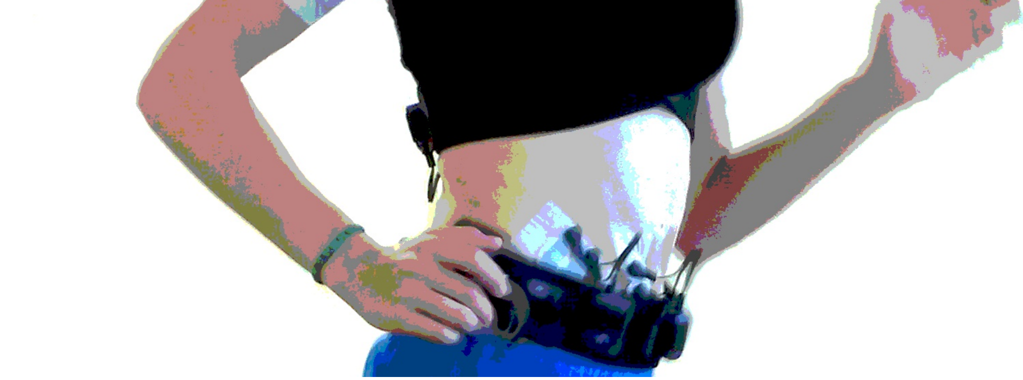

2nd International Autumn School on Movement Science

Berlin, 5th to 10th October 2015

Programme

BSMS
Berlin School of Movement Science

2nd International Autumn School on Movement Science

Berlin, 5th to 10th October 2015

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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Dr. Julius Verrel (Member of the Executive Committee)
Alessandro Santuz (Student Representative)

Scientific Advisory Board

Prof. Vasilios Baltzopoulos (GBR)
Prof. Walter Herzog (CAN)
Prof. Paavo Komi (FIN)

General Information

Venues

The lectures will be held from Monday 5th until Friday 9th of October.

Addresses:

Humboldt-Universität zu Berlin (HU Berlin)
Department of Training and Movement Sciences
Philippstr. 13, Haus 11
Lecture Hall 5 (Room 1.26)
10115 Berlin
Web: www.tbw.hu-berlin.de

Campus Virchow Klinikum (Campus Virchow)
Augustenburger Platz 1
Institutsgebäude Süd (IGS)
Auditorium
13353 Berlin
Web: jwi.charite.de

Max Planck Institute for Human Development (MPI Berlin)
Lentzeallee 94
Lecture Hall
14195 Berlin
Web: www.mpib-berlin.mpg.de

General Information

The Autumn School and the BSMS

The Berlin School of Movement Science (BSMS) is an interdisciplinary education programme based on scientific exchange and interaction, supporting PhD students to become highly skilled scientists in the fields of motor control and movement science. Our main research objectives are:

(a) to acquire knowledge about the fundamental principles of motor control in human movement,

(b) to investigate the effects of the musculoskeletal properties on the motor control strategies used during movement and
(c) to understand how the sensory-motor system controls biomechanical features and lead to adaptation on a structural level in tissues such as bone and muscle.

The BSMS organises yearly an International Autumn School on Movement Science for young scientists to give first-hand experience of the unique graduate training programme in the field of movement science.

In this Autumn School we want to provide an overview on movement viewed from different perspectives such as the brain, central nervous system, bone, muscle and spine as well as its associated diseases and therapeutic options using physical activity.

The participation to the Autumn School is free of charge. The BSMS provides 10 travel grants to invite Master's and PhD students from all over the world to participate in this Autumn School. The travel grants will cover travel expenses, accommodation and lunch for the whole duration of the Autumn School.

The Autumn School is of particular interest to those Master's and PhD students who are considering doing their doctoral or post-doctoral research in the field of movement science within the BSMS network. The 10 travel grants will be awarded depending on the quality of the application, merit and the relevance.

Sessions

Scientific Programme

Monday 5th October (HU Berlin)

09:30 to 10:30 **Yuri Ivanenko** – *Fondazione Santa Lucia Rome*
11:00 to 12:00 **Dominic Farris** – *University of Queensland*
13:30 to 14:30 **Karin Gerrits** – *VU University Amsterdam*
15:00 to 16:00 **Pietro Enrico di Prampero** – *University of Udine*

Tuesday 6th October (Campus Virchow)

09:30 to 10:30 **Edwin van Asseldonk** – *University of Twente*
11:00 to 12:00 **Verena Klamroth-Marganska** – *ETH Zürich*
13:30 to 14:30 **Patrick Ragert** – *MPI Human Cognitive and Brain Sci. Leipzig*
15:00 to 18:00 **BioThinking workshop**

Wednesday 7th October (MPI Berlin)

09:30 to 10:30 **Annegret Mündermann** – *University Hospital of Basel*
11:00 to 12:00 **Mohamad Parnianpour** – *Sharif University of Technology*
13:30 to 14:30 **Reinhard Blickhan** – *Friedrich Schiller University of Jena*
15:00 to 16:00 **Lena Ting** – *Georgia Institute of Technology*

Thursday 8th October (HU Berlin)

