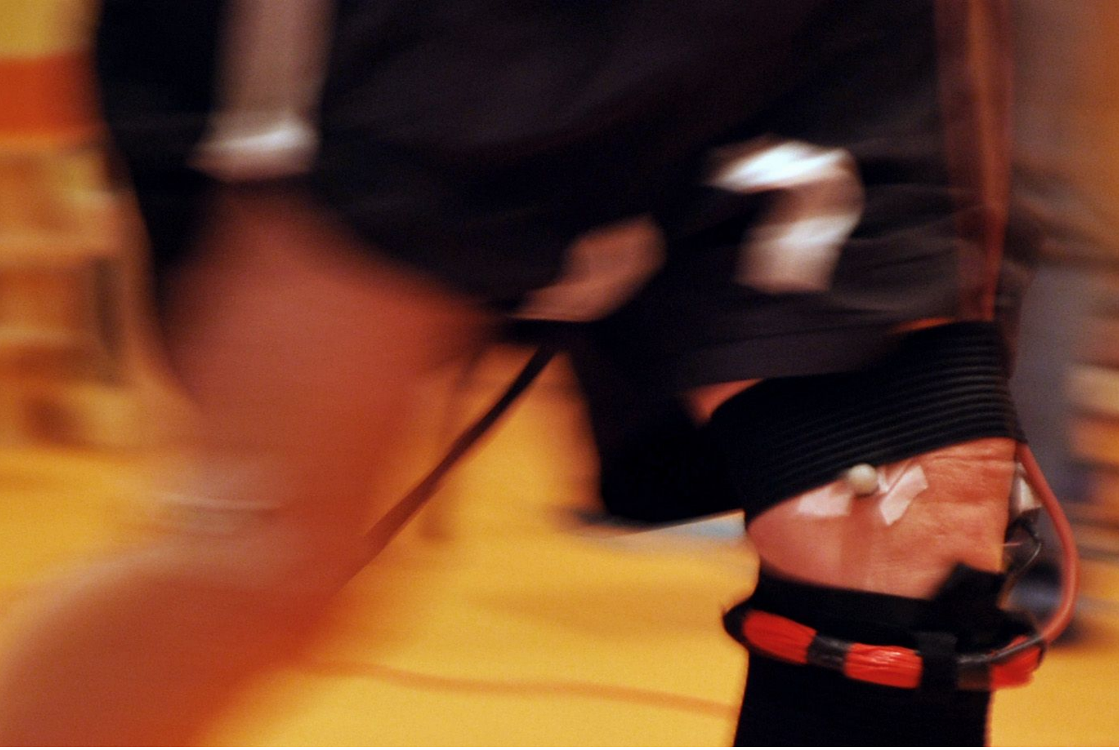
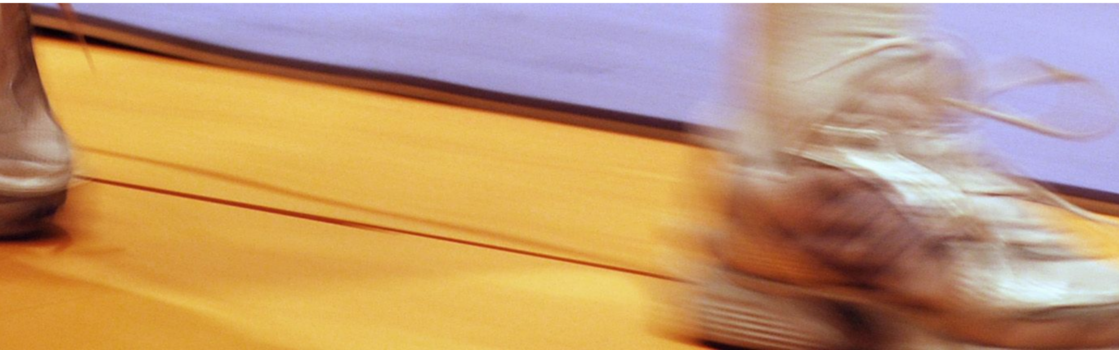


1st International Autumn School on Movement Science and BSMS Annual Retreat

Berlin, 13-24 October 2014

Programme

BSMS
Berlin School of Movement Science



BSMS
Berlin School of Movement Science

1st International Autumn School on Movement Science and BSMS Annual Retreat

Berlin, 13-24 October 2014

Programme

Hosted by

Humboldt-Universität zu Berlin, Institute of Sports Science
Charité - Universitätsmedizin Berlin, Julius Wolff Institute
Max Planck Institute for Human Development
Technische Universität Berlin, Department of Medical Technology
Zuse Institute Berlin (ZIB)

BSMS – Berlin School of Movement Science

Organisation

Scientific Coordination

Prof. Adamantios Arampatzis (Spokesperson)
Prof. Georg Duda (Deputy Spokesperson)

Administrative Coordination

Martina Piotrowski

Executive Committee

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Sessions
Scientific Programme

Monday 13th October......BSMS Students Projects

Tuesday 14th October......Movement Science

Wednesday 15th October......Motor Control & Learning

Thursday 16th October......Brain Plasticity

Friday 17th October......Gait Analysis

Monday 20th October......CNS & Movement Control

Tuesday 21st October......Muscle Tendon Adaptation

Wednesday 22nd October......Spine

Thursday 23rd October......Disease & Injuries

Friday 24th October......Therapy & Rehabilitation

Sessions
Social Programme

Monday 13th October......Boat Tour Festival of Lights

Tuesday 14th October......Otto Bock Science Center guided tour

Friday 17th October......Béjart Ballet Lausanne

Friday 17th October......Get-together dinner

Saturday 18th October......Olympiastadion tour

Tuesday 21st October......Berlin Wall tour

Friday 24th October......TV Tower dinner

Monday 13th October
BSMS Students Projects

Humboldt-Universität zu Berlin, Humboldt Graduate School | Luisenstr. 56 | "Festsaal"

09:00 to 10:00	Registration
10:00 to 10:20	Changes in mechanical and morphological properties of muscle and tendon due to eccentric training with different stimuli frequencies ***Robert Marzilger*** *– Supervisor: Adamantios Arampatzis*
10:20 to 10:40	Aging, Degeneration and Frailty: Development of a Multicomponent Exercise Intervention in frail old adults. ***Fyllis Papatzika*** *– Supervisor: Adamantios Arampatzis*
10:40 to 11:00	Effect of exercise interventions on locomotional stability and fall prevention in the elderly ***Azza Hamed*** *– Supervisor: Adamantios Arampatzis*
11:00 to 11:20	Break
11:20 to 11:40	Modular organisation of muscle activation and foot strike pattern assessment during human locomotion ***Alessandro Santuz*** *– Supervisors: Adamantios Arampatzis, Vasilios Baltzopoulos*
11:40 to 12:00	Development of biomechanical markers for estimation of neuromuscular trunk control. ***Arno Schroll*** *– Supervisor: Adamantios Arampatzis*
12:00 to 12:20	Studying the dynamic stability of locomotion using Lyapunov exponents: a reliability study ***Antonis Ekizos*** *– Supervisor: Adamantios Arampatzis*
12:20 to 13:00	Lunch Break

Monday 13th October
BSMS Students Projects

Humboldt-Universität zu Berlin, Humboldt Graduate School | Luisenstr. 56 | "Festsaal"

13:00 to 13:20	How does the sagittal alignment of the spine affect spinal loading, motion and the success of a surgical intervention in patients with degenerative spinal disorders? ***Marcel Dreischarf*** *– Supervisors: Hendrik Schmidt, Carsten Perka, Toni Rohlmann*
13:20 to 13:40	Analysis of spine movements among workers in awkward postures - relationship between physical activity and low back pain ***Esther Pries*** *– Supervisors: Hendrik Schmidt, Adamantios Arampatzis*
13:40 to 14:00	Break
14:00 to 14:45	"Forschungsnetzwerk Bewegung Berlin", an interdisciplinary scientific center for movement | Lab-tour ***Adamantios Arampatzis*** *– Humboldt-Universität zu Berlin – BSMS*

19:30 to 21:30 **Boat tour Festival of Lights**

Jannowitzbrücke | Meeting Point

Tuesday 14th October
Movement Science

Humboldt-Universität zu Berlin, Humboldt Graduate School | Luisenstr. 56 | "Festsaal"

09:00 to 09:45	Plasticity of the musculoskeletal system after long- and short-term mechanical loading | Lecture ***Adamantios Arampatzis*** *– Humboldt-Universität zu Berlin - BSMS*
09:45 to 10:00	Break
10:00 to 10:45	Mechanisms and adaptation of neuromuscular function in exercise | Lecture ***Paavo Komi*** *– University Jyväskylä*
10:45 to 11:00	Break
11:00 to 11:45	Movement biomechanics: Identification of musculoskeletal deficits and movement pathologies at an early time point | Lecture ***Bill Taylor*** *– ETH Zurich*
11:45 to 13:30	Lunch break

