P2-R-99 Insights into freezing of gait mechanisms from walking through a doorway and turning
Martina Mancini[1], John Nutt[1], Fay Horak[1]
[1]Oregon Health & Science University

P2-R-100 Upright standing after stroke: the non paretic leg pilots the postural stabilization
Dominic Pérennou[1], Patrice Rougier[2]
[1]Academic Hospital Grenoble, [2]Université de savoie

P2-R-101 Characterization and early detection of balance and gait deficits in Fragile X premutation carriers with and without fragile X-associated tremor/ataxia syndrome (FXTAS)
Erin Robertson-Dick[1], Elizabeth Berry-Kravis[1], Deborah Hall[1], Joan O'Keefe[1]
[1]Rush University Medical Center

P2-R-102 Does inconsistency in attentional control predict gait variability in Parkinson's disease?
Carolina Silveira[1], Eric Roy[1], Donald Stuss[2], Frederico Pieruccini-Faria[3], Quincy Almeida[3]
[1]University of Waterloo, [2]Baycrest, [3]Wilfrid Laurier University

P2-R-103 The effect of dual task training in patients with Parkinson's disease: preliminary results of the DUALITY study
Carolien Strouwen[1], Esther Molenaar[2], Liesbeth Münks[1], Samyra Keus[2], Bastiaan Bloem[2], Alice Nieuwboer[1]
[1]KU Leuven, [2]Radboud University Nijmegen Medical Centre

P2-R-104 The effect of wearing sensors continuously over 12 weeks on health-related quality of life in patients with Parkinson's disease
Janet van Uem[1], Katrin Maier[1], Markus Hobert[1], Ana Teresa Santos[2], Artur Serrano[3], Frank Larsen[3], Ingvild Akeren[3], Hilde Wangen[3], Olga Scheck[1], Joaquim Ferreira[2], Walter Maetzler[1]
[1]Universitätsklinikum Tübingen , [2]University of Lisbon, [3]Norwegian Centre for Integrated Care and Telemedicine

P2-R-105 Imaging of the cerebral orthostatic tremor network during stance
Andreas Zwergal[1], Florian Schöberl[1], Guoming Xiong[1], Katharina Feil[1], Peter Bartenstein[1], Christian la Fougere[2], Michael Strupp[1], Thomas Brandt[1], Marianne Dieterich[1], Klaus Jahn[1]
[1]University of Munich, [2]University of Tübingen

S Orthopedic diseases and injuries

P2-S-106 Factors affecting patient's ambulatory ability at discharge from an acute hospital in Japan following hip fracture surgery.
Nozomi Nagaoka[1], Osamu Nitta[2], Tadamitsu Matsuda[3]
[1]Higashi-Omiya general Hospital, [2]Tokyo Metropolitan University, [3]Uekusa Gakuen University

T Proprioceptive function and disorders

P2-T-107 The influence of cutaneous afferent input from the foot sole and foot dorsum on ankle proprioception
Robyn Mildren[1], Cathy Hare[1], Leah Bent[1]
[1]University of Guelph

P2-T-108 Influence of cutaneous input of sole foot and visual information in dyslexic children to maintain postural stability.

Nathalie Gouleme[1], Philippe Villeneuve[1], Emmanuel Bui-Quoc[1], Christophe-Loïc Gérard[1], Maria Pia Bucci[1]
[1]inserm UMR 1141

U Sensorimotor control, Visual function and disorders

P2-U-109 Dual tasking increases the risk of collisions during obstacle avoidance in individuals with post-stroke visuospatial neglect
Gayatri Aravind[1], Tatiana Ogourtsova[1], Anouk Lamontagne[1]
[1]McGill Univeristy

P2-U-110 Dual-task and task demand effects on sensorimotor coupling during postural control of young adults
Jose Barela[1], Giovana Genoves[2]
[1]Cruzeiro do Sul University, [2]Universidade Estadual Paulista

P2-U-111 Prior Athletic Training has No Effect on Alternate Foot placement During Planar Obstacle Avoidance
Brittany Baxter[1], Michael Cinelli[1]
[1]Wilfrid Laurier University

P2-U-112 Visual feedback from the foot is not important for determining foot placement accuracy when stepping in to a floor-based target
Richard Foster[1], Alan De Asha[2], Georgia Halstead[2], Andy Scally[2], John Buckley[2]
[1]Nottingham Trent University, [2]University of Bradford

P2-U-113 Associations between measures of structural morphometry and the sit-to-stand-to-sit performance in individuals with non-specific low back pain and healthy controls
Nina Goossens[1], Karen Caeyenberghs[2], Lotte Janssens[1], Madelon Pijnenburg[1], Kurt Claeys[1], Stephan Swinnen[1], Simon Brumagne[1]
[1]KU Leuven, [2]University of Ghent

P2-U-114 The effect of self-induced head rotations on path trajectory in the absence of vision.
Tanya Karn[1], Michael Cinelli[1]
[1]Wilfrid Laurier University

P2-U-115 Does effective Adapted Tango rehabilitation improve postural response scaling across stance widths in individuals with Parkinson disease?
J. Lucas McKay[1], Kimberly Lang[2], Madeleine Hackney[2], Lena Ting[1]
[1]Emory University and Georgia Tech, [2]Emory University

P2-U-116 Corticovestibular interactions underlying balance control in healthy subjects
Jean-Francois Nepveu[1], Jean-Pierre Gossard[1], Dorothy Barthélemy[1]
[1]Université de Montréal

P2-U-117 The effects of constraining vision and eye movements on whole-body coordination during standing turns
Rebecca Robins[1], Mark Hollands[1]
[1]Liverpool John Mooores University

P2-U-118 Task dependency of vestibular evoked arm movement
Craig Smith[1], Raymond Reynolds[1]
[1]University of Birmingham

P2-U-119 Effect of hand loads carried on gait of patients with Parkinson's disease in the approach phase to climb stairs
Claudia Teixeira-Arroyo[1], Rodrigo Vitório[1], Diego Orcioli-Silva[1], Lucas Simieli[1], Nubia Conceição[1], Lilian Teresa Gobbi[1]
[1]Univ Estadual Paulista - UNESP

P2-U-120 The effect of a gait synchronization task on dynamic characteristics of cardiac and gait rhythms
Matthew Wittstein[1], Christopher Rhea[1]
[1]University of North Carolina at Greensboro

V Tools and methods for posture and gait analysis

P2-V-121 Effect of position on precision within the recording field of a markerless motion capture system
Benoit Carignan[1], Catherine Lavigne-Pelletier[1], Hung Nguyen[1], Martine Lauzé[1], Laurent Frossard[2], Christian Duval[1]
[1]Universite du Quebec a Montreal, [2]Queensland University of Technology, Brisbane

P2-V-123 Test-retest reliability of centre of foot pressure measuring to assess postural control during anterior-posterior balancing on seesaw
Denis Ducommun[1], Céline Franco[2], Maurice Ouaknine[2], Petra Hlavackova[3], Nicolas Vuillerme[2]
[1]AGIM laboratory, Grenoble.ITO, Labége, [2]Univ. Grenoble-Alpes, AGIM Laboratory, La Tronche (France), [3]Grenoble University Hospital Center

P2-V-124 Effects of training with a new Smartphone-based biofeedback system (CuPiD) on mobility in people with Parkinson's disease: iTUG outcomes
Jeffrey Hausdorff[1], Moran Dorfman[1], Aner Weiss[1], Eran Gazit[1], Pieter Ginis[2], Alice Nieuwboer[2], Sinziana Mazilu[3], Alberto Ferrari[4], Laura Rocchi[4], Lorenzo Chiari[4], Anat Mirelman[1]
[1]Tel Aviv Sourasky Medical Center, [2]Ku Leuven university, [3]Swiss federal institute of Technology, [4]University of Bologna