09:30 to 10:30 **Marcus Pandy** – *The University of Melbourne*
11:00 to 12:00 **Neil Reeves** – *Manchester Metropolitan University*
13:30 to 14:30 **Vasilia Hatzitaki** – *Aristotle University of Thessaloniki*
15:00 to 16:00 **Jeroen Smeets** – *VU University Amsterdam*

Friday 9th October (HU Berlin)

09:30 to 10:30 **Roberto Bottinelli** – *University of Pavia*
11:00 to 12:00 **Hans Degens** – *Manchester MU, Lithuanian Sports University*
13:30 to 14:30 **Thomas Roberts** – *Brown University*
15:00 to 16:00 **Emilio Bizzi** – *Massachusetts Institute of Technology*

Sessions

Social Programme for invited students

Monday 5th October

20:00 to 23:00 **Get-together dinner**
Str. der Pariser Kommune 35, 10243 Berlin – *Meeting point*

Thursday 8th October

17:30 to 19:30 **Boat tour**
Weidendammer Brücke, 10117 Berlin – *Meeting point*

Friday 9th October

19:00 to 23:00 **Ballet - Dornröschen (Sleeping Beauty)**
Deutsche Oper Berlin
Bismarckstraße 35, 10627 Berlin – *Meeting point*
www.deutscheoperberlin.de

Saturday 10th October

13:30 to 15:00 **86th International long distance rowing regatta "Quer durch Berlin"**
Haus der Kulturen der Welt, John-Foster-Dulles Allee 10, 10557 Berlin – *Meeting point*

16:00 to 19:00 **Olympic stadium and Glockenturm (Bell tower) tour**
Am Glockenturm, 14053 Berlin – *Meeting point*

20:00 to 23:00 **Closing dinner**
Str. der Pariser Kommune 35, 10243 Berlin – *Meeting point*

Monday 5th October

Scientific Programme

Humboldt-Universität zu Berlin | Philippstr. 13, Haus 11 | Room 1.26

09:00 to 09:30	Welcome and introduction
09:30 to 10:30	Development of human locomotion ***Yuri Ivanenko*** – *Fondazione Santa Lucia Rome*
10:30 to 11:00	Break
11:00 to 12:00	The mechanics and energetics of normal and exoskeleton assisted locomotion: towards a muscle level understanding ***Dominic Farris*** – *University of Queensland*
12:00 to 13:30	Lunch break
13:30 to 14:30	Effects of ageing, disuse and chronic disease on neuromuscular performance ***Karin Gerrits*** – *VU University Amsterdam*
14:30 to 15:00	Break
15:00 to 16:00	The energy cost of running and the energy balance of current world records from 100 to 5000 metres ***Pietro Enrico di Prampero*** – *University of Udine*

Social Programme

20:00 to 23:00	**Get-together dinner** Str. der Pariser Kommune 35, 10243 Berlin – *Meeting point*

Monday 5th October

Abstracts

Development of human locomotion

Yuri Ivanenko – Fondazione Santa Lucia Rome, Italy

How do we walk when we start to walk? Biomechanical and neural constraints are different in infants. This presentation will outline recent advances in understanding how motor commands are expressed at different stages of human development. The development of human locomotion from the neonate to the adult starts from a rostrocaudal excitability gradient in the spinal motor output and involves a gradual functional reorganization of the pattern generation circuitry. It has been also argued that the nervous system may control numerous muscles through modularity, using neural patterns to activate muscles in groups called synergies. The alternating spinal motor output in neonates is consistent with a simpler organization of neuronal networks. The co-ordination of limb and body segments arises from the coupling of neural oscillators between each other and with limb mechanical oscillators. Despite millions of years of bipedal walking evolution, at the onset of walking, changes in vertical body loads are not compensated accurately by the kinematic controllers and the gravity-related pendulum mechanism of walking does not seem to be implemented, requiring each toddler to develop it. Unsupported walking experience may act as a functional trigger for gait maturation to accelerate the motor system’s ability to identify the optimal solution of walking in the gravity field. We discuss the precursor of the mature locomotor pattern in infants as an optimal starting point strategy for gait maturation.

Monday 5th October

Abstracts

The mechanics and energetics of normal and exoskeleton assisted locomotion: towards a muscle level understanding

Dominic James Farris – School of Human Movement & Nutrition Sciences, The University of Queensland, Australia

Humans walk and run with remarkable efficiency. It also seems we naturally choose to move at speeds and with gaits that minimise metabolic energy consumption. However, despite extensive academic interest in this paradigm it remains unclear why, from a mechanical standpoint, these gait choices are energetically optimal. One reason for this is that historically, studies have failed to assess the mechanical behaviour of the true sources and sinks of energy for locomotion – muscles. The first part of this talk will focus on my work that sought to better understand trends in human locomotor energetics by studying mechanics at the joint and individual muscle level. These studies employed ultrasound-imaging techniques in concert with gait analysis and energy consumption measurements to help further explain commonly observed trends in human walking and running mechanics and energetics.

Despite the impressive efficiency of human locomotion, a prominent current goal for bioengineers is to develop assistive devices to reduce the metabolic cost of human movement. Inspired by biological elastic mechanisms, some assistive ankle exoskeletons use elastic storage and return of energy in springs acting in parallel with the plantar flexors. While such devices help unload biological tissues, they might perturb the tuned muscle-tendon interaction of these muscles. Through experimental studies of muscle mechanics and OpenSim-based musculoskeletal modelling we examined how ankle exoskeletons interact with ankle muscles to better understand the effects of such devices. The second part of my talk will discuss the findings of these studies.