15:30 to 17:00 **Otto Bock Science Center guided tour**

Ebertstr. 15A | Meeting Point

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Wednesday 15th October

Motor Control & Learning

Humboldt Graduate School | Luisenstraße 56 | Seminar Room 144

09:00 to 09:45	Learning to move: early development of locomotion and manual control | Lecture ***Julius Verrel*** *– Max Planck Institute for Human Development, BSMS*
09:45 to 10:00	Break
10:00 to 10:45	Neuromuscular behaviour in prepubertal children | Lecture ***Dimitrios Patikas*** *– Aristotle University of Thessaloniki*
10:45 to 11:30	How visual and proprioceptive information is transformed into meaningful motor output for controlling posture and balance | Lecture ***Vasilia Hatzitaki*** *– Aristotle University of Thessaloniki*
11:30 to 13:00	Lunch break
13:00 to 13:45	Dopamine and motor learning - a role for reward and motivation? | Lecture ***Susan Leemburg*** *– University of Zurich*
13:45 to 14:00	Break
14:00 to 15:30	GAIT Analysis with Vicon | Hands-on Experience (15 Places) ***Esther Pries, Maxim Bashkuev*** *– BSMS*

Thursday 16th October
Brain Plasticity

Max Planck Institute for Human Development | Lentzeallee 94

09:00 to 09:45	How the brain produces movement, how repetition of movement changes the brain, age and how age and disease-related brain changes affect movement | Lecture ***Rachael Seidler*** – *University of Michigan*
09:45 to 10:00	Break
10:00 to 10:45	Aberrant motor behaviors and motor control - a clinical perspective | Lecture ***Christos Ganos*** – *UCL Institute of Neurology London*
10:45 to 11:00	Break
11:00 to 11:45	Reorganisation and plasticity of adult human brain during motor skill learning | Lecture ***Julien Doyon*** – *University of Montréal*
11:45 to 13:30	Lunch break
Group 1 13:30 to 14:00	The Max Planck Institute for Human Development | Lab tours: MRI lab, Movement lab, Baby lab, EEG lab (15 places) ***Elisabeth Wenger*** – *BSMS*
Group 2 14:45 to 15:15	The Max Planck Institute for Human Development | Lab tours: MRI lab, Movement lab, Baby lab, EEG lab (15 places) ***Elisabeth Wenger*** – *BSMS*

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Friday 17th October
Gait Analysis

Humboldt-Universität zu Berlin, Humboldt Graduate School | Luisenstraße 56 | "Festsaal"

09:00 to 09:45	Gait stability as a predictor of fall risk | Lecture ***Jaap H. van Dieën*** *– University of Amsterdam*
09:45 to 10:00	Break
10:00 to 10:45	Energetics and mechanics of different forms of locomotion | Lecture ***Alberto E. Minetti*** *– University of Milan*
10:45 to 11:00	Break
11:00 to 11:45	Muscle physiology and modelling | Lecture ***Tobias Siebert*** *– University of Stuttgart*
11:45 to 13:30	Lunch break
13:30 to 15:00	Gait Analysis with SIMI | Hands-on Experience (15 places) ***Antonis Ekizos, Alessandro Santuz*** *– BSMS*

19:30 to 21:30 **Béjart Ballet Lausanne (Ce que l'amour me dit | Le sacre du printemps)**

Möckernstraße 10 | Meeting Point

21:30 to 23:30 **Get-together dinner**

Wilhelmshavener Strasse 6 | Meeting Point

Saturday 18th October
Social Events

Olympiastadion Berlin

13:30 to 16:30 **Olympiastadion tour**

Olympischer Platz 3 | Meeting Point

This 120-minute tour brings you close to the fascinating history of German sports and architecture. In addition to the areas not open to the public at the Olympiastadion Berlin, you will also explore the Olympiapark. Those interested in sports, culture and architecture will be provided with many details on the complex history of the former "Reichssportfeld". Afterwards you can feel free to enjoy the panorama view from the observation platform of the "Glockenturm" bell tower.

Monday 20th October

CNS & Movement Control

Humboldt-Universität zu Berlin, Humboldt Graduate School | Luisenstraße 56 | "Festsaal"

09:00 to 09:45	Cortical Plasticity and Brain Computer Interfaces | Lecture ***Natalie Mrachacz-Kersting*** – *Aalborg University*
09:45 to 10:00	Break
10:00 to 10:45	Modular organization of balance control following perturbations during walking | Lecture ***Uwe Kersting*** – *Aalborg University*
10:45 to 11:00	Break
11:00 to 11:45	Arm control by muscle synergy combinations: experimental evidence and computational models | Lecture ***Andrea d'Avella*** – *Santa Lucia Foundation Rome*
11:45 to 13:00	Lunch break
13:00 to 13:45	From the surface EMG to the extraction of muscle synergies: linearity of the transformation of synaptic input by motor | Lecture ***Dario Farina*** – *Universitätsmedizin Göttingen*
13:45 to 14:00	Break
14:00 to 15:30	Laboratory techniques for muscle synergies evaluation | Hands-on Experience (25 places) ***Alessandro Santuz, Antonis Ekizos*** – *BSMS*

Tuesday 21st October
Muscle Tendon Adaptation

Humboldt-Universität zu Berlin | Philippstr. 13 - House 11 | Lecture Hall

09:00 to 09:45	Eccentric muscle contraction, its efficiency and modeling | Lecture ***Walter Herzog*** – *University of Calgary*
09:45 to 10:00	Break
10:00 to 10:45	Biomechanics of muscle and tendon in vivo function across the lifespan and implications for movement efficiency and mobility | Lecture ***Vasilios Baltzopoulos*** – *Brunel University London*
10:45 to 11:00	Break
11:00 to 11:45	Sarcopenia: causes, morphological features and functional consequences | Lecture ***Marco Vincenzo Narici*** – *University of Nottingham*
11:45 to 13:00	Lunch break
13:00 to 13:45	Mechanisms of adaptation to muscle and tendon following exercise, disuse, disease and ageing | Lecture ***Michael Kjær*** – *University of Copenhagen*
13:45 to 14:00	Break
14:00 to 15:30	Ultra sound measurements of muscle activity | Hands-on Experience (25 places) ***Georgios Charcharis, Sebastian Bohm*** – *BSMS*

18:00 to 20:00 **Berlin Wall Tour**

S-Bahn Nordbahnhof | Meeting Point

Wednesday 22nd October
Spine

Humboldt-Universität zu Berlin | Philippstr. 13 - House 11 | Lecture Hall

09:00 to 09:45	Effect of upright sitting postures on spinal-pelvic curvature and trunk muscle activation in a pain-free population | Lecture ***Wim Dankaerts*** *– University of Leuven*
09:45 to 10:00	Break
10:00 to 10:45	Finite element analysis of the mechanical behaviour of the spine | Lecture ***Hendrik Schmidt*** *– Charité - Universitätsmedizin Berlin*
10:45 to 11:00	Break

Group 1

11:00 to 12:30	Epionics SPINE monitoring | Hands-on Experience (10 places) ***Esther Pries, Marcel Dreischarf*** *– BSMS*
12:30 to 13:30	Lunch Break
13:30 to 15:00	Practical applications of dance-movement therapy due daily activities | Hands-on Experience (10 places) ***Fyllis Papatzika*** *– BSMS*

Group 2

11:00 to 12:30	Practical applications of dance-movement therapy due daily activities | Hands-on Experience (10 places) ***Fyllis Papatzika*** *– BSMS*
12:30 to 13:30	Lunch Break
13:30 to 15:00	Epionics SPINE monitoring | Hands-on Experience (10 places) ***Esther Pries, Marcel Dreischarf*** *– BSMS*

Thursday 23rd October
Disease & Injuries

Charité - Universitätsmedizin Berlin - Julius Wolff Institute (JWI) | Föhrerstr. 15 | Lecture Hall

09:15 to 10:00	Movement disorders | Lecture ***Andrea Kühn*** *– Charité - Universitätsmedizin Berlin*
10:00 to 10:15	Break
10:15 to 11:00	Motion Analysis, Physical Therapy, and Management of Musculoskeletal Disorders | Lecture ***Ahmed Radwan*** *– Utica College*
11:00 to 13:00	Lunch break
13:00 to 13:45	In vivo measurement of joint loading | Lecture ***Georg Bergmann*** *– Julius Wolff Institute Berlin*

Friday 24th October
Therapy & Rehabilitation

Humboldt-Universität zu Berlin | Philippstr. 13 - House 11 | Lecture Hall

09:00 to 09:45	Movement performance is directed by biarticular muscles | Lecture ***Hans Savelberg*** – *Maastricht University*
09:45 to 10:00	Break
10:00 to 10:45	Prevention and treatment of major degenerative conditions associated with aging and physical inactivity | Lecture ***Markus Gruber*** – *University of Konstanz*
10:45 to 11:30	How cognitive and physical training can improve the memory function of healthy elderly and in the early stage of Alzheimer's disease | Lecture ***Emrah Düzel*** – *German Center for Neurodegenerative Diseases (DZNE)*
11:30 to 13:00	Lunch break
13:00 to 13:45	Exploring the value of dance movement psychotherapy for diverse populations: research evidence to date | Lecture ***Vasiliki Karkou*** – *Edge Hill University*
13:45 to 14:00	Break
14:00 to 14:45	Exercise and movement in the prevention and treatment of low back pain | Lecture ***Anne Mannion*** – *University of Zurich*

18:45 to 22:00 TV Tower dinner

Panoramastr. 1A | Meeting Point

BSMS - Berlin School of Movement Science

Student Biographies

Georgios Charcharis graduated from the department of Sport Science at the Kapodistrian University of Athens, Greece in 2011. He specialized in the Coaching of Swimming and Exercise, Wellness and Health. As from 2011 onwards, he is working on his PhD at the Department of Training and Movement Sciences at the Humboldt University of Berlin, Germany. The focus of his dissertation is on the Plasticity of morphological and mechanical properties of muscles and tendons: Effects of maturation and athletic training.