P2-V-125 Describing Neurological Disorders as changes in Gait Domains
Klaus Jahn[1], Cauchy Pradhan[1], Max Wuehr[1], Thomas Brandt[1], Roman Schniepp[1]
[1]University of Munich

P2-V-126 Concurrent Validity of a Wearable Smartphone-Enabled Camera-Based System for Assessment of Postural Sway
***Albert Kim*[1], Junyoung Kim[1], Michel Heijnen[1], Shirley Rietdyk[1], Babak Ziaie[1]**
[1]Purdue University

P2-V-127 Reliability of wearable motion capture system with inertial and pressure sensors for gait analysis to predict joint forces and moments in whole body
***Yoon Hyuk Kim* [1], Tsolmonbaatar Khurelbaatar[1], Kyungsoo Kim[1]**
[1]Kyung Hee University

P2-V-128 Construct validity of the Mini-BESTest in mild to moderate Parkinson's disease
***Niklas Löfgren*[1], David Conradsson[1], Martin Benka Wallen[1], Erika Franzén[1]**
[1]Karolinska Institutet

P2-V-129 Association between the Outcomes of a Smartphone-based Instrumented Timed Up and Go and Traditional Clinical Assessment Tools in Community-Dwelling Older People
***Sabato Mellone*[1], Marco Colpo[2], Alice Coni[1], Stefania Bandinelli[2], Lorenzo Chiari[1]**
[1]University of Bologna, [2]Azienda Sanitaria Firenze, Florence, Italy

P2-V-130 Supplementing clinical gait tests with body-worn sensors in incomplete spinal cord injury
***Kristin Musselman*[1], Tarun Arora[2], Joel Lanovaz[2], Alison Oates[2]**
[1]Toronto Rehabilitation Institute/University of Toronto, [2]University of Saskatchewan

P2-V-131 A preliminary study of quantitative analysis for body sway using electromagnetic tracker
***Eigo Omi*[1]**
[1]Akita University School Of Medicine

P2-V-132 Evaluation of Estimating Plantar Pressure Distribution Based on Plantar Images by Image Processing
Hiroshi Takemura[1], Takayuki Shiina[1], Hiroshi Tsubo[1], Takumi Ishikawa[1], Takeshi Yamakoshi[1], Yoshiyuki MIDORIKAWA[1], Hiroshi Mizoguchi[1], Yuka Iijima [1]
[1]Tokyo University of Science

P2-V-133 ROMBERG RATIO IN QUIET STANCE POSTUROGRAPHY ? TEST TO RETEST RELIABILITY
***Fredrik Tjernström*[1], Eva-Maj Malmstrom[2]**
[1]Dept. OtoRhinoLaryngology, Head and Neck Surgery, [2]Department of Neurology and Rehabilitation Medicine

P2-V-134 The hip joint extension during a gait stance phase is simultaneous with the extension of the knee
***Hiroyuki Yamamoto*[1]**
[1]HImeji Dokkyo Unuiversity/Faculty of Health Care Sciences

W Vestibular function and disorders

P2-W-135 Sensory and reflexive hypersensitivity in mal de debarquement syndrome
***Richard Fitzpatrick*[1], Linda Forsberg[2], Shaun Watson[3]**
[1]University of New South Wales, [2]University of Gothenburg, [3]UNSW

P2-W-136 The vestibular function in patients with type 2 diabetes mellitus and a history of falls.
***Kathrine Jauregui-Renaud*[1], Catalina Aranda-Moreno[1], Aline Herrera-Rangel[1]**
[1]Instituto Mexicano del Seguro Social

P2-W-137 Postural threat modulates vestibulo-spinal and vestibulo-ocular reflexes during stance
***Eduardo Naranjo*[1], Taylor Cleworth[2], John Allum[3], J. Timothy Inglis[2], Jane Lea[4], Brian Westerberg[5], Mark Carpenter[2]**
[1]The University of British Columbia, [2]University of British Columbia, [3]University Hospital Basel, [4]St. Paul's Hospital, [5]St. Paul?s Hospital

P2-W-138 Vertigo induced by downhill mountain biking
***Philippe Perrin*[1], Alexis Lion[2], Dominique Vibert[3], Gilles Bosser [4], Gerome Gauchard[2], Art Mallinson[5]**
[1]University of Lorraine and University Hospital Nancy, [2]Nancy University, [3]University of Bern, [4]University Hospital, Vandoeuvre-les-Nancy , [5]Vancouver General Hospital/UBC

P2-W-139 Influence of visual contrast and prominence of task-relevant stimuli on obstacle negotiation in fallers with and without Parkinson's disease.
***Lisa Alcock*[1], Brook Galna[1], Jeffrey Hausdorff[2], Sue Lord[1], Lynn Rochester[1]**
[1]Newcastle University Institute for Ageing, Newcastle University, [2]Tel Aviv Sourasky Medical Center

Poster Session 3

Thursday, July 2, 11:30 – 13:30

A Activity Monitoring

P3-A-1 Characterization and quantification of mobility and activity outcomes in community living older adults using wearable global positioning technology
Patrick Boissy[1], **Catherine Lavigne?Pelletier**[2], **Margaux Blamoutier**[2], **Christian Duval**[2], **The EMAP team**[2]
[1]Faculty of Medicine and Health Sciences, Université de Sherbrooke, [2]Faculty of Sciences, Université du Québec à Montréal

P3-A-2 Hesitation before walking is a measurable characteristic of free living mobility in stroke survivors
Kristen Hollands[1], **Andrew Kerr**[2], **Daniel Rafferty**[3], **Malcolm Granat**[1]
[1]University of Salford, [2]University of Strathclyde, [3]Glasgow Caledonian University

P3-A-3 Sit-to-stand transition time estimation based on wrist and hip acceleration sensors
Tomislav Pozaic[1], **Anna-Karina Grebe**[1], **Jochen Klenk**[2], **Ulrich Lindemann**[2], **Clemens Becker**[2], **Wilhelm Stork**[3]
[1]Bosch Healthcare Solutions GmbH, [2]Robert-Bosch-Krankenhaus, [3]Karlsruher Institut für Technologie

B Adaptation, learning, plasticity and compensation

P3-B-4 Lower Limb Adaptations and Compensation to Altered Kinematic Properties in Human Gait
Benjamin Cornish[1], **Emily McIntosh**[1], **Stephen Prentice**[1], **Andrew Laing**[1]
[1]University of Waterloo

P3-B-5 Dizziness increases precautionary locomotor behaviour in patients with unilateral vestibular disorder
Diego Kaski[1], **Mitesh Patel**[1], **Shamim Quadir**[1], **Karen Bunday**[2], **Edwards Roberts**[1], **Qadeer Arshad**[1], **Adolfo Bronstein**[1]
[1]Imperial College London, [2]Institute of Neurology, UCL

P3-B-6 Does instruction type affect motor learning of a bilateral lower extremity motor task after stroke?
Svetlana Knorr[1], **George Mochizuki**[2], **Kara Patterson**[1]
[1]Toronto Rehabilitation Institute, [2]Sunnybrook Research Institute

P3-B-7 What is the role of augmented feedback in learning reactive balance control?
Roshanth Rajachandrakumar[1], **Julia Fraser**[2], **Anthony Aqui**[2], **Bimal Lakhani**[3], **Kara Patterson**[4], **Avril Mansfield**[5]
[1]University of Toronto, [2]Toronto Rehabilitation Institute, [3]University of British Columbia, [4]Toronto Rehabilitation Institute; University of Toronto, [5]Toronto Rehabilitation Institute; University of Toronto; Canadian Partnership for Stroke Recovery

P3-B-8 How do young adults improve their recovery performance following large backward balance perturbations?
Vivian Weerdesteyn[1], **Ghita Puts**[1], **Digna De Kam**[1], **Jolanda Roelofs**[1], **Geert Van Bon**[1]
[1]Radboud University Medical Centre