Monday 5th October

Abstracts

Effects of ageing, disuse and chronic disease on neuromuscular performance

Karin (H.L.) Gerrits – VU University Amsterdam, Netherlands

Neuromuscular performance, for instance in terms of muscle peak power and fatigue is impaired during aging and with a chronic reduction in usage, such as during bed rest, disease, and (most extreme) after a spinal cord injury. As a consequence, ageing is associated with a decline in physical functioning and loss of mobility and frail older adults are particularly vulnerable for developing disabilities and increased dependency.

Sarcopenia (i.e. loss of muscle mass and strength) has been generally considered as the key contributing factor to the loss of physical functioning, independence and frailty. Part of this decline in muscle mass and strength, results from the biological process of ageing. In addition, along with the increase of a sedentary lifestyle as age proceeds, processes of disuse augment this reduction in neuromuscular performance.

Physical exercise, for instance during rehabilitation, can attenuate functional decline and combat disability among seniors and (chronic) patients and may also be advantageous to the even more vulnerable institutionalised oldest old. Nevertheless, existing guidelines lack more detailed recommendations, especially for frail persons, pointing towards the need to extent these recommendations based on new scientific knowledge about this population.

During this lecture, the current knowledge of adaptations of the neuromuscular system in response to ageing will be discussed and related to those observed in (human) disease and disuse models, and how these relate to impaired muscle function and physical functioning. Further, to obtain indications for how training or other interventions could effectively prevent these adverse effects, current knowledge of training induced changes in neuromuscular performance and physical functioning will be discussed.

Monday 5th October

Abstracts

The energy cost of running and the energy balance of current world records from 100 to 5000 metres

Pietro Enrico di Prampero – University of Udine, Italy

Metabolic power requirement during 100 to 400 m top running performances in world class athletes was estimated assuming that accelerated running on flat terrain is biomechanically equivalent to uphill running at constant speed, the slope being dictated by the forward acceleration. Since the energy cost of running uphill is known, knowledge of the speed time course allows one to estimate energy cost and metabolic power (i.e. the product of the two) of accelerated running. Peak metabolic power amounted to 163, 99 and 75 W/kg for the 100 and 200 metres current word records (9.58 and 19.19 s) and a 400 m top performance (44.06 s). Average metabolic power and overall energy expenditure during 100 to 5000 metres current world records in running were also estimated as follows. The energy spent in the acceleration phase, as calculated from mechanical kinetic energy, assuming 25 % efficiency for the transformation of metabolic into mechanical energy, was added to the energy spent for constant speed running (air resistance included). Average metabolic power decreased from 73.8 to 28.1 W/kg with increasing distance form 100 to 5000 m. For the three shorter distances (100, 200 and 400 m), this approach yielded results rather close to mean metabolic power values obtained from the more refined analysis described above. For distances between 1000 and 5000 metres the overall energy expenditure increases linearly with the corresponding world record time. The slope and intercept of the regression yield maximal aerobic power and maximal amount of energy derived from anaerobic stores in current work records holders; they amount to 27 W/kg (≈ 77.5 ml O2/(kg min) VO2max above resting) and 1.6 kJ/kg (≈ 76.5 ml O2/kg). This last value is on the same order of the maximal amount of energy that can be derived from complete utilisation of phosphocreatine in the active muscle mass and from maximal tolerable blood lactate accumulation.

Tuesday 6th October
Scientific Programme

Campus Virchow Klinikum | Augustenburger Platz 1 | Lecture Hall

09:30 to 10:30	Taking robotic gait training to the next level ***Edwin van Asseldonk*** – *University of Twente*
10:30 to 11:00	Break
11:00 to 12:00	Robot-assisted Neurorehabilitation of the arm ***Verena Klamroth-Marganska*** – *ETH Zürich*
12:00 to 13:30	Lunch break
13:30 to 14:30	Motor learning and associated cortical plasticity in the adult and aging brain ***Patrick Ragert*** – *MPI for Human Cognitive and Brain Sciences Leipzig*
14:30 to 15:00	Break
15:00 to 18:00	***BioThinking workshop***

As Uri Alon described, even when your research is leading you to lots of dead ends you can find joy in getting lost and see opportunities in problems rather than obstacles. This is what BioThinking is aiming at, offering a path through the unknown of research. This three-hour course will get you into the world of team dynamics and creative processes of interdisciplinary research. We will fast forward through a small BioThinking project, getting to know lots of methods and tools to creative problem-solving. You will work in teams, researching on a given topic, synthesizing your findings and coming up with first prototypes in order to solve a real-world challenge.