Marcel Dreischarf studied Mechanical Engineering and Human Medicine at the Technical University Berlin and the Charité-Universitätmedizin Berlin. After his studies, he continued his research in spine biomechanics in the laboratory of James Iatridis in New York City at the Mount Sinai Hospital. In 2012, Marcel started his PhD at the Julius Wolff Institute investigating the sagittal alignment of the spine and its effect on spinal loading, motion and the success of a surgical intervention in patients with degenerative spinal disorders.

Antonis Ekizos received his Bachelor in "Sport Science and Physical Education" at the Kapodistrian University in Athens. He continued his studies in Maastricht University where he obtained the MSc in Biology of human performance. With his master thesis he examined the mechanical properties of Achilles tendon. Following his master, he was actively involved in biomechanics research and became a PhD candidate at the Humboldt-Universität zu Berlin focusing on dynamic stability and metabolic cost of locomotion.

Azza Hamed studied physical therapy (Bachelor and Master) in Cairo University, Egypt. Her Master thesis was about "Effect of fatigue on support moments of lower extremities following anterior cruciate ligament reconstruction". Since April 2013, she is a DAAD PHD student in the Department of Training and Movement Sciences, Humboldt University in Berlin. Her PHD study focuses on "Effect of exercise interventions on stability of locomotion and fall prevention in elderly population".

Robert Marzilger graduated in sports engineering at the University of Magdeburg in April 2010. In his diploma thesis he investigated the feasibility to use modern video game systems in astronauts training. In spring and summer 2010 he continued this work at the Albert-Ludwigs-University in Freiburg. During his studies he was working as student assistant at the Institute of Sport Science at the University of Magdeburg. Beside his job at the Institute he is working as a judo trainer.

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Student Biographies

Fyllis Papatzika graduated in Physical Education and Sport Science (bachelor and master) at the Aristotle University of Thessaloniki, Greece in 2011. She specialized in Rhythmic Gymnastics. Furthermore, she made another degree at the Royal Academy of Dance in Classical Ballet Studies. Since 2012, she has been working as a research assistance focusing on ultrasonography in the Department of Training and Movement Science in the Institute of Sport Science, Humboldt University of Berlin. She continues with her PhD studies in the field of aging, degenreation process and frailty. She investigates the development of multicomponent exercise Intervention in frail old adults.

Esther Pries finished her Master studies in "Public Health" at the University of Bremen in 2010. After her studies she worked in two different companies in the health and safety management and was responsible for workplace health promotion. Since April 2013 Esther is conducting her PhD research in the Julius Wolff Institute with the focus on spinal movements in awkward postures and the relationship between physical activity and low back pain.

Alessandro Santuz studied Aerospace Engineering at the University of Padua and took his Master's Degree in 2009. From 2006 he worked as a Motorsport Race Engineer. Since December 2012, he is a PhD student in the department of Training and Movement Sciences at the Humboldt-Universität zu Berlin. His main research topics are Motor Coordination (Muscle Synergies theory), gait analysis and energy cost of Locomotion.

Arno Schroll studied mathematics and physics at the Free University of Berlin. In his thesis in the field coding theory he investigated the error correction of check digit systems. Since January 2012, he is working at the Department of Training- and Movement Sciences at the Humboldt-Universität zu Berlin.

Elisabeth Wenger began studying at the University of Vienna and received her Diploma degree in Psychology from the Free University of Berlin. In her dissertation at the department for Lifespan Psychology of the Max-Planck-Institute for Human Development, supervised by Prof. Ulman Lindenberger, Dr. Martin Lövdén, and Dr. Simone Kühn, she wanted to investigate the time course of grey matter alterations during motor skill acquisition. In her next studies, she will examine structural changes evoked by musical training and language learning.

Invited students

Biographies

Nicola Giovanelli lives in the North of Italy at the feet of the Dolomites. He took his Master's Degree in Sports Science in 2012 and since January 2013, he is a PhD student at the University of Udine, Italy. His main field of study is the energetics and mechanics of running with a focus on ultra-endurance running. He loves endurance sports and he is himself a trail runner.

Matthias Hösl initially studied Sport Science at the Technical University Munich. After receiving his diploma, he went to Amsterdam to study Clinical and Fundamental Human Movement Science. Since 3 years, he is employed in a gait lab in an orthopaedic paediatric hospital located in Aschau in the very south of Germany. He is working with neuro-orthopaedic patients with congenital and acquired disabilities and movement disorders. His main research is focused on muscle adaptation and walking in children with Cerebral Palsy.

Karolina Janikowska received her MD and MSc degrees from Medical University in Lublin. In 2011 she entered the specialty training in Orthopaedics and Traumatology in the Departments of Medical University of Lublin and started PhD studies in the Department of Mathematics and Biostatistics Medical University in Lublin. She was awarded with the title of Best Medical Student of Poland in the Students' Noble Contest and became a laureate of the "Paw to Harvard". Main focuses of her scientific interest are human biomechanics, functionality of neuromuscular system and application of the advanced statistical methods in clinical medicine.

Aris Karamperis studied automation engineering at T.E.I. of Chalkida, Greece, and graduated in 2007. In Jan 2009 he began his studies on the Department of Physical Education and Sport Science at the University of Thessaly. The last year he worked in the Department of Training and Movement Science at the Humboldt-Universität zu Berlin under the auspices of Erasmus program. His placement at the Department was at the area of muscle mechanics, muscle-tendon interaction and their applications on human locomotion.

Pablo Ortega graduated from physiotherapy from UPLA University, Valparaiso, Chile, in 2008. He worked in a gait analysis laboratory at Mayor University in Chile during 5 years, where his main interest was kinematics and translation of data into a clinical meaning. Currently he is starting the second year of the research master's in human movement sciences at Vrije University. His research interests are gait analysis, electromyography, variability and occupational health.

Invited students

Biographies

Maria Papadopoulou began her studies on the Department of Physical Education and Sport Science at the University of Thrace. Her specialization is directly related to the Sector of Exercise and Health, Sports Rehabilitation, Muscle and Skeleton Injuries. Recently, she completed her postgraduate studies in "Exercise and Quality of life" and her traineeship at Julius Wolff Institute in Berlin in the field of Biomechanics and Musculoskeletal Regeneration. Her focus research area is motor function and spine diseases.

Patricio Pincheira graduated from Physical Therapy from Saint Thomas University (Santiago, Chile) in 2009. During 4 years, he worked in a Motion Analysis Lab, at University of the Andes and in Mayor University, doing research and undergrad teaching. Since 2013, he is a Master student in biomechanics, at the Neuromuscular Research Center, University of Jyväskylä. Now, his main research topic is energy cost of locomotion, and his interests include electromyography, gait analysis, and ultrasonography.

Puneet Singh received Bachelor's degree in Mechanical and Automation engineering from IP University, Delhi, India, in 2010. Currently, he is pursuing a PhD in Bioengineering and working on "How the human brain solves arm redundancy". He is working with two professors' from Neuroscience and Robotics background at Indian Institute of Science, Bangalore. His research interests include movement control, robotics, brain–machine interfaces and biomechanics.

Petra Velísková graduated in Slovak University of Technology in Bratislava in 2013. The topic of her Master thesis was dealing with the human spine biomechanics, especially FE analysis under various structural and loading conditions. She decided to continue to develop the topic of spine biomechanics during the PhD studies, with a focus on regenerative strategies on intervertebral disc.

Yajie Zhang received her Bachelor in Human Movement Science in 2012, and she is currently studying Sports Biomechanics at the School of Kinesiology, Shanghai University of Sport, China. Now she is a visiting postgraduate student at the University College in Dublin, doing research on musculo-articular stiffness. Yajie's main research activities focused on national athletes, even Olympic silver medallist Mengtao Xu. Since 2013, she also investigates the effects of physical activity on public health.