P3-B-9 Investigation of postural motor learning in people with Multiple Sclerosis
Geetanjali Dutta[1], **Brett Fling**[1], **Karen Ooteghem**[1], **Fay Horak**[1]
[1]Oregon Health & Science University

C Aging

P3-C-10 The association between the impact of dizziness on quality of life and the postural fractality in elderly dizzy patients.
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P3-C-11 Postural control and brain stimulation: A neuromodulation approach to age differences in sensory reweighting
Chesney Craig[1], **Mihalis Doumas**[1]
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P3-C-12 The effects of foot type and shoes on gait characteristics during backward walking in older adults
Michal Elboim Gabyzon[1], **Shira Rotchild**[1]
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P3-C-13 Single and dual task gait speed: Implications for older pedestrians crossing the road
Orna Donoghue[1], **Cara Dooley**[1], **Rose Anne Kenny**[1]
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P3-C-14 Muscle co-contraction in the ankle joint at different performance speeds in elderly adults.
Yoshitaka Iwamoto[1], **Koichi Shinkoda**[1], **Tomonori Sawada**[1], **Masaya Anan**[1], **Makoto Takahashi**[1]
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P3-C-15 Co-contraction during quiet standing in the elderly does not reduce postural sway
Kei Masani[1], **Michael Jones**[1], **Masaki Abe**[2], **Kimitaka Nakazawa**[3]
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P3-C-17 Contributors to Poor Mobility in Older Adults: Integrating Small Vessel Disease and Conditions Affecting Other Systems: the Cardiovascular Health Study
Andrea Rosso[1], **Stephanie Studenski**[2], **William Longstreth**[3], **Caterina Rosano**[1]
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P3-C-18 Gait speed in relation to cognitive scores and symptoms of depression in Mexican older adults: A secondary analysis

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P3-C-19 Enhancing adherence to technology-based exercise programs: What do older adults have to say? A Qualitative Study

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P3-C-20 Foot sole sensory function is enhanced by transcranial direct current stimulation (tDCS) in older adults

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D Biomechanics

P3-D-21 Spectrum Analysis of Body Sway in Bipedally Standing Rat

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P3-D-22 What feet position must be used in standardized stabilometry?

Pierre-Marie Gagey[1], Gérard DI MASCIO[2], Arnaud LECERF[3], Serge HELBERT[4]

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P3-D-23 Effects of shoe bending stiffness on running economy

Keonyoung Oh[1], Sukyung Park[1]

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P3-D-24 Effect of nigral stimulation on gait in Parkinson?s disease

Marlieke Scholten[1], Johannes Klemt[1], Friedemann Bunjes[1], Rejko Krüger[2], Daniel Weiss[1]

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E Brain imaging/activation during posture and gait

P3-E-25 Cortical correlates of congruent and incongruent visuo-vestibular inputs

Hena Ahmad[1], Richard Roberts[1]

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P3-E-26 Cortical load of human gait in a dual task

Nick Kluft[1], Andreas Daffertshofer[2], Jaap Van Dieën[2], Sjoerd Bruijn[2]

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P3-E-27 Cortical activations associated with the anticipatory postural adjustments prior to stepping

Jessy Parokaran Varghese[1], Dan Merino[1], Brian Tan[1], Kit Beyer[1], William McIlroy[1]

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P3-E-28 The neural correlates underlying dual tasking in Parkinson's disease

Keren Rosenberg-Katz[1], Inbal Meidan[1], Yael Jacob[1], Shirley Shema[1], Nir Giladi[1], Talma Hendler[1], Jeff Hausdorff[1], Anat Mirelman[1]

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F Cognitive impairments

P3-F-29 Relationship between balance and cognitive impairment in older people

Jackie Campbell[1], Massimo Leandri[2], Luigi Molfetta[3], Cristina Barbera[3], Massimo Tabaton[3]

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P3-F-30 Stepping task requiring memory and mimic and cognitive function

Ryosuke Shigematsu[1]

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G Cognitive, attentional, and emotional influences

P3-G-31 Remote monitoring reveals how clinical factors influence walking patterns in older people

Matthew Brodie[1], Milou Coppens[2], Andreas Ejupi[3], Yves Gschwind[1], Janneke Annegarn[4], Stephen Lord[1], Kim Delbaere[1]

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P3-G-32 The impact of anxiety on the attentional control of older adults during adaptive dual-task walking

Adam Cocks[1], William Young[1], Toby Ellmers[1], Robin Jackson[1], A. Mark Williams[1]

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P3-G-33 Effect of cognitive interference on postural stability

Guillaume Giraudet[1], Emilie Blin[1], Jocelyn Faubert[1]

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P3-G-34 Changes in metabolic parameters during dual-task while walking; comparison between younger and older adults
Rachel Kizony[1], **Einat Kodesh**[1]
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P3-G-35 Effects of different visual attention tasks on obstacle crossing in healthy young adults
On-Yee Amy Lo[1], **Taylor Kay**[1], **Li-Shan Chou**[1]
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P3-G-36 Walking while talking is cognitively demanding for young adults.
Tiphanie Raffegeau[1], **Jeffrey Haddad**[2], **Jessica Huber**[2], **Shirley Rietdyk**[3]
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H Coordination of posture and gait, Devices to improve posture and gait

P3-H-37 Tuning of postural responses to instability and cost function
Matteo Bertucco[1], **Amber Dunning**[1], **Terence Sanger**[1]
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P3-H-38 The equilibration of the elderly person used with hip strategy can be changed by postural Insoles treatment
Maleville David[1], **rouchon marie-emmanuelle**[1], **porteils elisabeth**[1]
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P3-H-39 Effect of postural deviations on trunk and hip muscle activity during walking
Ryo Fujitani[1], **Takumi Jiroumaru**[1], **Masahiro Fujimoto**[2], **Tadao Isaka**[2]
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P3-H-40 The step width of young and middle-aged adults was substantially reduced by texting and walking
Michel Heijnen[1], **Albert Kim**[1], **Junyoung Kim**[1], **Babak Ziaie**[1], **Shirley Rietdyk**[1]
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P3-H-41 Human cervical spinal cord circuitries can be activated by tonic input to generate rhythmic arm movements
Yuri Ivanenko[1], **Irina Solopova**[2], **Victor Selionov** [2], **Dmitry Zhvansky** [2], **Victor Gurfinkel**[3]
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P3-H-42 Does the passability of apertures change depending on the size of the obstacles?
Kristen Kaster[1], **Amy Hackney**[2], **Michael Cinelli**[1]
[1]Wilfrid Laurier University , [2]University of Waterloo

P3-H-43 The application of functional principal components analysis to the study of gait with high heel shoes
Juan Lopez-Pascual[1], **Clara Solves-Camallonga**[1], **Constanza San Martín Valenzuela**[1], **Sergio Puigcerver Palau**[1], **Juan Belda-Lois**[1]
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P3-H-44 Anticipatory postural adjustment in patients with Parkinson´s disease assessed with wearable sensors
Katrin Maier[1], **Susanne Nußbaum**[2], **Morad Elshehabi**[2], **Markus Hobert**[2], **Martina Mancini**[3], **Daniela Berg**[2], **Sandra Hasmann**[2], **Walter Maetzler**[2]
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P3-H-45 Effect of muscle atrophy on standing postural response to perturbation in older adults
Koutatsu Nagai[1], **Yusuke Okita**[2], **Shinya Ogaya**[3], **Tadao Tsuboyama**[2]
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P3-H-46 Impact of Spasticity on Balance Control During Quiet Standing in Persons Post-Stroke
Reza Rahimzadeh Khiabani[1], **Shannon Reid**[2], **Khurram Hussain**[2], **Farooq Ismail**[2], **Chris Boulias**[2], **Allan Adkin**[3], **William Gage**[1], **Chetan Phadke**[2]
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P3-H-47 Patients with Parkinson disease and healthy elderlies share the same walking strategy: ground reaction forces (GRF) and trunk inclination during linear and curved trajectories.
Anna Turcato[1], **Marco Godi**[1], **Andrea Giordano**[1], **Marco Schieppati**[2], **Antonio Nardone**[3]
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P3-H-48 A comparison of platform translation and shoulder pull paradigms through the analysis of balance correcting responses induced using both methods
Dmitry Verniba[1], **Jason Tokunaga**[1], **William Gage**[1]
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P3-H-49 Characterization of stability control in early recovery from traumatic brain injury
Olinda Habib Perez[1], **Robin Green**[2], **George Mochizuki**[3]
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P3-H-50 Effect of wearable sensors on leg movement quantity in infants
Beth Smith[1]
[1]University of Southern California