Tuesday 6th October

Abstracts

Taking robotic gait training to the next level

Edwin van Asseldonk – University of Twente, Netherlands

Robotic gait training devices are more and more used in rehabilitation centers mainly for the rehabilitation of stroke survivors and patients with a (partial) spinal cord injury. Effect studies have shown that robot-aided gait training (RAGT) has a similar effectiveness as conventional training, however the physical strain on the therapist is reduced. It is widely acknowledged that there is still much room for improvement of RAGT such that patients show larger and/or faster functional recovery and/or that more patients can benefit from it. These improvements can be achieved by encouraging the patients to actively participate, by making balance control an integral part of gait training, but also by spending more time on the actual training and less on the donning and doffing of the device. They are different technological developments to improve on these aspects. First, novel body weight support systems have been developed that provide support during over ground walking (and other gait related tasks). Second, ambulatory exoskeletons that were originally being designed to assist patients during every day activities are now being used to provide gait training. Third, the design and control of the treadmill based robotic gait trainers have made large advancements. In this presentation I will discuss these different developments and their potential to improve robotic gait training. Here I will also discuss the advanced treadmill based robotic gait trainer LOPES II, which we have developed at the University of Twente.

Tuesday 6th October

Abstracts

Robot-assisted Neurorehabilitation of the arm

Verena Klamroth-Marganska – Sensory-Motor Systems Lab, ETH Zurich, Switzerland

The field of neurorehabilitation is changing rapidly, one reason being the increasing knowledge about neural plasticity and recovery, another reason being the availability of robotic devices for rehabilitation. Early robot-assisted therapy of the arm was mostly empirical and based on hardware that was originally designed for industrial applications. More recent applications build on neuroscientific knowledge of motor learning and re-learning. Therapy robots incorporate successful motor learning strategies such as high intensity, error amplification, or multimodal feedback. Clinical studies indicate that robots are superior to conventional therapy forms with regard to improvements in activities of daily living and arm function. More than 100 prototypes and several commercially available devices exist.

In this talk you get an overview of the history of robot-assisted neurorehabilitation of the arm. We will discuss advantages of this therapy form and identify factors that limit clinical application. Furthermore, we will discuss recent developments in robotic devices and potential directions for future research.

Tuesday 6th October

Abstracts

Motor learning and associated cortical plasticity in the adult and aging brain

Patrick Ragert – MPI Human Cognitive and Brain Sci. Leipzig, Germany

In contrast to the long-held view that brain plasticity is restricted to critical periods during ontogenesis, it is now well established that the adult human brain preserves its capacity for functional and structural changes throughout life. Although early experimental studies were mainly performed in animals, technical developments in the field of magnetic resonance imaging (MRI) enabled the non-invasive observation of functional as well as structural reorganization in the living human brain. In my talk, I will provide an overview about recent insights into dynamic functional and structural brain plasticity as a consequence of motor skill learning. I will highlight recent insights from non-invasive brain imaging studies in young adults, athletes, older individuals and neurological patients. Furthermore, I will discuss how these findings can be used to augment motor skill learning over the lifespan by using non-invasive brain stimulation. This knowledge might open novel perspectives in aging research to prevent the age-related decline in motor function as well as for neurorehabilitation to optimize recovery processes.

Wednesday 7th October

Scientific Programme

Max Planck Institute for Human Development | Lentzeallee 94 | Main lecture hall

09:30 to 10:30	Functional Biomechanics in orthopaedic and neurological conditions ***Annegret Mündermann*** – *University Hospital of Basel*
10:30 to 11:00	Break
11:00 to 12:00	Spinal stability, trunk performance, fatigue, and movement control ***Mohamad Parnianpour*** – *Sharif University of Technology*
12:00 to 13:30	Lunch break
13:30 to 14:30	Avian bipedal locomotion: Can we learn from birds? ***Reinhard Blickhan*** – *Friedrich Schiller University of Jena*
14:30 to 15:00	Break
15:00 to 16:00	Neuromechanical principles underlying movement modularity and their implications for rehabilitation ***Lena Ting*** – *Georgia Institute of Technology*

Wednesday 7th October

Abstracts

Functional Biomechanics in Orthopaedic and Neurological Conditions

Annegret Mündermann – Functional Biomechanics, University Hospital Basel, Switzerland

This lecture focuses on the clinical relevance and opportunities of movement science in orthopaedics and neurology. Joint motion and ambulatory load provide critical information on understanding disease mechanisms, diagnosis and treatment of orthopaedic and neurological conditions.

Ambulatory loads at the knee have been associated with the presence and rate of progression of knee osteoarthritis and are used for evaluating possible non-invasive and surgical treatment modalities. Moreover, linking ambulatory loads during specific physical exercise to biological markers provides a unique insight into the in vivo mechanosensitivity of musculoskeletal tissue. In this lecture, opportunities and challenges of interdisciplinary studies into these mechanisms will be considered.

To date movement related aspects of neurological conditions in adults have recently received increasing scientific scrutiny. For instance, motor fatigue is a common symptom in patients with multiple sclerosis, yet to date objective measure for detecting this symptom is lacking. Changes in movement pattern and their variability during a physical stress test have been used to develop an index for classifying motor fatigue. This index is not only critical for evaluating interventions but also for the diagnosis of motor fatigue and for determining disability justifying early retirement, which can have a great impact on a patient's quality of life and further disease progression. The development of this fatigue index will be discussed.