Monday 13th October

BSMS Students Projects - Abstracts

Changes in mechanical and morphological properties of muscle and tendon due to eccentric training with different stimuli frequencies

Robert Marzilger

Regular training can lead to structural adaptation on muscle and tendon. That results in changes of mechanical parameters of the two structures, e.g. muscle force, contraction velocity and muscle power as well as tendon cross sectional area (CSA), tendon stiffness and E-Modulus. The literature shows that eccentric training is superior in stimulating muscle hypertrophy (Vikne et al. 2006), when compared with concentric training and supports longitudinal muscle adaptation (Butterfield et al., 2005). In addition eccentric contractions can generate up to 80% higher forces than isometric contraction (Katze, 1939), therefore they are particularly suitable to generate the necessary strain to induce tendon adaptation (Maliaras et al., 2013). However, the influence of movement velocity during eccentric training needs to be verified (Arampatzis et al. 2010). Hence the aim of the current Ph.D. thesis is to evaluate the influence of movement velocity (strain frequency) to the adaptational response of muscle (vastus lateralis) and tendon (patellar tendon). We hypothesize that high strain frequencies will lead to a higher longitudinal muscle adaptation, than low strain frequencies, whereas low strain frequencies will support radial muscle hypertrophy. In contrast, we expect that low strain frequencies will lead to a superior increase of tendon CSA and stiffness in comparison to high strain frequencies. To test these hypotheses we will recruit 45 voluntary male persons, 30 of them will participate in an eccentric training program and the other 15 will form the control group, not involved in a specific training program. The participants will be randomly assigned to four different training protocols (one for each leg of each participant) with the same loading volume but different movement velocities (45-300°/s). The training consists of 31 trainings session, with three training days per week. Before and after the training intervention we will measure the patellar tendon CSA and stiffness as well as the vastus lateralis CSA, fascicle length and the force length relationship.

Monday 13th October
BSMS Students Projects - Abstracts

Aging, Degeneration and Frailty: Development of a Multicomponent Exercise Intervention in frail old adults

Fyllis Papatzika

''Aging seems to be the only available way to live a long life.'' Although most persons remain autonomous and healthy until late life, after age 65 many experience chronic multimorbidity, cognitive impairment and declining physical functioning, leading to disability. Age-related functional decline is usually slow and includes a preclinical phase during which individuals at risk can be identified and referred for preventive interventions. Therefore, is it possible that physical exercise prevents or even reverses age-related frailty? Normal aging process, itself is a complex degenerative process that is affecting at the molecular, cellular and systemic level of the individuals, while frailty is a state characterized by a more progressive decline in the physiological and adaptive capacity. Major determinants of frailty results are physical inactivity, morbidity, institutionalization and increase the risk of muscle weakness, which is associated with loss of muscle strength, bone mass and functional independence that affective the dynamic stability control. The loss of balance is one of the leading causes of accidents, while fear of falling limits the mobility and ability to perform activities of daily life of the frail old adults. Epidemiology studies report that 30% of people over 65 and more than 40% over 80 fall at least once per year and 2/3 fall repeatedly in the investigated period. The loss of muscle mass and the decrease of muscle strength as well as impairments in cardiovascular capacity are important age-related deficits, which lead to a deterioration of activities of daily living and an increase the risk of falls in frail adults. It has been demonstrated that exercise interventions of mechanisms for dynamic stability increase the stability performance of elderly. There is evidence that training under unstable conditions increases the demand of muscles and might be an important stimulus for muscle hypertrophy in the aged. Furthermore ballet and dance based exercise because of the multifarious and carefully arranged movement of the head, trunk, upper and lower extremities, may motivate frail elderly and promote the development of factors that improve balance ability, muscle strength and cardiovascular capability in this population. Thus, we aimed to investigate the effects of a multicomponent exercise intervention, which includes training of dynamic stability control under unstable conditions as well as ballet and danced based exercise, on muscle strength, balance ability and cardiovascular capacity.

Monday 13th October

BSMS Students Projects - Abstracts

Effect of exercise interventions on stability of locomotion and fall prevention in elderly population

Azza Hamed Ali Fahmy

Approximately one third of adults over 65 years of age fall at least once a year. Most of these falls occur after a loss of stability in a forward direction such as tripping while walking. With ageing, falls risk shifts from being spread out over many diverse activities, situations, and environments to being focused on basic movements required for routine daily activities. Adequate postural control requires keeping the center of gravity over the base of support during both static and dynamic situations. The body must be able to respond to translations of the center of gravity voluntarily and involuntarily or unexpectedly imposed. Thus, balance requires proper neuromechanical properties of the musculoskeletal system.
The purpose of this study is to examine the effects of exercising the mechanisms of dynamic stability under unstable conditions on stability performance of old people and compare the effects to a traditional muscle strength exercises. Sixty healthy non-athletic active old adults (65 to 78 years old) will be included in the study. They will be divided into three groups. Group one and two will practice stability training and muscle strength exercises respectively. The third group will be inactive. A pre-test and post-test measurement will be done.

REFRENCES

Arampatzis, A., Peper, A., Bierbaum, S., 2011. Exercise of mechanisms for dynamic stability control increases stability performance in the elderly. J. Biomech.44, 52-58.

Bierbaum,S.,Peper, A., Karamanidis , K., Arampatzis, A., 2010. Adaptational responses in dynamic stability during disturbed walking in the elderly. J. Biomech. 43, 2362–2368.

Monday 13th October

BSMS Students Projects - Abstracts

Modular organisation of muscle activation and foot strike pattern assessment during human locomotion

Alessandro Santuz

Since the end of the 1960s (Bernshteĭn, 1967), it has been accepted that the nervous system can simplify the production of movements by creating specific muscle activation patterns, called Muscle Synergies (MS) (Bizzi et al., 2008). In humans, both walking and running are likely to be controlled by shared synergies (Cappellini et al., 2006). This presentation focuses on the repeatability and accuracy evaluation of a method for assessing muscle synergies during locomotion. We will also talk about the foot strike patterns (FSP), a parameter commonly associated to injury risk (Daoud et al., 2012) and performance (Hasegawa et al., 2007), but rarely connected to MS. To distinguish and quantify FSPs (rearfoot, midfoot and forefoot strike), we created an automatic and observer-independent method. Then we validated it by comparison with the widely used, but time-consuming and observer-dependent, visual observation (VO) technique.

To create our own FSP evaluation method, we recruited 85 men and 60 women. The participants ran, shod, for 120 s at three different speeds: preferred, faster, slower. Afterwards they ran, barefoot, for 120 s at the preferred speed. The ground pressure distribution, together with a high-speed (550 Hz) video of the sagittal plane, were recorded. FSP data were obtained in two ways: by VO analysis and through a numerical approach implemented in "R 3.1.1". For assessing the MS, the activity of 24 ipsilateral lower limbs, trunk and upper limbs muscles were recorded in 10 men and 10 women. The participants ran and walked on a treadmill, self-selecting their comfortable speeds. We recorded 50 gait cycles per each condition. To evaluate the intraday and interday repeatability we repeated the measurement within the same day and after a minimum of two days. MS data were extracted through a custom "R 3.1.1" algorithm using the non-negative matrix factorization approach (Lee & Seung, 2001).

In this presentation, I'll present the results of the two projects, together with a theoretical background of the used methods.

Monday 13th October

BSMS Students Projects - Abstracts

Development of biomechanical markers for estimation of neuromuscular trunk control

Arno Schroll

The various number of joints in the body and their possibilities of movement guarantee redundancy of the system in order to achieve a specific task. Hence, just measuring the variability of joint angles in a certain movement, doesn't answer the question of movement quality or repeatability. This degrees of freedom problem was early addressed by Bernstein (1967). Furthermore, it is still an interesting question how the central nervous system is planning and realizing these many degrees of freedoms. Hence, there is a need for approaches quantifying neuromuscular control. In the last decades more and more mathematical methods entered the interdisciplinary field of biomechanics. The application of these methods on neuromuscular trunk control appears natural, especially when thinking of the huge amount of back pain patients in our society. Even though back pain may have a wide range of influencing factors it is well established, that trunk instability (Panjabi 2003) as well as the ability to respond to perturbations (Radebold et al 2000, Hodges et al 2009) seem to play an important role. We planned to evaluate empirical data from low back pain patients using the method of effective trunk stiffness as well as Lyapunov exponents and the uncontrolled manifold theory. Furthermore it is thought to compare different evaluation procedures of these methods. For calculating the effective trunk stiffness (Cholewicki et al 2000), subjects are fixed at the hip in a semi-seated position and the upper part of the body is hold via an rope by an electromagnet. Switching of the magnet with random delay results in an unexpected perturbation of the trunk. Effective trunk stiffness, as one parameter from a differential equation is estimated as optimal fit to the kinematic data. Lyapunov exponents, as parameter for local dynamic stability, are calculated for a dynamic lifting task and for a static situation where the subjects ability to follow a force curve is evaluated by nonlinear analysis. The concept of uncontrolled manifold theory (Scholz & Schöner 1999) tries to figure out, which kind of measured variability is contributing to a specific task/movement. It is planned to evaluate the center of mass control while applying surface perturbations. Calculating these parameters for different groups (with and without pain) and times (before and after training interventions) with different evaluation procedures can provide a better understanding and estimation of neuromuscular trunk control.

Monday 13th October

BSMS Students Projects - Abstracts

Studying the dynamic stability of locomotion using Lyapunov exponents: a reliability study

Antonis Ekizos

Dynamic stability refers to the ability of a system to damp the oscillations, by restoring moments and gradually return to its original state, when disturbed from an original state of steady motion in an upright position, or the ability of the human body to not fall in spite being perturbed. It has been established that using the theory of the non-linear dynamical systems, such as finite-time Lyapunov exponents, the local stability (which quantifies how the system's states respond to very small perturbations continuously in real time) during walking can be investigated.