P3-H-104 Control of standing and gait in autism spectrum disorders
John Stins[1], **Claudia Emck**[2], **Peter Beek**[2]
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I Development of posture and gait

P3-I-51 Planning your success: development of avoidance strategies
Sharissa Corporaal[1], **Stephan Swinnen**[2], **Jacques Duysens**[2], **Sjoerd Bruijn**[3]
[1]KU Leuven, [2]Catholic University of Leuven, [3]Research Institute MOVE, University Amsterdam

P3-I-52 The Timed Up and Go test and Pediatric Balance scale: complementary tests in the assessment of balance control in 3 to 6-year-old children?
Evi Verbecque[1], **Luc Vereeck**[1], **An Boudewyns**[2], **Paul Van de Heyning**[2], **Ann Hallemans**[1]
[1]University of Antwerp, [2]Antwerp University Hospital

J Developmental disorders

P3-J-53 Postural control deficits in Autism Spectrum Disorder: The role of sensory integration
Mihalis Doumas[1], **Roisin Magee**[1], **Blain Murphy**[1]
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K Devices to improve posture and gait

P3-K-54 Tactile ground information for navigation during locomotion
Sjoerd Bruijn[1], **Lieke De Wit**[1], **Nanda Pluijter**[1], **Myrthe PLaisier**[1]
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P3-K-55 Foot contact occurs prior to pole contact during Nordic Pole Walking among healthy young and elderly naïve pole walkers
Jeev Kiriella[1], **Samy Shash**[1], **Ahmed El-Sadig**[1], **William Gage**[1]
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P3-K-56 Effects of different insole designs on postural control in people with Parkinson's disease and healthy elderly.
Ellen Lirani-Silva[1], **Lucas Simieli**[1], **Rodrigo Vitório**[1], **Claudia Teixeira-Arroyo**[1], **Fabio Barbieri**[1], **Lilian Teresa Gobbi**[1]
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P3-K-57 Biomechanical effects of lateral and medial wedge insoles on unilateral weight-bearing
Tomonori Sawada[1], **Nobuhiro Kito**[2], **Masaki Yukimune**[3], **Kazuki Tokuda**[1], **Kenji Tanimoto**[1], **Masaya Anan**[1], **Makoto Takahashi**[1], **Koichi Shinkoda**[1]
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P3-K-58 Long-term effects of electrotactile sensory substitution therapy on balance disorders
Toshiaki Yamanaka[1], **Nobuya Fujita**[1]
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L Effect of medication on posture and gait

P3-L-59 The effect of laterally wedged insole on human lower extremity during gait cycle
SeungJu Lee[1], **Jeyeon Shim**[1], **Sangbaek Park**[1], **Soo-Won Chae**[1]
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M Ergonomics

P3-M-60 The factor of largest interpersonal variability in gait pattern when healthy adults walk normally on level ground
Yoshiyuki Kobayashi[1], **Hiroaki Hobara**[1], **Thijs Heldoorn**[1], **Makiko Kouchi**[1], **Masaaki Mochimaru**[1]
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P3-M-61 Older adults alter foot trajectory with varying length of nosing projections on stairs: a pilot study
Alison Novak[1], **Vicki Komisar**[2], **Brian Maki**[2], **Roger Montgomery**[2], **Geoff Fernie**[2]
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N Exercise and physical activity

P3-N-62 Assessing the physiological cost of active video games (Xbox Kinect) versus sedentary video games in young healthy males
Gillian Barry[1], **Daniel Tough**[2], **Phillip Sheerin**[2], **Oliver Mattinson**[2], **Rachael Dawe**[2], **Lisa Board**[2]
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P3-N-63 Effects of a music-accompanied walking program on sensory organization and postural control amongst people living with Parkinson's disease
Natalie de Bruin[1], **Hannah Allen**[1], **Matthew Schneider**[1], **Jon Doan**[1], **Bin Hu**[2], **Lesley Brown**[1]
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P3-N-64 Long-term effects of the HiBalance program in elderly with Parkinson's disease
Erika Franzén[1], **Linda Rennie**[2], **David Conradsson**[1], **Niklas Löfgren**[1], **Håkan Nero**[1], **Maria Hagströmer**[1]
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P3-N-65 Daily life activities in the elderly population: effects on gait, cognition and falls.
Antoine Langeard[1], **Kristell Pothier**[2], **Gwendoline-Anne Graindorge**[2], **Christian Marcelli**[3], **Chantal Chavoix**[2]
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P3-N-66 Exergaming in older adults: The effect of the games on movement characteristics during gameplay
Nina Skjæret[1], **Espen A. Ihlen**[1], **Jorunn Helbostad**[1], **Beatrix Vereijken**[1]
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P3-N-67 i-walk: a novel form of walking exercise to improve lower limb muscle strength
Takahiro Tanaka[1], **Toyoyuki Honjo**[1], **Masahiro Fujimoto**[1], **Tadao Isaka**[1]
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0 Falls and fall prevention

P3-0-68 Anxiety symptoms during hospitalization of elderly is associated with increased risk for post-discharge falls
Maayan Agmon[1], **Anna Zisberg**[1], **Orly Tonkikh**[1], **Garry Sinoff**[1], **Efrat Shadmi**[1]
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P3-0-69 Orthopaedic patients with total hip arthroplasty have a higher risk of falling than patients with total knee arthroplasty: a retrospective cohort study.
Mina Arvin[1], **Mirjam Pijnappels**[1], **Bart Burger**[2], **Sabine Verschueren**[3], **Jaap van Dieën**[1], **Marco Hoozemans**[1]
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P3-0-70 PARAMETERS HARVESTED FROM REAL-WORLD FALLS TO ELDERLY PEOPLE FOR THE L5 LOCATION RECORDED USING INERTIAL SENSORS
Alan Bourke[1], **Jochen Klenk**[2], **Lars Schwickert**[2], **Kamiar Aminian**[3], **Espen Ihlen**[4], **Jorunn Helbostad**[4], **Lorenzo Chiari**[5], **Clemens Becker**[6]
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P3-0-71 Gait and balance measured with inertial sensors in elderly men
Patricia Carlson-Kuhta[1], **Martina Mancini**[1], **Jodi Lapidus**[1], **Amy Laird**[1], **Eric Orwoll**[1], **Fay Horak**[1]
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P3-0-72 Spatiotemporal Gait parameters in Elderly are unaffected by internal or external attention
Jonathan de Melker Worms[1], **John Stins**[2], **Peter Beek**[2], **Ian Ioram**[1]
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P3-0-73 Development and evaluation of Kinect-based tests for clinical and in-home assessment of fall risk in older people
Kim Delbaere[1], **Yves Gschwind**[2], **Matthew Brodie**[2], **Stephen Lord**[2], **Andreas Ejupi**[2]
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P3-0-74 The Narrow Path Walking Test - a new tool to identify elderly fallers
Yoav Gimmon[1], **Avi Barash**[1], **Ronen Debi**[2], **Yoram Snir**[3], **Yair Bar David**[4], **Jacob Grinshpon**[5], **Itshak Melzer**[1]
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P3-0-75 Falls and fear of falling in dizzy patients
Klaus Jahn[1], **Cornelia Schlick**[1], **Max Wuehr**[1], **Roman Schniepp**[1]
[1]University of Munich