Wednesday 7th October
Abstracts

Spinal Stability, Trunk Performance, Fatigue, and Movement Control

Mohamad Parnianpour – Dept. Mech. Eng. Sharif University of Technology, Iran

The economic and human cost of low back pain have remained a major challenge for all those involved in their prevention, surgical or conservative treatment and rehabilitation, and return to work strategies encountered by industrial, occupational and athletic populations.

The theoretical and rational conceptualization have evolved in the last few decades and the bio-psychological model still remains the most complex and viable paradigm of study. Resource Economics applied to human performance as developed by Prof. George V. Kondraske allows us to link the human performance, functional maximum capacity assessment along basic elements of performance, fatigue (as a probability based on utilization ratio), strength failure (overexertion injury), coordination, etc.

On the other hand, the contribution of Prof. Manhor Panjabi, in conceptualization of sub-elements coordination of the passive, active, and sensory spinal endowment was immensely ingenious in relating how this smart structure can function and how the pain may develop due to malfunctioning of osteo-ligamentous-muscular system of spine. The issues of stability that brings familiar notation of Euler buckling to those bioengineers with strong mechanical orientation fails to mimic the gradual deformation of the spine and lead to concept of hypermobility that considered the concerns of occurrence of pain as well. However, pure structural-mechanical paradigm was replaced by nonlinear dynamical system theory of biological system. While spine column has enormous degrees of freedom (having both kinematic and kinetic redundancies) is very difficult to analyze but is a master piece to learn from in terms of evolutionary wisdom in its development.

Theory of synergies, self-organizing systems and emerging patterns underlying the complex systems have been applied in the study of movement control. The random and chaotic structure of trunk performance have been evaluated using local stability measures such as Lyapunov Exponents, Recurrence Quantification Analysis, and Variability Index amongst others.

One of the linguistically challenging task of spine researchers is that most of the terms such as strength, fatigue, stability and pain have multiple usage in the technical literatures and colloquial language. This lack of precision leads to often conceptual difficulty that prevents the clarity of conceptualization needed for an effective multi-disciplinary approach to this challenging task. Reviewing these terms realizing this outstanding problem may provide initial steps toward the unifying understanding.

Wednesday 7th October

Abstracts

Avian bipedal locomotion: Can we learn from birds?

Reinhard Blickhan – Institute of Sport Science, Friedrich-Schiller-University, Jena, Germany

Birds and their ancestors used bipedal locomotion long before primates. This prolonged optimization period should foster adaptations with respect to functional morphology and control. Despite of some general similarities differences between birds and humans seem to be obvious. We hypothesize that they may have intrinsic mechanical reasons.

At the level of center of mass dynamics the gaits used seem to be similar. Both groups walk and run. The gaits follow the idea of a rather stiff spring loaded inverted pendulum with low energy during walking and a higher energy allowing flight phases during running. A closer look reveals that especially small birds prefer to use across a wide range of speeds "grounded running": a gait without aerial phases but with a running dynamics. Human subjects seem to avoid this intermediate gait. A striking difference is the respective posture of the trunk. In simulations assuming a virtual pivot point (VPP) control the upright human posture seems to represent a small, delicate island of stability whereas there is a wide range of pronate postures in which stability can be achieved. The pronate posture in turn is related to the leg function. Whereas the human leg is able to work almost conservative, in birds the caudal displacement of the hip requires asymmetric leg operation with axial absorption and tangential propulsion. Bird legs geometry also differs from ours. The almost horizontal femur shifts the "knee" close to the center of mass. This minimizes work and allows the distal segments to store and/or absorb energy. At least birds of small and intermediate size are able cope with strongly uneven ground. It has to be shown whether this advantage represents a desired outcome of the prone posture.

Altered physical conditions, or boundary conditions enforced by environment and anatomy might alter the way we use our legs. In humans locomotive tools such as roller skates and skis enforce altered angles of attack as well as postures. This may make grounded running a preferred gait. First experiments while walking with enforced bent postures result in force patterns typical for grounded running. Posture seems to effectively modulate leg properties.

Wednesday 7th October

Abstracts

Neuromechanical principles underlying movement modularity and their implications for rehabilitation

Lena Ting – Georgia Institute of Technology, USA

Neuromechanical principles define the properties and problems that shape neural solutions for movement. Although the theoretical and experimental evidence is debated, I will present evidence and arguments for consistent structures in motor patterns, i.e. motor modules, that are neuromechanical solutions for movement particular to an individual and shaped by evolutionary, developmental, and learning processes. As a consequence, motor modules may be useful in assessing sensorimotor deficits specific to an individual, and define targets for the rational development of novel rehabilitation therapies that enhance neural plasticity and sculpt motor recovery. I propose that motor module organization is disrupted and may be improved by therapy in spinal cord injury, stroke, and Parkinson's disease. Recent studies provide insights into the yet unknown underlying neural mechanisms of motor modules, motor impairment and motor learning, and may lead to better understanding of the causal nature of modularity and its underlying neural substrates.