Reliability data on the measurement's technique to date are inconclusive and data acquisition strategies in the studies using Lyapunov exponent analysis in locomotion have been inconsistent in the quantity and choice of body landmarks. It came to become evident in previous studies that plenty of parameters are directly affecting the resulting Lyapunov exponents' value, including marker placement, overall speed of locomotion, state-space reconstruction technique and overall time of the trial.

In the current project 11 markers are simultaneously used, examining the optimal placement to achieve the highest reliability and the differentiation resulting between conditions. The subjects performed trials on 6 different days and under 7 different conditions: shod walking and running in preferred and a predefined speed, barefoot walking and running, as well as uphill walking. Moreover, cameras worked synchronously with a force plate allowing us to gain information on the step patterns. We aim to gauge the consistency of the measurement and propose the finest combination of the examined markers, while ultimately rendering the measurement simple and easily applicable to clinical populations.

Monday 13th October

BSMS Students Projects - Abstracts

The local and global shape of the lumbar spine depends on age and gender and influences the lumbar range of motion – An in vivo study on 323 volunteers

Marcel Dreischarf

The individual shape of the lumbar spine is a predisposed factor for lumbar degenerative diseases and influences the success of a clinical intervention [1-3]. An understanding of the interplay between age and gender on the one hand and local and global lumbar shape and range of motion (RoM) on the other hand is essential for an optimised clinical intervention. The aim of this study was, to determine the gender specific influence of age on the lumbar lordosis in standing and the lumbar range of motion and to find out, whether the individual shape of the lumbar lordosis influences the local and global range of motion. The device "EpionicsSpine" allows a non-invasive measurement of the local and global shape of the back as well as the RoMs in the sagittal plane [4]. The system consists of two flexible sensor strips, which were placed in a standardised manner onto the back of 323 asymptomatic volunteers (Age: 20-75; ♀/♂=214/184). A standardised motion choreography in the sagittal plane was performed. The impact of age on the lumbar lordosis in standing and the RoM was gender specifically evaluated for each segment and the whole lordosis (ANOVA, $\alpha=0.01$). Furthermore, the direct relationship between the lumbar lordosis in standing the resultant RoM was investigated. With increasing age, the lumbar lordosis in standing is significantly reduced. The loss of lordosis is more pronounced in women than in men. Furthermore, the lumbar lordosis is cranially more reduced than in its caudal part. With increasing age, the lumbar RoM is reduced. Independent from age and gender, volunteers with a pronounced lumbar lordosis in standing showed on average a bigger RoM. In agreement with the majority of the literature, the lumbar lordosis in standing as well as the range of motion is gender specifically reduced with increasing age. It is however the first time shown that the loss of lordosis increases from caudal to cranial. Furthermore, it was shown that independently from age the amount of lordosis in standing and its range of motion are in relationship.

Literature:

[1] Barrey et al., EurSpineJ, 2007
[2] Strube et al., JSDT 2012
[3] Roussouly et al., Spine 2005
[4] Taylor et al., Med Eng Phys 2010

Monday 13th October

BSMS Students Projects - Abstracts

A Novel Method to Analyse Posture and Motion of the back – the sedentary workplace as an example

Esther Pries

As employees spent more and more time sitting, ergonomics at the workplace has become an essential topic in the prevention of low back pain which can be caused by working in static or awkward postures. Hence, analyzing spinal posture and motion of employees is necessary for the introduction of preventative measures and their evaluation. However, only a few tools allow the unhampered long term assessment of the spine in the workplace.
The novel measurement tool Epionics SPINE determines spinal motion, lumbar lordosis and orientation of the pelvis under nearly unrestricted circumstances. In this study we demonstrate, after an extension of the system, how this measurement tool can be used in the analysis and evaluation of workplaces exemplarily shown at the sedentary workplace. Ten male subjects were monitored for the effect of dynamic sitting whilst seated for 2 hours on a static and a dynamic office chair and an exercise ball.
The results show that sitting on different chairs does not significantly affect the lumbar lordosis but the orientation of the pelvis. No significant differences in the number of movements could be detected between the different sitting furniture in the long run. The Epionics SPINE system successfully analyzed employees in their workplaces in long term measurements without any restrictions.
Active seating furniture, as recommended by ergonomists, did in general not increase the number of spinal movements nor broaden the sitting spectrum in the long run. The results moreover indicate that each employee has to be individually analyzed. Although the system Epionics SPINE is in general applicable, refinements were necessary for the use in the workplace, demonstrating its potential in the field of ergonomics.

Tuesday 14th October

Movement Science - Abstracts

Plasticity of the musculoskeletal system after long- and short- term mechanical loading

Adamantios Arampatzis
Humboldt-Universität zu Berlin, Department of Training and Movement Sciences

The compliance of tendon has a profound influence on the force-length-velocity relationship of the muscle and consequently on its force generating potential. Although numerous in vitro studies have demonstrated the acute effects of static and cycling mechanical loading on tendon compliance, there is little information for in vivo conditions in humans. Therefore, in a series of experiments we examined the strain-force relationship of the gastrocnemius medialis and vastus lateralis tendon and aponeurosis of young and old adults before and after three fatiguing protocols: a) a sustained submaximal isometric contraction, b) submaximal concentric isokinetic contractions until task failure and c) maximal isokinetic contractions until task failure. The results show that neither static nor cyclic long-lasting mechanical loading that produces strains of 2-6% has an acute effect on the in vivo strain-force relation of the tendon and aponeurosis at the lower extremities. Muscle is unable to sustain the force for a sufficient duration during fatiguing contractions to induce an alteration in tendon properties.

On the other hand, long term mechanical loading stimulates cells for remodelling affecting the tendon mechanical properties. Therefore, in an additional series of experiments we investigated the effect of strain magnitude, strain frequency, strain rate and strain duration on the Achilles tendon adaptation. The results demonstrate that a high strain magnitude beyond habitual loading must be applied to the tendon to induce adaptive responses. A certain tendon strain duration of about 3 s seems to be necessary for an effective transmission of the external tendon strain on the cellular level and, therefore, plyometric exercises like jumping may not be an optimal training stimulus for tendon adaptation. Furthermore, the advantageous effect of longer tendon strain duration (i.e., >3 s) seems to be limited and repetitive application of strain provided a more effective stimulus for tendon adaptation.

Tuesday 14th October

Movement Science - Abstracts

Basic consideration of muscle-tendon interaction for sport performance

Paavo V. Komi, Masaki Ishikawa and Caroline Nicol

It has been a long experience that when two locomotor activities such as vertical jumps are performed successively, the second one is consistently higher than the first one. This potentiation effect due to countermovement action was later called as “wind-up” movement (Asmussen and Sorensen 1971) until Norman and Komi (1979) named it as stretch-shortening cycle (SSC). SSC is the natural way the skeletal muscles function during locomotion, and it has been mostly demonstrated in walking, running, jumping and throwing. The fundamental characteristics of SSC have been examined quite extensively with isolated muscle models (e.g. Cavagna et al, 1965 and 1968) and also with human muscles (e.g. Bosco et al 1981; Komi, 1983). By definition, SSC refers to the lengthening (stretch) of the active muscle followed immediately by shortening in the push-off phase of the leg extensor muscles, for example. The basis for the use of SSC instead of pure concentric muscle actions is simple: the neuromuscular system makes an effort to perform the movement as efficiently as possible. In SSC the active stretching phase (eccentric phase, also called negative work) allows storage of elastic energy which can be utilized partly in the subsequent shortening (concentric phase; positive work). The centrally controlled preactivation combined with the active eccentric phase prepare the muscle to receive the “impact” and store this elastic energy. The passive (non-active) muscle can only store a minimum amount of elastic energy. One very important point in the discussion of SSC potentiation is the interaction between fascicles and tendon structures. The definition of SSC as given above, relates to the entire muscle – tendon unit (MTU), and consequently the mechanisms may be too simplified. In fact the fascicles may not necessarily, and in some instances not at all, follow the stretch - shortening pattern of MTU. Depending on the imposed impact load the fascicles may show lengthening, which can be very short- lived and consequently the possible reflex induced force potentiation may not be visible with standard type Ultrasound machines of lower scanning frequency (Ishikawa and Komi, 2008). The present report will emphasize how this fascicle – tendon interaction will be influenced by the type of muscles, intensity of effort, aging process, fatigue and training. It is believed that considerable amount of information is already available to demonstrate how this interaction applies to various sport activities.

Institutes: Paavo Komi, University of Jyväskylä, Finland
Masaki Ishikawa, Osaka University of Sport and Health Sciences, Japan
Caroline Nicol, Univmed, Marseille, France

Wednesday 15th October

Motor Control & Learning - Abstracts

Learning to move: early development of locomotion and manual control

Julius Verrel
Max Planck Institute of Human Development, Berlin

How infants learn to interact with their environment in an effective and efficient way is a major question both for movement science and developmental psychology. In my talk, I will discuss research on early motor development using different scientific approaches, from neurophysiology to ethology, and at different levels of behavioral complexity. The emphasis will be on two action domains which undergo huge developmental changes during the first two years of life, manual control and locomotion.