P3-0-76 Real-time smartphone based fall detection platform for at-risk populations
Beom-Chan Lee[1], **Stefan Madansingh**[1], **Timothy Thrasher**[1], **Charles Layne**[1]
[1]University of Houston

P3-0-77 An adverse interaction between joint pain and habitual walking on incidence of falls among community-dwelling older adults
Yoshiro Okubo[1], **Teho Kim**[1], **Noriko Yabushita**[1], **Satoshi Seino**[2], **Yosuke Osuka**[1], **Songee Jung**[1], **Miyuki Nemoto**[1], **Rafael Figueroa**[1], **Kiyoji Tanaka**[1]
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P3-0-78 Qualitative Evaluation of the Stay Well At Home Multifactorial Fall Risk Reduction Program
Debra Rose[1], **Erin Blanchard**[1], **Kathleen Wilson**[1]
[1]California State University, Fullerton

P3-0-79 Accelerometer based detection of rising from the floor to describe recovery
Lars Schwickert[1], **Clemens Becker**[1], **Jochen Klenk**[1], **Michael Schwenk**[1], **Ulrich Lindemann**[1]
[1]Robert-Bosch-Hospital

P3-0-80 Differences in elderly balance recovery response by stepping: effect of faller past and perturbation duration
Romain Tisserand[1], **Thomas Robert**[2], **laurence Cheze**[1]
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P Habilitation & rehabilitation

P3-P-81 Sensitivity of different combinations of locomotor-cognitive tasks to assess adolescents following concussion
Isabelle Cossette[1], Marie-Eve Gagne[1], Marie-Christine Ouellet[1], Philippe Fait[2], Katia Sirois[1], Isabelle Gagnon[3], nathalie lesage[4], sophie blanchet[1], Bradford McFadyen[1]
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P3-P-82 Community ambulation in the first six months after stroke
Niruthikha Mahendran[1], Kuys Suzanne[2], Sandra Brauer[1]
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Q Modeling

P3-Q-83 Investigating adaptation in hindlimb split-belt treadmill walking by rats using kinematic measurement and a neuromusculoskeletal model
Shinya Aoi[1], Soichiro Fujiki[1], Dai Yanagihara[2], Tetsuro Funato[3], Yota Sato[3], Nozomi Tomita[1], Naomichi Ogihara[4], Kei Senda[1], Kazuo Tsuchiya[1]
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P3-Q-84 Limit cycle oscillations in upright human posture of individuals with neurological impairments
Arvind Raman[1], Jeffrey Haddad[1], Shirley Rietdyk[1], Howard Zelaznik[1], Michael Cinelli[2], Luke Denomme[2], Kaley Powers[2], Jim Chagdes[3]
[1]Purdue University, [2]Wilfrid Laurier University, [3]University of Oregon

R Neurological diseases

P3-R-85 Smaller obstacle height increases variability of spatial parameters compared to bigger obstacle height
Fabio Barbieri[1], Lucas Simieli [2], Diego Orcioli-Silva[3], André Baptista[3], Vinicius A. Pereira[3], Victor Beretta[3], Lilian Gobbi[3]
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P3-R-86 Pattern recognition of gait parameters - a 16 weeks cross-sectional study in a Neurology University Department
Felix Bernhard[1], Kristina Bettecken[2], Jennifer Sartor[2], Yvonne Weber[1], Sven Poli[1], Sandra Hasmann[2], Markus Hobert[2], Walter Maetzler[2]
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P3-R-87 Are muscle synergies used for balance recovery impaired after stroke?
Digna de Kam[1], Vivian Weerdesteyn[1], Gelsy Torres-Oviedo[2]
[1]Radboud University Medical Center, [2]University of Pittsburgh

P3-R-88 Secondary Tasks' Nature Determines Prioritisation Strategies in PD Patients during Dual Tasking
Morad Elshehabi[1], Kathrin Maier [2], Sandra Hassmann[2], Tanja Heger[2], Susanne Nußbaum[2], Daniela Berg[2], Markus Hobert[2], Walter Maetzler[2]
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P3-R-89 Gait-related postural control and asymmetry are early discriminant markers of Parkinson's disease
Brook Galna[1], Sue Lord[1], Lynn Rochester[1]
[1]Newcastle University

P3-R-90 Enhancing foot clearance in people with Parkinson's disease
Pieter Ginis[1], Rudi Pirani[2], Silvia Basaia[2], Alberto Ferrari[2], Lorenzo Chiari[2], Elke Heremans[1], Colleen Canning[3], Alice Nieuwboer[1]
[1]KU Leuven, [2]University of Bologna, [3]University of Sydney

P3-R-91 Does anxiety compete for processing resources during walking and a dual-task in Parkinson's disease?
Brittany Intzandt[1], Carolina Rodrigues Alves Silveira[2], Kaylena Ehgoetz Martens[2], Quincy Almeida[1]
[1]Wilfrid Laurier University, [2]University of Waterloo

P3-R-92 The necessity of smooth weight transfer for the restoration of independent walking in hemiplegic patients after CVA
Arinori Kamono[1], Naomichi Ogihara[2]
[1]Showa University, [2]Keio University

P3-R-93 Comparing single and dual-task gait as predictors of decline in attention in people with Parkinson's disease
Rosie Morris[1], Sue Lord[1], Brook Galna[1], David Burn[1], Lynn Rochester[1]
[1]Newcastle University

P3-R-94 Cortical Motor Planning for Initiating Stepping After Stroke: A case study
Sue Peters[1], Tanya Ivanova[1], Bimal Lakhani[1], S Jayne Garland[1], Lara Boyd[1]
[1]University of British Columbia

P3-R-95 Effects of dual-task walking on different motor and cognitive complexities in pre-clinical stages of degenerative cerebellar ataxia
Cornelia Schatton[1], Zofia Fleszar[1], Martin Giese[1], Ludger Schöls[1], Matthis Synofzik[1], Winfried Ilg[1]
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P3-R-96 Does post-stroke lower limb spasticity influence the recovery of standing balance control? A multilevel growth model of stability control measures over two years
Jonathan Singer[1], Kanako Nishihara[2], George Mochizuki[3]
[1]University of Manitoba, [2]University of Toronto, [3]Sunnybrook Research Institute

P3-R-97 Functional and perceptual limitations in motor ability following a stroke
Ruth Stout[1], Michael Lewek[2], Scott Ross[1], Christopher Rhea[1]
[1]UNC-Greensboro, [2]UNC-Chapel Hill

P3-R-98 Dominance of the right cerebral hemisphere for balance control: evidence from unilateral cerebral stroke
Luis Teixeira[1], Corina Fernandes[1], Daniel Coelho[1]
[1]University of São Paulo

P3-R-99 The relationship between quantitative parameters of the Timed-up-and-Go phases, and health-related quality of life in Parkinson's disease
Janet van Uem[1], Stefan Walgaard[2], Erik Ainsworth[2], Sandra Hasmann[1], Tanja Heger[1], Susanne Nussbaum[1], Markus Hobert[1], Ecarna Mico Amigo[2], Rob van Lummel[2], Walter Maetzler[1]
[1]Universitätsklinikum Tübingen , [2]McRoberts

S Orthopedic diseases and injuries

P3-S-100 Static single-leg standing balance performance is impaired in individuals with patellofemoral pain
Anna Hatton[1], Kyla Stableford[1], François Hug[1], Kay Crossley[1], Natalie Collins[2]
[1]The University of Queensland, [2]The University of Melbourne