Thursday 8th October
Scientific Programme

Humboldt-Universität zu Berlin | Philippstr. 13, Haus 11 | Room 1.26

09:30 to 10:30	Computational modeling of lower-limb muscle function in human locomotion ***Marcus Pandy*** – *The University of Melbourne*
10:30 to 11:00	Break
11:00 to 12:00	Gait impairment in diabetes ***Neil Reeves*** – *Manchester Metropolitan University*
12:00 to 13:30	Lunch break
13:30 to 14:30	Using visual feedback in balance rehabilitation ***Vasilia Hatzitaki*** – *Aristotle University of Thessaloniki*
14:30 to 15:00	Break
15:00 to 16:00	The building blocks of prehension ***Jeroen Smeets*** – *VU University Amsterdam*

Social Programme

17:30 to 19:30 **Boat tour**

Weidendammer Brücke, 10117 Berlin – *Meeting point*

A break from the school to relax on a city cruise. We will sail in the very centre of the city, watching it from a different point of view. We will see the Mühlendammlock, the Berlin Cathedral, the Museum Island, the Seat of the German Government, the Government Quarter, the House of World Cultures and back to the Weidendammer bridge.

Thursday 8th October

Abstracts

Computational modeling of lower-limb muscle function in human locomotion

Marcus G. Pandy – Dept of Mech. Eng., University of Melbourne, Australia

Gait analysis techniques have led to a more objective assessment of locomotion biomechanics, yet its ability to discern the actions of individual muscles is limited because a net joint moment can be produced by many combinations of muscle forces. Rapid increases in computing power combined with more efficient algorithms for modeling the human neuromusculoskeletal system have enabled detailed analyses of muscle function. This presentation will demonstrate how the computational modeling approach can be used to address the following fundamental questions related to lower-limb muscle function in human locomotion:

- Which muscles provide support, progression and balance during walking?

- Why do humans switch from walking to running at speeds near 2 m/s?

- How do humans progress running speed from jogging to sprinting?

A computationally-efficient method for performing predictive simulations of movement based upon optimal control theory will also be described.

Thursday 8th October

Abstracts

Gait impairment in diabetes

Neil D. Reeves – School of Healthcare Science, Manchester Metropolitan University, United Kingdom

Patients with diabetic peripheral neuropathy (DPN) are at an increased risk of falls. Diabetic neuropathy impairs sensory perception and motor function in the lower limbs. Although diabetes is known to be associated with alterations to temporal-spatial aspects of gait, the mechanisms predisposing gait impairment and falls are not clear. This presentation will describe work investigating biomechanical and visual-motor impairments to gait with DPN and the potential benefit of exercise and visual gaze training in this population.

Three participant groups were investigated: patients with moderate/severe diabetic neuropathy, patients with diabetes but without neuropathy and healthy controls without diabetes. Participants were examined in a gait laboratory walking over level ground and ascending and descending stairs. Kinematics were assessed using motion analysis and ground reaction forces measured from ground and step-embedded force platforms. Joint moments and the rate of joint moment development were calculated. Visual gaze behaviour was examined during walking over a 7-m stepping walkway using an eye-tracking device.

Patients with diabetes and particularly those with DPN displayed a significantly slower rate of joint moment development at the knee and ankle upon initial step contact during stair ascent and descent compared to controls. This was underpinned by alterations to the timing of knee extensor and ankle plantarflexor muscle activation. Patients with diabetes and DPN were significantly less accurate at stepping onto targets compared to controls. Patients with diabetes and particularly those with DPN were slower to visually acquire the stepping target, remained looking at the target until after foot-target contact and were slower to look between targets compared to controls. An intervention programme in diabetes patients involving resistance exercise training and visual gaze training improved the rate of moment generation and stepping accuracy.

Thursday 8th October

Abstracts

Using visual feedback in balance rehabilitation

Vassilia Hatzitaki – Motor Control and Learning Laboratory, Aristotle University of Thessaloniki, Greece

Exercising with the use of augmented visual feedback improves functional motor behaviour and particularly balance and locomotion. Over the past years, several visual feedback protocols, systems and devices have been developed and commercialized promising an effective means of improving balance function in aging and disease alleviating the risk of falling. A major challenge however, is how efficiently these systems improve balance and prevent falling in older adults and patient populations. Through visually guided practice an internal visuo-motor transformation of the practiced task is acquired. Nevertheless, the generalization or transferability of the acquired visuo-motor transformation to other motor tasks is questionable. In this talk, I will present research evidence showing how the motor system uses visual information to control voluntary postural tracking and what are the specific task and visual stimuli characteristics that optimize visuo-motor learning [1, 2]. For the 2nd part of the talk, research studies showing how aging affects the ability to learn novel visually guided tasks [3] and the effectiveness of visual feedback training [4] will be reviewed. Research results point to the importance of enhancing perception-action mechanisms instead of developing specific visuo-motor transformations with visual feedback training. Directions for future research and development will be discussed at the end.