Recommended reading:

- Adolph, K. E., & Robinson, S. R. (2013). The road to walking: What learning to walk tells us about development. Oxford handbook of developmental psychology, 1, 403-443.
- Corbetta, D. (2009). Brain, body, and mind: Lessons from infant motor development. Toward a Unified Theory of Development: Connectionism and Dynamic Systems Theory Re-Considered, 51-66.
- Keen, R. (2011). The development of problem solving in young children: A critical cognitive skill. Annual review of psychology, 62, 1-21.
- Von Hofsten, C. (2004). An action perspective on motor development. Trends in cognitive sciences, 8(6), 266-272.

Wednesday 15th October

Motor Control & Learning - Abstracts

Neuromuscular behavior in prepubertal children

Dimitrios Patikas, Ph.D.
Aristotle University of Thessaloniki

Age is one of the most fundamental factors that influence human performance. More particularly, developmental age shows the most rapid structural and functional changes along the lifespan. These changes are accompanied by adaptations on neuromuscular level. This lecture will focus on some important neuromuscular parameters that determine the performance of prepubertal children. More specifically, the presentation will cover the differences between children and adults in two different conditions: during jumping and during fatigue. The former condition covers the aspect of neuromuscular control and coordination in the presence of structural alterations due to age, such as muscle mass and stiffness. The latter condition introduces the aspect of neural adaptations and the ability to fully recruit the motor units in the presence of metabolic (biochemical) dissimilarities between children and adults, since children rely less on the anaerobic metabolism. According to the literature, children adopt biomechanical strategies that result in an "absorbing" jump type which is well described by neuromuscular indicators. On the other hand, children show increased resistance to fatigue, not only in terms of force output but also in terms of electromyographic activity. However, this occurs only when the intensity of the contraction is high and the anaerobic metabolism is of greater importance. Regarding recovery, children recover faster after fatigue protocols of any kind, although the contribution of neural afferent pathways is still not verified. It is concluded that the neuromuscular system responds to the physiological and biochemical differences that appear during development. Furthermore, indications that training may have a positive effect on performance by compensating neuromuscular deficits are discussed.

Wednesday 15th October

Motor Control & Learning - Abstracts

How visual and proprioceptive information is transformed into meaningful motor output for controlling posture

Vassilia Hatzitaki PhD, Associate Professor
Motor Control and Learning Laboratory
Aristotle University of Thessaloniki

The ability to synthesize and reweight multiple sensory inputs is of paramount importance for ensuring appropriate postural corrections when the accuracy of a sensory modality is compromised in a dynamic environment. In this talk, I will present a series of studies designed to investigate the impact of ageing on the CNS's capacity to reweight multiple sensory information while standing. In the first study, young and old adults stood in a virtual environment where visual reweighing was evoked by visual surround oscillations (0.3Hz, 20cm) while introducing collision avoidance to probe the visual modality. The resulting postural behaviour revealed that visual anticipation of collision avoidance negatively affected the intra-modal visual reweighting in both age groups[1]. In the second study, proprioceptive reweighting was evoked by bilateral Achilles tendon vibration (80 Hz, 3 mm) while introducing collision avoidance to probe the visual modality. Visual anticipation of collision avoidance reduced the relative postural sway induced by Achilles tendon vibration [2]. In the third experiment, multisensory reweighting was evoked by perturbing vision and proprioception together while introducing 2 s trains of Galvanic Vestibular Stimulation (GVS) to probe the vestibular modality. Intermittent GVS reduced the destabilizing influence of the multisensory perturbations in young but not in older adults [3]. Overall, the results of these experiments indicate that sensory reweighting can be modulated by top-down perceptual processes such as visual anticipation and intermittent vestibular stimulation. Older adults delay exploiting visual anticipation to down-weight the inaccurate proprioception possibly due to their long-term overreliance on vision.

Acknowledgement
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1. Eikema, D.J., et al.,. Age (Dordr), 2012. 34(6): p. 1381-92
2. Eikema, D.J., et al.,. Neuroscience, 2013. 234: p. 22-30
3. Eikema, D.J., et al., Neurosci Lett, 2014. 561: p. 112-7

Wednesday 15th October

Motor Control & Learning - Abstracts

Dopamine and motor learning - a role for reward and motivation?

Susan Leemburg
Clinical Neurorehabilitation, Department of Neurology, University Hospital Zurich, Switzerland

Reward signals have been shown to play an important role in learning processes. We have previously shown that the dopamine in the primary motor cortex (M1) is essential for learning new motor skills, but not for the execution of an already learned skill. Moreover, inhibition of dopamine signalling prevents long term potentiation (LTP) in M1, preventing neuronal plasticity needed for memory formation.
Interestingly, activation of both D1 and D2 dopamine receptors is needed for M1 LTP and inhibition of either receptor subtype has a detrimental effect on motor skill acquisition. This synergistic effect, as well as the persistence of LTP and motor learning during the PKA pathway inhibition, indicates that the dopamine receptors in M1 use different signalling pathways and receptor clustering than in other brain regions (i.e. the striatum). Indeed, inhibition of the phospholipase C pathway leading to a loss of LTP as well as a lack of motor learning indicates that dopamine signalling in M1 is mediated oligomers containing D1 and D2 receptors, rather than individual receptors.
The main dopaminergic projection to M1 originates in the ventral tegmental area (VTA), giving an potential intersection of the networks that are involved in both reward processing and motor systems. It is still unclear if dopamine release in M1 during acquisition of a motor skill is caused by reward signals, or by motor learning itself. Preliminary results from our group indicate that a skilled reaching task preferentially activates the VTA in the trained hemisphere. Rewarding stimuli that don't require forelimb movements show no such asymmetry. This differential activation of VTA neurons by reward-and motor skill acquisition may point to the existence of a separate, learning specific VTA-M1 pathway.

Thursday 16th October

Brain Plasticity - Abstracts

Cognitive Contributions to Motor Skill Learning

Rachael D. Seidler, PhD, Professor of Kinesiology and Psychology
University of Michigan

During the initial stages of skill learning, motor performance is cognitively demanding and uncoordinated. My recent work has focused on understanding the neurocognitive mechanisms that allow learners to process motor errors and refine subsequent actions, eventually resulting in automatic, skilled performance. We have demonstrated an important role for spatial working memory, linked to right prefrontal and parietal cortices, in the early stages of both sequential learning and sensorimotor adaptation. We propose that spatial working memory is relied upon for processing motor error information to update motor control for future actions, and for chunking together individual action elements. I will discuss these findings, as well as our recent work examining interactions between emotion, cognition, and motor learning, and efforts to modulate cognitive contributions to learning with noninvasive brain stimulation.

Thursday 16th October

Brain Plasticity - Abstracts

Aberrant motor behaviours and motor control - a clinical perspective

Christos Ganos
Clinical Movement Disorders Group, Sobell Department of Motor Neuroscience and Movement Disorders, UCL Institute of Neurology

Goal-directed motor behaviour involves the appropriate selection and execution of intended actions. An important, but often neglected, aspect of these processes is the cancellation or inhibition of competing motor programs. Volition, i.e. choosing one's own actions based on internal processes or "free will", may strongly depend on these inhibitory processes, since producing an intentional action necessarily involves inhibiting other voluntary and involuntary movements. This "intentional inhibition" emerges via a clear developmental trajectory both in anatomy and function. For example, the seemingly involuntary, uncoordinated, hyperkinetic nature of infants transforms to well-orchestrated and context-appropriated motor output in adolescents and adults, subserving the achievement of internally set goals.

However, in neurodevelopmental and other disorders, not all elements of motor control undergo this developmental process. Many such disorders, such as for example Gilles de la Tourette syndrome, involve seemingly superfluous extra movements, behavioural deficits and aberrant motor control. The characteristic motor and phonic tics share many kinematic and most neurophysiological properties with normal movements and complex tics may resemble voluntary actions.

In my talk I will briefly outline movement disorders that resemble and/or interfere with the execution of voluntary actions. I will then focus on the main clinical features of Gilles de la Tourette syndrome and present an overview of the prevailing pathophysiological model of tic emergence and tic control. I will finally present how knowledge gained from the study of such a disorder may provide novel insights into physiological brain organisation and function.

Thursday 16th October

Brain Plasticity - Abstracts

Reorganisation and Plasticity of Adult Human Brain During Motor Skill Learning

Julien Doyon, Ph.D.
Scientific Director
Functional Neuroimaging Unit
University of Montreal
Director
Quebec Bio-Imaging Network

For the last 20 years, research in my laboratory has focused on investigating the behavioral, neuronal and neurophysiological determinants of motor skill learning and consolidation (Albouy et al., 2013; Doyon, 2008; Doyon & Ungerleider, 2002; Doyon & Benali, 2005; Doyon et al., 2003, 2009; 2011, Fogel et al., 2012; King et al., 2013 for reviews). During this presentation, I will first review some of our work focusing on motor sequence learning (MSL), which refers to the process by which movement elements come to be performed effortlessly as a unitary sequence through multiple sessions of practice. I will summarize the results of studies, which demonstrate that interactions between the cortico-striatal and cortico-cerebellar systems are critical for establishing the motor routines used to acquire new sequence of movements, but that the cortico-striatal system plays a major role in automatizing and maintaining this type of motor skill behaviour over time. I will then describe a recent study in which we are showing that the spinal cord is also contributing to the learning process of a motor sequence. Finally, I will report results of studies that have more recently shown that consolidation of the memory trace acquired during practice depends upon greater functional integration of the cortico-striatal system in link with N-REM sleep spindle activity measured during the night following the initial training session.