P3-S-101 Neuromuscular response to unexpected single-planar versus multi-planar support perturbations.
Sabine Verschueren[1], Bart Malfait[1], Aijse De vries[1], Filip Staes[1], Annemie Smeets[1], Mark Robinson[2], Jos Vanrenterghem[2]
[1]KU Leuven, [2]Liverpool John Moores University

T Proprioceptive function and disorders

P3-T-102 Interaction between Multisensory and Plantar Mediation Stimulation on Postural Gain
Marc Janin[1], Sophie Loureau[1]
[1]none

P3-T-103 Gender differences in the shoulder joint position sense acuity
Amir Vafadar[1], Julie Cote[1], Philippe Archambault[1]
[1]McGill University

U Sensorimotor control, Visual function and disorders

P3-U-105 Sensorimotor coupling adaptation to environmental changes in postural control is compromised by sleep deprivation in young adults
Jose Barela[1], Stefane Aguiar[2]
[1]Cruzeiro do Sul University, [2]University of Cruzeiro do Sul

P3-U-106 Validating the use of a smartphone to measure postural control of healthy subjects during standing
Jordan Craig[1], Jeff Radel[2], Adam Bruetsch[2], Mark Burghart[2], Jessie Huisinga[2]
[1]University of Kansas, [2]University of Kansas Medical Center

P3-U-107 Tremor and sway in Parkinson's disease subtypes as detected using a single body-fixed sensor: A Romberg-like test for parkinsonian tremor?
Talia Herman-Feinstein[1], Aner Weiss[1], Marina Brozgol[1], Nir Giladi[1], Jeffrey Hausdorff[1]
[1]Tel Aviv Sourasky Medical Center

P3-U-108 Processing time of addition or withdrawal of single or combined posture-stabilizing visual and haptic information.
Jean-Louis Honeine[1], Oscar Crisafulli[2], Stefania Sozzi[2], Marco Schieppati[2]
[1]University of Pavia - Fondazione Salvatore Maugeri, I.R.C.S.S., Istituto di Pavia, [2]University of Pavia

P3-U-109 Effects of a sensorimotor training on postural control and pain in patients with non-specific low back pain: Study protocol of a parallel, single-blinded RCT
Michael McCaskey[1], Corina Schuster-Amft[2], Brigitte Wirth[1], Eling de Bruin[1]
[1]ETH Zurich, [2]Reha Rheinfelden

P3-U-110 The effect of light touch on balance control during over ground walking in healthy young adults
Alison Oates[1], Janelle Unger[1], Cathy Arnold[1], Joyce Fung[2], Joel Lanovaz[1]
[1]University of Saskatchewan, [2]McGill University

P3-U-111 Sway-dependent changes in standing ankle stiffness caused by muscle thixotropy
Tania Sakanaka[1], Raymond Reynolds[1], Martin Lakie[2]
[1]University of Birmingham, [2]

P3-U-112 Visual and Somatosensory Deficit Patterns on the Sensory Organization Test: Comparison of Five Diagnostic Groups
Jeffrey Staab[1], Neil Shepard[1], Eliane Sohsten[2], Roseli Bittar[2], Scott Eggers[1], Brian Neff[1]
[1]Mayo Clinic, [2]Universidade de São Paulo

P3-U-113 PREDICTIVE POSTURAL CONTROL DRIVES THE ONLINE CORRECTION OF ARM MOVEMENTS DURING STANCE REGARDLESS OF DIRECTION AND EXTENT OF VISUOMOTOR PERTURBATION.
Paul Stapley[1], Julia Leonard[2], Alexander Stamenkovic[1], Darryl McAndrew[1], Sophie Bos[1], Stephen Palmisano[1]
[1]University of Wollongong, [2]Université de Montreal

P3-U-114 Effect of visual dependence on postural responses to visual perturbation in spastic cerebral palsy
Yawen Yu[1], **Emily Keshener**[1], **Carole Tucker**[1], **Elizabeth Thompson**[1], **Richard Lauer**[1]
[1]Temple University

P3-U-115 Dynamical auditory information can influence body sway of standing subjects
Lennie Gandemer[1], **Gaetan Parseihian**[1], **Richard Kronland-Martinet**[1], **Christophe Bourdin**[1]
[1]CNRS

P3-U-116 An experimental test of hypothesized sensory fusion mechanisms contributing to sensory reweighting in human balance control.
Lorenz Assländer[1], **Georg Hettich**[1], **Robert Peterka**[2], **Thomas Mergner**[1]
[1]Albert-Ludwigs-University of Freiburg, [2]Oregon Health & Science University

V Tools and methods for posture and gait analysis

P3-V-117 Defining postural control over first time trials of Nintendo Wii game play
Laura Carvalho[1], **Chelsey Sanderson**[1], **William Montelpare**[1], **Rebecca Reed-Jones**[1]
[1]University of Prince Edward Island

P3-V-118 Characteristics of gait during long-duration walking in people with multiple sclerosis
Carolin Curtze[1], **Geetanjali Gera Dutta** [1], **Fay Horak**[1]
[1]Oregon Health & Science University

P3-V-119 Measuring Step Width During Gait Using Inertial and Ranging Sensors
Mahmoud El-Gohary[1], **James McNames**[1], **Paul Vasilyev**[1], **Sean Pearson**[1], **Fay Horak**[1]
[1]APDM Inc.

P3-V-120 Test-retest reliability and concurrent validity of a fMRI-compatible pneumatic vibrator to stimulate muscle proprioceptors during upright standing
Nina Goossens[1], **Lotte Janssens**[1], **Madelon Pijnenburg**[1], **Paul Meugens**[1], **Simon Brumagne**[1]
[1]KU Leuven

P3-V-121 A Multi-Kinect system for the quantitative analysis of spatial- temporal gait measures in neurological movement disorders
Winfried Ilg[1], **Nicolas Ludolph** [1], **Bjoern Mueller**[1], **Matthis Synofzik**[1], **Martin Giese**[1]
[1]Hertie Institute for Clinical Brain Research

P3-V-122 Influence of balance disturbance method on the timing and accuracy of reach-to-grasp balance recovery reactions during level ground walking
Vicki Komisar[1], **Alison Novak**[2], **Emily King**[3], **Brian Maki**[3], **Karl Zabjek**[3], **Geoff Fernie**[3]
[1]Toronto Rehab - University Health Network, [2]Toronto Rehabilitation Institute - University Health Network, [3]University of Toronto

P3-V-123 Reliability of Multifractal Detrended Fluctuation Analysis using Smartphone Technology
Joshua Liddy[1], **Junyoung Kim**[1], **Michel J.H. Heijnen**[1], **Albert Kim**[1], **Babak Ziaie**[1], **Shirley Rietdyk**[1]
[1]Purdue University

P3-V-124 Video-based body shape capture for movement study - Application to a walking sequence.
Olivier Martin[1], **Julien Pansiot**[2], **Lionel Reveret**[2]
[1]Gipsa-Lab/CNRS, [2]INRIA Grenoble Rhône-Alpes

P3-V-125 Crowdsourced annotation of EMG onset times in healthy individuals and Parkinson disease
J. Lucas McKay[1], **Tingting Zhu**[2], **Aiden Payne**[1], **Lena Ting**[1], **Gari Clifford**[3]
[1]Emory University and Georgia Tech, [2]University of Oxford, [3]Emory University

P3-V-126 Methods for assessing Achilles T-reflex during stance
Robyn Mildren[1], **Martin Zaback**[2], **Allan Adkin**[2], **Jim Frank**[3], **Leah Bent**[1]
[1]University of Guelph, [2]Brock University, [3]University of Waterloo

P3-V-127 Novel approaches to clinical walking assessment in pediatric populations
Kristin Musselman[1], **Kyra Kane**[2], **Derek Bisaro**[2], **Alison Oates**[2], **Joel Lanovaz**[2]
[1]Toronto Rehabilitation Institute/University of Toronto, [2]University of Saskatchewan