References

1. Hatzitaki, V., et al., PLoS One, 2015. 10(3): p. e0119828.

2. Radhakrishnan, S.M., et al. Gait Posture, 2010. 32(4): p. 650-5.

3. Hatzitaki, V. and S. Konstadakos, Exp Brain Res, 2007. 182(4): p. 525-35.

4. Hatzitaki, V., et al.,. Gait Posture, 2009. 29(2): p. 296-9.

Thursday 8th October

Abstracts

The building blocks of prehension

Jeroen Smeets – VU University Amsterdam, Netherlands

Prehension is a prototype of human movement coordination. Since the pioneering work of Marc Jeannerod, this movement is generally considered to be a coordinated combination of hand transport and grip formation. One of the main theoretical reasons for choosing transport and grip as building blocks is that they are anatomically independent: one can determine for each muscle, joint or brain area whether it belongs to transport or grip. We propose a different view on grasping, in which the coordination problem is formulated as one related to the movements of the digits' tips through space. According to this view, both the transport of the hand and the formation of the grip emerge from the combination of independent movements of the digits' tips towards the objects' surface. This independency of the movements of the digits' tips might seem counterintuitive, as the muscles that are used to move the tip of the thumb to the object are to a large extent the same arm muscles as those that are used to move the tips of other digits. However, we propose that the independency of the digits is not anatomically defined but is defined at a more abstract level. It resembles the independence of synergies. A synergy is a set of muscles that is activated in a coordinated way. Different synergies are activated independently, but a single muscle can be part of several synergies. In this talk I will present a selection of the experimental evidence (including data on visuomotor adaptation) that we collected to support this view that the digits' movements are the building blocks of prehension.

Friday 9th October
Scientific Programme

Humboldt-Universität zu Berlin | Philippstr. 13, Haus 11 | Room 1.26

09:30 to 10:30	The cellular and molecular mechanisms of skeletal muscle functional heterogeneity & plasticity ***Roberto Bottinelli*** – *University of Pavia*
10:30 to 11:00	Break
11:00 to 12:00	Strong in old age and living forever? Don’t be silly! ***Hans Degens*** – *Manchester Metropolitan University*
12:00 to 13:30	Lunch break
13:30 to 14:30	A comparative perspective on muscle function during movement ***Thomas Roberts*** – *Brown University*
14:30 to 15:00	Break
15:00 to 16:00	Muscle synergies, concept, principles, and potential use in neurorehabilitation ***Emilio Bizzi*** – *Massachusetts Institute of Technology*

Social Programme

19:00 to 23:00	**Ballet - Dornröschen (Sleeping Beauty)** Choreography by Nacho Duato, music by Pyotr I. Tchaikovsky Deutsche Oper Bismarckstr. 35, 10627 Berlin – *Meeting point*

With "Sleeping Beauty", Pyotr I. Tchaikovsky has created one of the most beautiful pieces in ballet history. It was devised in a unique collaboration with Marius Petipa and most probably belongs to the most treasured classics of all. Nacho Duato retells this beloved fairytale translating the magical spirit of this famous ballet into truly enchanting images. Nacho Duato’s version of "Sleeping Beauty" premiered at the Mikhailovsky Theater in St. Petersburg in 2011.

Friday 9th October

Abstracts

The cellular and molecular mechanisms of skeletal muscle functional heterogeneity & plasticity

Roberto Bottinelli – University of Pavia, Italy

Skeletal muscles are the tolls that animals, including humans, use to interact with their environment. All movements including locomotion, eating and biting, as well as speaking and writing are made possible by skeletal muscle contractions. Consequently, skeletal muscles show a large functional heterogeneity and a striking plasticity, i.e. a ability to adapt to variations in activity and working demand. Since the end of the '80, it has been definitely established that both phenomena are to a large extent based on the differential expression of isoforms of myofibrillar proteins and especially of myosin isoforms, which have very different contractile and energetic properties. Human adult limb muscles normally express three myosin heavy chain (MHC) isoforms, 1, 2A, 2X. Most skeletal muscle fibers express a single MHC isoform although coexistence of MHCs is often observed. Therefore, three pure fiber types (1, 2A and 2X) and two hybrid fiber types (1-2A and 2A-2X) can be identified based on MHC isoform content. Such fiber types widely differ in mechanical and energetic properties. Shortening velocity, power output, ATP consumption decrease in the order type 2X > type 2A > type 1. Consistently, the relative distribution of fiber types is a major determinant of the velocity and power output of muscles in vivo. To understand why myosin isoforms have such a large functional diversity, acto-myosin interaction had to be studied at a molecular level using biochemical assays and single molecule mechanics. Both approaches have indicated that a slow myosin is slower than a fast isoform because, during the acto-myosin interaction cycle, it spends more time attached to actin than a fast isoform, whereas the distance travelled by an actin filament propelled by a slow or a fast isoform is similar. The same approaches have clarified that the longer time of attachment of slow myosin depends on a lower rate of ADP release from acto-myosin.

The lesson will briefly deal with muscle fibers and their properties and will then focus on the molecular mechanisms of myosin isoform diversity.

Friday 9th October

Abstracts

Strong in old age and living forever? Don't be silly!

Hans Degens – School of Healthcare Science, Manchester Metropolitan University, Manchester, United Kingdom. Lithuanian Sports University, Kaunas, Lithuania.