Friday 17th October

Gait Analysis - Abstracts

Gait stability as a predictor of fall risk

Jaap H. van Dieën; Sjoerd M. Bruijn; Mirjam Pijnappels
VU University Amsterdam

Falls have a high prevalence among the growing group of adults over 65 years. While fall-prevention programs have shown to have a reasonable efficacy, large-scale implementation of such programs appears less successful. Selectively targeting individuals at risk may be one way to increase (cost-) effectiveness, but current models have only limited predictive value. In this presentation, we will discuss to what extent measures of gait stability can predict fall risk.

Many gait characteristics have been used as indicators of gait stability and several of these were shown to differ between individuals with and without a history of falls. However, studies were retrospective and most parameters were reported only once, hence predictive value cannot be ascertained and type I errors may be common. To circumvent these problems we have proposed a multi-step validation procedure to assess gait characteristics as indicators of stability. In this presentation, we will apply this approach to variability and local dynamic stability of gait. We will first focus on gait on a treadmill. We will discuss clinimetric aspects and the predictive value of these characteristics as assessed in model studies. Furthermore, we will show that age, experimentally induced balance impairments and externally imposed balance challenges affect these gait characteristics and that these characteristics are indeed related to fall risk, albeit assessed retrospectively.

Next, we will focus on the association of these gait characteristics as measured from daily-life, unsupervised gait with fall incidence studied prospectively. We will show that information contained in daily-life gait only partially overlaps with that obtained from treadmill gait and that daily-life gait data can substantially enhance fall risk predictions compared to currently available methods.

Friday 17th October

Gait Analysis - Abstracts

Energetics and mechanics of different forms of locomotion

Alberto E. Minetti
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Human locomotion has been for ages confined to walking and running, our ancestral gaits that developed optimally to assure fast, economical and safe movement on the surface of the planet. Strive for exploration and for challenges brought men to face other environments, as water/ice and air. But, Unaided swimming occurs at a very low efficiency, witnessing a poor body design for that media and the need for passive tools, as fins, to increase it. In recent years human powered airplanes were flown at a quite low aerobic power, due to sophisticated engineering and material science. Even more recently, transport technology (hybrid/electric vehicles) beat biology (walkers and runners) in the search for CO2 emission minimization.
All forms of locomotion can be studied both from the mechanical and the energetic points of view, most often with the former studied to explain the latter. While energetics is easier to assess by using commercial metabographs, heart rate monitors and lactate analyzers, locomotion mechanics is a complicated matter. Concepts as body centre of mass, force, friction, speed, moments, potential/kinetic energy, external/internal work, energy storage/release, power and its possible amplification/dissipation need to be carefully handled. Often closed solutions to problems are out of reach and approximations are obtained. By combining mechanics and energetics, locomotion efficiency (and its components: transmission, propulsive, muscular) can be estimated.
In the lesson I will deal with historic locomotion (on water/ice/snow), with modern locomotion-related sports (cycling, skyscraper runup races, fell running) and future challenges (optimal bipedal gaits on hypogravity planets). I will show that by dissecting the mechanical work in its prime components, each form of locomotion can be easily understood. Also, a comprehensive comparison of energetics across all those forms of locomotion will provide a framework to better appreciate the concept of economy.

Friday 17th October

Gait Analysis - Abstracts

Muscle physiology and modelling

Tobias Siebert
Department of Sport and Motion Science, University of Stuttgart, Germany

In real life about 600 skeletal muscles enable complex movement tasks like locomotion or laughing. Their contraction dynamics depend on the internal muscle structure as well as on the interaction of the 3D muscle-tendon complex with its surrounding tissues or external forces. Thus, muscle force depends on e.g. muscle length, velocity and activation but also on the contraction history (force depression after muscle shortening and force enhancement after muscle lengthening) and muscle compression.
In this lecture development and validation of muscle models with increasing complexity will be presented, beginning with typical and enhanced 1D Hill-type muscle models reproducing force enhancement and force depression (Rode et al. 2009), further to 2D muscle models simulating the impact of muscle compression (Siebert et al. 2014a,b), up to 3D muscle models reproducing muscle deformation and force generation during dynamic contractions (Böl et al. 2013). Basic requirement for the presented model generation is a close linkage between experiment and simulation.

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Monday 20th October

CNS & Movement Control - Abstracts

Cortical Plasticity and Brain Computer Interfaces

Natalie Mrachacz-Kersting
Aalborg University

Brain Computer Interfaces (BCIs) for restoration of lost motor function are designed to induce neuroplasticity of areas damaged by a central nervous system lesion. Over the past 5 years my collaborators and I have concentrated efforts into the design of a robust algorithm that can detect user intend and transfer this for device control that reproduces the intended movement. By continuous pairing of user intend and artificial reproduction of that movement our BCI follows the principle of Hebbian association that underlies motor learning leading to plasticity and associated functional changes. We have shown this in healthy and impaired populations. Our most recent experiments relate to understand how the firing of neuronal assemblies within the human motor cortex and surrounding areas is altered during the learning of a new motor task - a characteristic imperative for a robust BCI. As complex motor tasks are learned, the area that is activated during task performance expands. For BCI performance this has significant implications since the algorithm used to extract user intend is based on a training set recorded at the start of a BCI session. If the BCI user is subjected to plasticity induction then the algorithm performance may be seriously affected. The most recent results indicate that significant improvements in task performance are accompanied by a significantly greater variability of the brain signals 2-1 s prior to movement onset. The implications for the BCI for online detection of movement where algorithm identifies when the EEG activity attains a specific threshold level is significant. Data show that the performance of the algorithm declines as plasticity is induced opening up a new avenue for future BCI development.

Monday 20th October

CNS & Movement Control - Abstracts

Arm control by muscle synergy combinations: experimental evidence and computational models

Andrea d'Avella
Fondazione Santa Lucia, Rome, Italy

A fundamental challenge in neuroscience is understanding how the central nervous system (CNS) controls motor skills by coordinating a large number of degrees-of-freedom. A long-standing hypothesis is that the CNS relies on a modular organization to simplify motor control and skill learning. In the last 15 years, evidence for modularity has come from the observation of spatiotemporal regularities in the muscle patterns across species, behaviors, and tasks. For example, the muscle patterns for human reaching and catching are captured by linear combinations of a small number of muscle synergies, coordinated activations of groups of muscles. These results suggest that muscle synergies are control modules that exploits regularities in the musculoskeletal system and in the motor task. Indeed, a computational analysis shows that it is possible to control a kinematic chain by combining a small set of torque profiles embedding features of both the desired task and the system dynamics. However, whether muscle synergies are a parsimonious description of the motor commands rather than basic elements organized by the CNS is still debated. A novel experimental approach in which human subjects use myoelectric control to move a mass in a virtual environment has recently provided direct evidence for modularity. By altering the mapping between recorded muscle activity and simulated force applied on the mass, as in a complex surgical rearrangement of the tendons, it has been possible to test the prediction that in a truly modular controller it is harder to adapt to perturbations that are incompatible with the modules. These results and simulations with a musculoskeletal model of the arm indicate that muscle synergies are basic elements of a modular controller and that learning synergy structure is slower than recombining existing synergies.

Tuesday 21st October

Muscle Tendon Adaptation - Abstracts

Eccentric Muscle Contraction: its Efficiency and Modeling

Walter Herzog
Faculty of Kinesiology, University of Calgary, Canada

Eccentric contractions have puzzled scientists since the introduction of the cross-bridge model of contraction by Andrew Huxley in 1957. Huxley himself admitted that eccentric contractions were not well predicted by his theory, that they would hold surprises in the future, and that special features might be identified that allow for eccentric contractions to take place in a stable manner. Twelve years ago, we identified that passive structural elements contributed to eccentric contractions, and with sophisticated experiments on the single myofibril and single sarcomere level demonstrated that the structural protein titin is one of the primary contributors to eccentric force. In the past four years, we showed that titin contributes much more force in active compared to passive eccentric contractions. We demonstrated that it does this by binding calcium to the glutamate rich region of the so-called PEVK segment and to specific sites on the repeat immunoglobulin domains of titin, thereby increasing the stability of these segments and making them stiffer, and thus stronger, upon active (but not passive) stretching. By labeling titin with specific fluorescently tagged antibodies, and by deleting crucial regions of titin in genetically modified mice, we demonstrated that titin also binds to actin in an activation and force-dependent manner, thereby decreasing its free spring length, increasing its associated spring stiffness, and providing increased force in active compared to passive eccentric contractions. In summary, we identified through research on eccentric contractions that force regulation in muscle is not determined solely by the contractile proteins actin and myosin, but also by the structural protein titin. Andrew Huxley thus was right when predicting that new features might emerge that can explain eccentric contractions.