P3-V-128 Feasibility and Validity of Functional Movement Screen in Assessing Postural Control of Operative Firefighters Aged 22-59
Anne Punakallio[1], **Sirpa Lusa**[1], **Miia Wikström**[1]
[1]Finnish Institute of Occupational Health

P3-V-129 Reliability of clinical and instrumented balance assessments in patients with Parkinson`s Disease.
Simon Steib[1], **Heiko Gaßner**[1], **Björn Eskofier**[1], **Jürgen Winkler**[1], **Klaus Pfeifer**[1], **Jochen Klucken**[1]
[1]Friedrich-Alexander University Erlangen-Nürnberg

P3-V-130 Distribution of traction coefficient in the contact area between shoe sole and floor during straight walking
Takeshi Yamaguchi[1], **Fumiya Meguro**[1], **Yusuke Nakajima**[1], **Kazuo Hokkirigawa**[1]
[1]Tohoku University

P3-V-131 Between-subjects differences in CoP measures on stable and unstable spring-supported platform
Erika Zemková[1], **Du?an Hamar**[1]
[1]Faculty of Physical Education and Sports, Comenius University

W Vestibular function and disorders

P3-W-132 Perceived Timing of Auditory and Inertial Cues During a Fall
Julian Lupo[1], **Michael Barnett-Cowan**[1]
[1]University of Waterloo

P3-W-133 Reliability of the instrumented Timed Up and Go and Postural Sway tests in Patients with Vestibular Disorders
Claudia Mazzà[1], **Sathish Sankarpandi**[1], **Alice Baldwin**[2], **Jaydip Ray**[3]
[1]The University of Sheffield, [2]Sheffield Hallamshire Hospital, [3]Sheffield Teaching Hospitals

P3-W-134 Functional Interactions of vestibular and cortico-spinal networks in the control of neck musculature
Sofia Nousi[1], **Varsha Kadaba**[1], **Michael Gresty**[1], **Adolfo Bronstein**[1], **Paul Strutton**[1]
[1]Imperial College

P3-W-135 To compensate or not to compensate: that is the question in vestibular failure
Andreas Zwergal[1], **Klaus Jahn**[1], **Thomas Brandt**[1], **Marianne Dieterich**[1]
[1]University of Munich

P3-W-136 Effect of postural control in frontal plane by virtual reality
Tadamitsu Matsuda[1], **Kaz Amimoto**[2], **Atsushi Manji**[3], **Manabu Nakamura**[4], **Yasushi Kusumoto**[5]
[1]Uekusa Gakuen University, [2]Tokyo Metropolitan University, [3]Saitama Misato Rehabilitation Hospital, [4]Takenoduka Rehabilitation Hospital, [5]Tokyo Technology University

P3-W-137 Long-term balance training with vibrotactile biofeedback: Two case reports
Tian Bao[1], **Kathleen Sienko**[1], **Brooke Klatt**[2], **Wendy Carender**[1], **Catherine Kinnaird**[1], **Susan Whitney**[2]
[1]University of Michigan, [2]University of Pittsburgh

P3-W-138 The interplay of eye movements and gait in patients with downbeat nystagmus syndrome
Klaus Jahn[1], **Roman Schniepp**[1], **Cauchy Pradhan**[1], **Max Wuehr**[1]
[1]University of Munich

EXHIBITOR PROFILES

APDM *booth 4*

www.apdm.com

APDM produces the highest quality wearable sensors on the market, used in hundreds of universities and hospitals worldwide. Our most popular system is a full body gait and balance analysis system, called Mobility Lab.

biomechSOLUTIONS *booth 10*

www.biomech-solutions.com

biomechSOLUTIONS is the spanish leading company in measurement and analysis systems for biomechanical applications in many different areas like research, clinical, ergonomics, sports, rehabilitation, etc. We offer solutions for motion analysis, EMG, force, pressure, biomechanical sensors, exoskeleton, thermal cameras, etc. from the top companies in the market and we give training courses about the main biomechanical technologies. Trust on biomechSOLUTIONS for your biomechanical projects

CIR Systems/GAITRite *booth 6*

www.gaitrite.com

GAITRite is a truly portable pressure sensitive walkway with a quick 5 minute setup measuring temporal spatial parameters, providing easy identification of gait anomalies.The system comes in various lengths which record and analyze multiple gait cycles in a single walk, allowing accurate testing of patients.

Cometa Systems *booth 9*

www.cometasystems.com

Cometa Systems is an ISO 13485 certified company that provides the smallest wireless EMG systems in the world, suitable for both clinical and research applications. Wave systems can be equipped with data logger, accelerometers and can be easily synched with Protokinetics Zeno mats.

CONTEMPLAS GmbH *booth 3*

www.contemplas.com

CONTEMPLAS GmbH, with its headquarter in Kempten/Germany, develops and distributes worldwide software solutions for general motion analysis in the sport and medicine market. With the motion analysis software TEMPLO and VICON MOTUS, CONTEMPLAS offers the possibility to do professional analysis in different fields of applications and integrate other systems, such as EMG, pressure and force measurement.

Gait Up *booth 8*

www.gaitup.com

Born in Research - Made in Switzerland - Used in Clinics Gait Up offers a practical and accurate tool to measure and analyze human locomotion & Physical Activity. This innovative solution is a wearable sensor system & its dedicated algorithm developed through collaborations between research & clinics. Gait Up: a must-have for institutions requiring routinely easy & valid spatio-temporal gait performance parameters! Valorize your treatment! Go for reknown tools!

MediTouch *booth 12*

www.meditouch.co.il

MediTouch have introduced the BalanceTutor a Perturbation Treadmill and an innovative postural control and balance trainer. BalanceTutor provides novel balance therapy including expected and unexpected controlled perturbation that simulates a slip and a trip in both standing and during a specific gait phase of walking.

EXHIBITOR PROFILES

Motekforce Link *booth 1*

www.motekforcelink.com

In July 2014, the companies Motek Medical and Force Link merged. The new company, Motekforce Link, combines more than fifteen years of experience in high-quality rehabilitation technologies and real-time feedback, using virtual reality techniques. A first major milestone for Motekforce link was the announcement of the merger with DIH Technologies on April 20th of 2015. DIH is an international player and aspiring market leader in the field of Rehab & Sports Medicine and Intelligent Medication & Supply businesses, with passionate teams in San Diego, Soul, Hong Kong, Beijing and Amsterdam.

Noraxon USA, Inc *booth 11*

www.noraxon.com

Noraxon is a U.S. based, international leader in manufacturing and distribution of research grade applications for measurement devices and software. Products include EMG, gait analysis, biofeedback and 2D/3D motion analysis. Noraxon's integrated reporting and single interface enable a whole body approach to real-time biomechanics measurement for clinical and research applications.

PAL Technologies Ltd *booth 7*

www.paltechnologies.com

PAL Technologies develops and supplies solutions for quantifying participation in free-living daily activities. The activPAL(TM)physical activity logger records posture changes (sit-stand and stand-sit) over seven days. Characterising limb acceleration into functional activities, it allows patterns of upright activity and sedentary behaviour to be analysed and related to disease progression.

Tekscan *booth 2*

www.tekscan.com

Tekscan manufactures a broad range of tools for better pressure offloading and enhanced gait analysis. Our systems use paper-thin, high-resolution sensors to measure plantar pressure distribution, timing and Center of Force (CoF) trajectory in dynamic evaluations. The unique information these systems provide helps you objectively validate treatments and improve outcomes.