During the first 20 or so years of our life almost all our bodily and mental functions are improving, to then decrease gradually after reaching maturity ultimately resulting in death. The muscular system is no exception and with increasing age, we become progressively weaker. At some stage, the loss of muscle power exceeds a certain threshold and causes mobility limitations and a reduced quality of life. Part of this is due to a loss of muscle mass, but also specific tension, the maximal force generating capacity per muscle cross-sectional area, is reduced. This reduction in muscle quality is not only attributable to an increase in the proportion of connective tissue and a reduced proportion of fast fibres in the muscle, but also to intrinsic changes in the contractile properties of individual muscle fibres. The intrinsic slowing of the muscle, also seen in single muscle fibres, plays an even more important role than muscle weakness in the loss of muscle power and slower walking speed in, even healthy, older people. But, are muscle weakness and death inevitable? Is it all maybe because we become less active in old age? Would maintaining our activity levels help maintain muscle function and even open the chance to live eternally? While there is no doubt that resistance exercise increases the force generating capacity even in the oldest and frail old, the hypertrophic response is attenuated in old age and in some cases even leads to further muscle weakness rather than gains in strength! To address the question of the cause of ageing in general and ultimately death, theories of ageing will be discussed briefly and whether there is any evidence at all in nature for the possibility of eternal life. If there is, how may this be translated to humans. It may appear that the question in the title is not so silly as one might think.

Friday 9^{th} October

Abstracts

A comparative perspective on muscle function during movement

Thomas Roberts – Brown University, Providence, USA

Many principles of locomotor mechanics and energetics have been elucidated from comparative studies of animal movement. In particular animals studies have allowed us to use patterns, e.g., the scaling of metabolic cost with animal size, to develop models for the physiological basis for the metabolic cost of locomotion. Comparative studies have also provided insights into the mechanical function of muscles during movement, and to understand how fundamental muscle properties such as the force-length and force-velocity relations influence performance. The action of elastic structures has a particularly important influence on muscle function. By influencing the speed of contractile elements, elastic structures affect muscle force, power, and work. Tendon springs can store and recover energy to act as power amplifiers or attenuators during rapid accelerations or decelerations. Tendons also store and recover during running. It is generally believed that reduction of muscle work by tendons during running reduces the metabolic cost of movement, but this idea is challenged by recent measurements of the cost of force production in isolated muscles. The connective tissue skeleton that envelops muscle cells and fascicles also has spring-like properties, but the mechanical significance of this elasticity has received much less attention. These structures may influence the force and speed of contraction, via their influence on dynamic architecture and muscle shape changes.

Friday 9th October

Abstracts

Muscle synergies, concept, principles, and potential use in neurorehabilitation

Emilio Bizzi – Massachusetts Institute of Technology, Cambridge, USA

When the central nervous system (CNS) generates voluntary movement, many muscles, each comprising thousands of motor units, are simultaneously activated and coordinated. Computationally, this is a daunting task, and investigators have strived to understand whether and how the CNS's burden is reduced to a much smaller set of variables. In the last few years we and our collaborators have searched for physiological evidence of simplifying strategies by exploring whether the motor system makes use of motor modules, to construct a large set of movement.

The core argument for the neural origin of motor modules rests on studies of the spinal cord in several vertebral species, conducted using a variety of techniques. With these approaches, we and others were able to provide the experimental basis for a modular organization of the spinal cord circuitry in vertebrates. A spinal module is a functional unit of spinal interneurons that generates a specific motor output by imposing a specific pattern of muscle activated with a muscle synergy.

Muscle synergies are neural coordinative structures that function to alleviate the computational burden associated with the control of movement and posture. In my presentation, I will address two critical questions: 1) are muscle synergies explicitly encoded in the nervous system? And, 2) how do muscle synergies simplify movement production? I will argue that shared and task-specific muscle synergies are neurophysiological entities whose combination, orchestrated by the motor cortical areas and the afferent systems, facilitates motor control and motor learning.

Saturday 10th October
Social Programme

13:30 to 15:00 **86th International long distance rowing regatta "Quer durch Berlin"**
Haus der Kulturen der Welt, John-Foster-Dulles Allee 10, 10557 Berlin – *Meeting point*

This international long distance rowing regatta crosses 13 bridges of the inner-city from the Charlottenburg Palace to the Federal Chancellery. Around 150 boats will take part on the 7km course, trying to reach as fast as possible the finish line set at the Haus der Kulturen der Welt on the Spree river.

16:00 to 19:00 **Olympic stadium and Glockenturm (Bell tower) tour**
Am Glockenturm, 14053 Berlin – *Meeting point*

Since its reopening in August of 2004, more than 300.000 visitors from around the world come to the Olympiastadion Berlin every year, thus making the stadium one of the most frequented sights of Berlin. The observation platform on top of the Bell Tower provides an excellent view of the city and the surrounding areas: from Spandau in the west, to the Alexanderplatz in the center of Metropolitan Berlin. On a clear day, visitors are able to see all the way to Potsdam and the Mueggelberge. You also have a terrific view of the Olympic Stadium! The tower was modernized for the 2006 World Cup of Soccer at a cost of nearly 7 million Euros. A newly constructed, glass-enclosed elevator, enables visitors to view scenes from the history of the building. The ground floor features a documentary exhibition, sponsored by the German Historical Museum, and informs visitors in both German and English about the Olympic Games of 1936 and the history of the site.

20:00 to 23:00 **Closing dinner**
Str. der Pariser Kommune 35, 10243 Berlin – *Meeting point*

2nd International Autumn School on Movement Science

Berlin, 5th to 10th October 2015

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