Tuesday 21st October

Muscle Tendon Adaptation - Abstracts

Biomechanics of muscle and tendon in vivo function across the lifespan and implications for movement efficiency and mobility

Vasilios Baltzopoulos
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Centre for Sports Medicine and Human Performance
Brunel University London

During growth and development in children and as we age later in life there are changes in the dimensions and properties of the musculoskeletal system that alter the structural and mechanical characteristics of muscles and tendons. These changes can affect their functional characteristics with implications for maximal muscular force production and performance across a range of activities. There is some growing evidence that the mechanical properties of the muscle-tendon complex, in particular its stiffness, adapts to changes in growth- or training-related loading due to the plasticity of the musculoskeletal system across the life-span. Our recent work on the effects of growth and development on muscle-tendon structural and functional properties in children (8-9 years old) and young adults showed that tendon stiffness and Young's modulus were up to 99% different in children than in adults. Fascicle length was longer in adults although pennation angle was not significantly different. These changes have been found to have a significant effect on rapid muscle force production which is an important factor contributing to movement success or failure and the prevention of injuries or falls in certain conditions. As a consequence, they are important for both daily tasks and sporting performance across different populations. This presentation aims to give an overview of our recent work and current knowledge of developmental changes in both the physiological and mechanical factors that influence muscular force production in children and the changes with aging later in life. In addition, implications for complex skill acquisition, sports performance, injury prevention and activities of daily living will be discussed.

Tuesday 21st October

Muscle Tendon Adaptation - Abstracts

Sarcopenia: causes, morphological features and functional consequences

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Sarcopenia, the age-related loss of muscle mass, has a prevalence of 20% in individuals aged 60- to 70-years and approaches 50% in those over 75 years of age (1). Between the 2nd and 7th decades of life, about 20% of muscle mass is lost during the normal ageing process. Several factors are known to contribute to sarcopenia but amongst these, neuroendocrine changes are commonly regarded as primary drivers of this process (2). These changes are responsible for degeneration of alpha-motoneurons and of the neuromuscular junction (NMJ) and for muscle fibre denervation, also fuelled by mitochondrial dysfunction and oxidative damage at the NMJ, leading to a loss of motor units and muscle weakness. In fact, one of the crucial systems severely affected in aging is the neuromuscular system as the loss of effective connection between muscle and nerve becomes compromised. This, leads to a pathological non-communication between the two tissues. There is now growing evidence that cross-talk between muscle and nerve via anterograde/retrograde axonal transport influences motoneuron survival, NMJ integrity, motor unit number and muscle fibre phenotypic, metabolic and functional characteristics (3). Several neurotrophic and myotrophic factors have indeed been found to orchestrate these changes and many of these, such as brain-derived neurotrophic factor (BDNF) and insulin like growth factor (IGF-1) have potent neuroprotective and myotrophic effects and are modulated by physical activity and nutrition. One of the major functional consequence of sarcopenia is the disproportionate loss of muscle strength: at the age of 80 yrs, the loss of muscle strength is about 4-fold greater than that of muscle size (4). This intrinsic muscle weakness, also known as a deterioration in 'muscle quality' has traditionally been reconducted to a decrease in fibre specific tension, reduced excitation-contraction coupling and reduced neural drive. However, new evidence suggests that this disproportionate loss of force also arises from changes in the extracellular matrix (ECM) and of associated proteins, leading to a decrease in lateral force transmission (5), which in young muscle normally contributes to >50% of muscle force output. Indeed, as recently reported for rat muscle, lateral force transmission is markedly reduced in old animals (-20%) and even more in very old ones (-44%) (6).

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Hence, the muscle weakness associated with sarcopenia may not only take origin from muscular changes but also in the ECM tissue connecting sarcomeres to the tendon; this seems supported by recent MRI diffusor tensor imaging data obtained in older humans (7).

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Thursday 23rd October

Disease & Injuries - Abstracts

Motion Analysis, Physical Therapy, and Management of Musculoskeletal Disorders

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The focus of the presentation will be directed towards recent contribution of motion analysis to the management of musculoskeletal disorders such as anterior cruciate ligament (ACL) dysfunction. Physical therapists as motion analysis experts have been able to bridge the gap between engineers and surgeons to enable better functional assessment and problem based management of patients with musculoskeletal problems. They have been successfully able to convert theoretical concepts of motion analysis research into applied management models. The results of recently published studies that points out such conversion from theory into practice will be shared during this presentation. These studies include assessment of post-reconstruction ACL integrity, assessment of possible correlation between shoulder dysfunction and core instability, assessment of mechanical and metabolic costs of leg simulators, and possible ergonomic strategies to prevent mechanical Low back pain in seated workers.

Friday 24th October

Therapy & Rehabilitation - Abstracts

Movement performance is directed by biarticular muscles

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Muscle functioning is a major determinant of human performance in motor tasks. Therefore to optimize performance it is necessary to understand which muscles contribute to a specific task and thus which muscles should be trained or reconditioned. Performance is not only determined by the maximal amplitude of the force that can be exerted on the environment, but also the direction of this force. As has been shown by van Ingen Schenau et al. (1992) the direction of an external force is controlled by the co-operation of mono- and biarticular muscles. In this presentation this theory of biarticular muscles controlling direction of external forces will be applied to a variety of movement tasks. It will be explained how in walking excessive plantar pressure patterns in people with type 2 diabetes result from weakness in the muscles in the leg. Also it will be discussed how an imbalance between knee joint extensors and flexors in elderly might compromise the capacity to recover from a stumble and can be a cause of a higher falling risk. As a third application it will be addressed how manipulation of trunk angle and body orientation can affect cycling performance.

Van Ingen Schenau G.J. et al. The constrained control of force and position in multi-joint movements. Neuroscience, 46(1): 197-207, 1992.

Friday 24th October

Therapy & Rehabilitation - Abstracts

Prevention and treatment of major degenerative conditions associated with aging and physical inactivity

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The rapid aging of most western industrial nations entails various challenges for society. One of these challenges is to enable the elderly to age in good health and remain active participants in society. Physical performance seems to be a key player in this context. In a recent position statement of the ACSM the authors concluded that there is strong evidence that: (a) Strength declines from age 40 years, and losses are substantially accelerated after the age 65-70; (b) Lower body strength declines faster than upper body strength and power declines at a faster rate than strength; (c) Maximal O2 uptake declines at 9% decline per decade; (d) The preferred walking speed slows down with advancing age, stride length becomes shorter and gait variability increases (Chodzko-Zajko et al., 2009). Interestingly, similar decrements have been reported consistently also after extensive periods of inactivity, like stays in microgravity, e.g. for astronauts on the ISS or during bed rest. In aging as well as for the above mentioned inactivity models, exercise programs have been shown to be protective against deteriorations in physical performance and degenerations of biological systems of the human body.
The aim of this presentation is to (i) provide an overview on the major degenerative conditions that occur during the ageing process and during longer periods of physical inactivity and (ii) present recent findings on exercise programs that can mitigate age- and inactivity-related biological changes of the human body.

Reference: Chodzko-Zajko, W.J., Proctor D.N., Fiatarone Singh M.A., Minson C.T., Nigg C.R., et al. (2009) American College of Sports Medicine position stand. Exercise and physical activity for older adults. Med Sci Sports Exerc 41: 1510–1530.

Friday 24th October

Therapy & Rehabilitation - Abstracts

Exploring the value of dance movement psychotherapy for diverse populations: research evidence to date

Professor Vicky Karkou, Edge Hill University, Ormskirk, UK

The Cartesian split between the mind and the body has persisted for centuries, leading to negative references of the body as an object that is often dissected, sexualised and/or shamed. Interventions such as dance movement psychotherapy perceive this split as problematic and as a cause of many mental and physical illnesses. As a consequence, dance movement psychotherapy aims to bridge the rift between cognition, emotions and the body and thus foster integration (ADMP UK 2014). The medium for this is creative movement and dance which is used intentionally for therapeutic outcomes. As a form of psychotherapy, the relationship between the client and the therapist is key to therapeutic change; so is the relationship amongst group members (Karkou and Sanderson 2006). There is currently a growing body of evidence to suggest that bridging the Cartesian split between the mind and the body can be effective for certain populations. For example, systematic reviews of randomised controlled trials with client groups such as schizophrenia (Ren and Xia 2013), cancer care (Bradt et al 2011), depression (Meekums et al 2012) and dementia (Karkou and Meekums 2014) indicate that dance movement psychotherapy has a lot to offer to these populations. Areas such as autism, anxiety and trauma are also popular areas of work with growing research evidence (Karkou, Lykou, Rova, submitted for publication; Koch et al 2014). In this presentation, some of this evidence will be presented and discussed with regards to depression and dementia in particular. The limitations of relying solely on quantitative evidence will be explored, making suggestions for the value of looking at participants' perceptions of the work through qualitative means. Arguments will also put forward for the value of movement work in itself as sufficient, and in some cases as more appropriate, to communicate impactful information about the process and outcome of the work.

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