Vicon *booth 5*

www.vicon.com

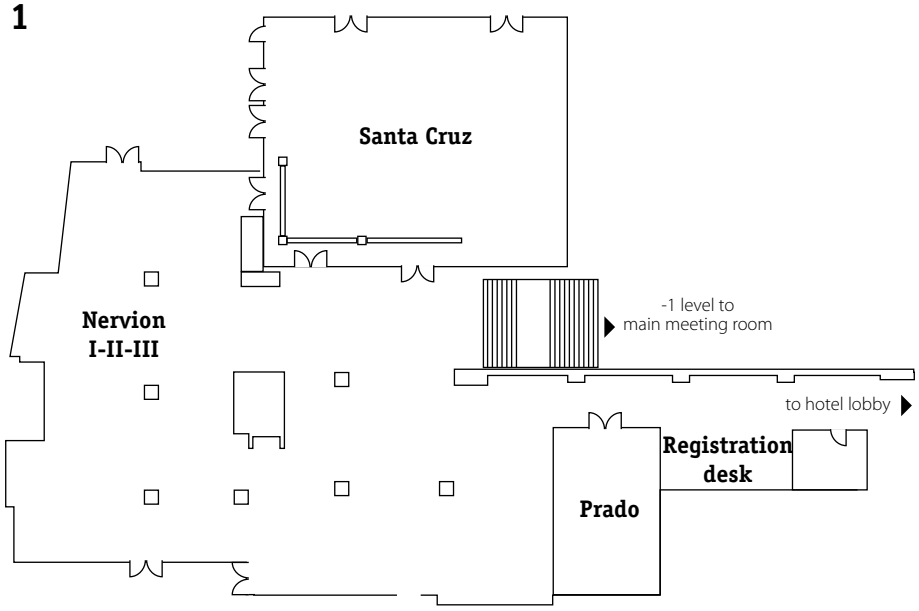
Vicon delivers highly accurate 3D motion capture systems for use in gait analysis. Nearly 400 clinical gait labs world-wide use Vicon technology. Its flagship camera line offers the highest resolution, frame rates and accuracy available, allowing detailed motion capture in almost any environment. Bonita is Vicon?s next generation camera, combining size, power, and price performance into one amazing solution.

NOTES

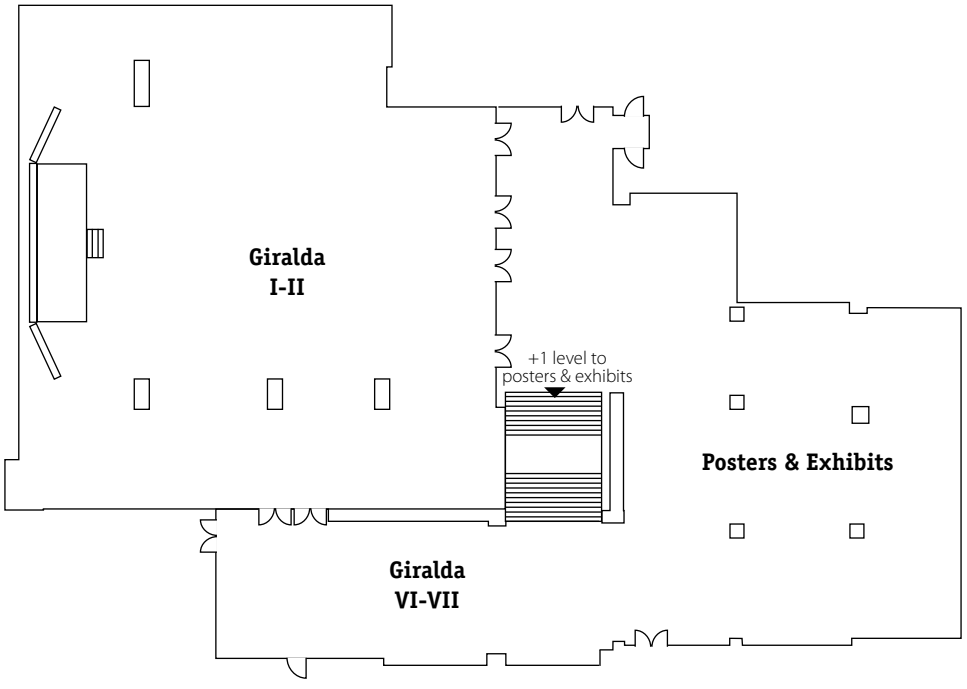
MEETING FLOOR PLANS

Melia Sevilla Hotel

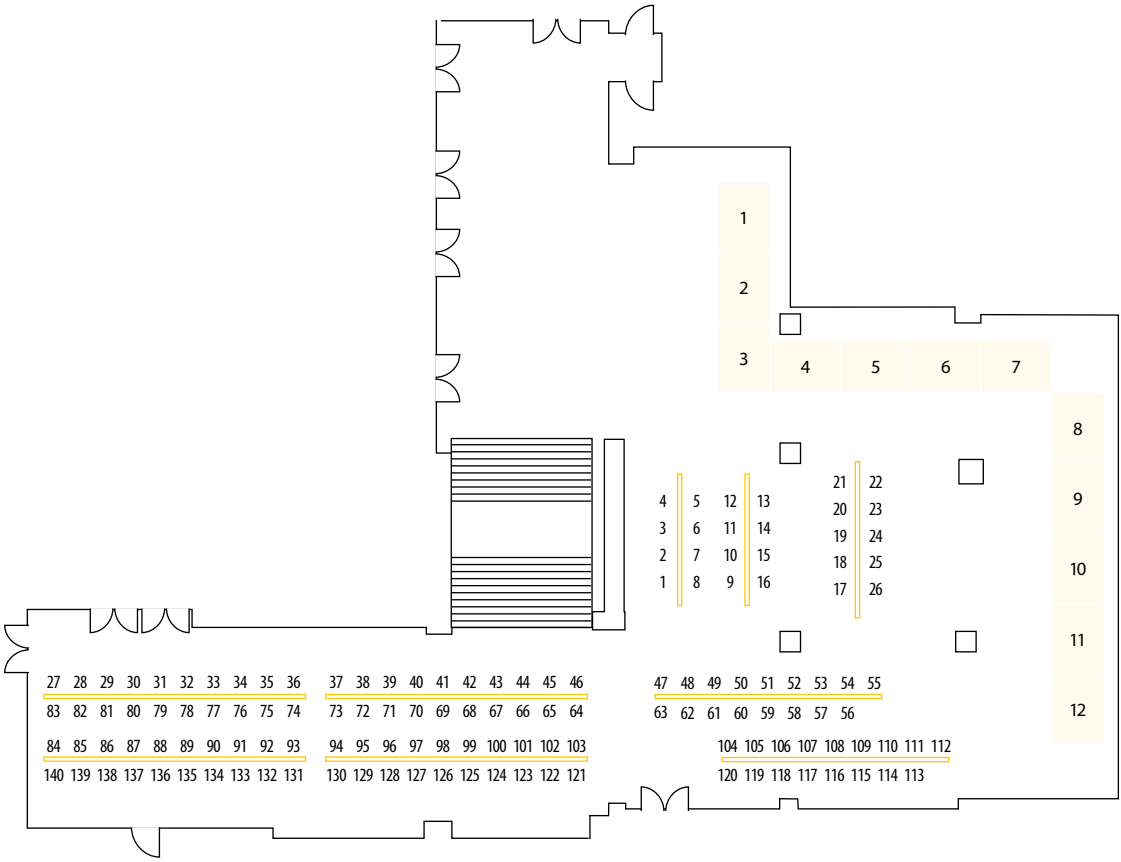
Hall 1



Hall 2



POSTER AND EXHIBITOR FLOOR PLAN



Exhibitors

4	APDM	12	MediTouch
10	biomechSOLUTIONS	1	Motekforce Link
6	CIR Systems/GAITRite	11	Noraxon USA, Inc
9	Cometa Systems	7	PAL Technologies Ltd
3	CONTEMPLAS GmbH	2	Tekscan
8	Gait Up	5	Vicon

THANK YOU TO OUR EXHIBITORS