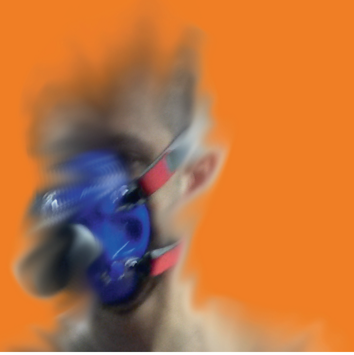

4th International Autumn School on Movement Science

Berlin, 9th to 13th October 2017

Programme

BSMS
Berlin School of Movement Science

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Berlin School of
Movement Science

4th International Autumn School on Movement Science

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Programme

DAAD

Hosted by

Humboldt-Universität zu Berlin, Institute of Sports Science

BSMS – Berlin School of Movement Science

Organisation

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

Administrative Coordination
Martina Piotrowski

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

Lectures will take place from Monday 9th until Friday 13th of October. Note that on Monday the lectures will be in a different location than the rest of the week.

Addresses (map at page 33).

(Monday) Humboldt-Universität zu Berlin
Faculty of Life Sciences
Invalidenstr. 42
Lecture Hall 1
10115 Berlin
Web: www.tbw.hu-berlin.de

(Tuesday to Friday) Humboldt-Universität zu 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

The Wi-Fi network eduroam (education roaming) is available at the venue. Students, researchers and staff can obtain Internet connectivity across the campus using the respective institutional credentials.

Supported by

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 and ageing from different perspectives such as the brain, central nervous system, muscle and tendon as well as the associated diseases and therapeutic options using physical activity.

The participation to the Autumn School is free of charge and 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.

Sessions
Scientific Programme

Monday 9th October
Day 1

09:30 to 10:30 **Roger Enoka** – *University of Colorado*
11:00 to 12:00 **Turgay Akay** – *Dalhousie University*
13:30 to 14:30 **Caroline Nicol** – *Aix-Marseille Université*
15:00 to 16:00 **Masaki Ishikawa** – *Osaka University*

Tuesday 10th October
Day 2

09:30 to 10:30 **Kiros Karamanidis** – *London South Bank University*
11:00 to 12:00 **Jacques Duchateau** – *Université libre de Bruxelles*
13:30 to 14:30 **Jens Bo Nielsen** – *University of Copenhagen*
15:00 to 16:00 **Stig Peter Magnusson** – *University of Copenhagen*

Wednesday 11th October
Day 3

09:30 to 10:30 **Jaak Duysens** – *Katholieke Universiteit Leuven*
11:00 to 12:00 **Itshak Melzer** – *Recanati School*
13:30 to 14:30 **Heiko Wagner** – *University of Münster*
15:00 to 16:00 **Albert Gollhofer** – *Albert Ludwigs University of Freiburg*

Thursday 12th October
Day 4

09:30 to 10:30 **Constantinos Maganaris** – *Liverpool John Moores University*
11:00 to 12:00 **Andrew Cresswell** – *The University of Queensland*
13:30 to 14:30 **Marco Aurelio Vaz** – *Federal University of Rio Grande do Sul*
15:00 to 16:00 **Michael Lavagnino** – *Michigan State University (videoconf.)*

Friday 13th October
Day 5

09:30 to 10:30 **Monica Daley** – *Royal Veterinary College*
11:00 to 12:00 **Charalambos Papaxanthis** – *University of Burgundy*
13:30 to 14:30 **Daniel Ferris** – *University of Florida*
15:00 to 16:00 **Gregory Sawicki** – *North Carolina State University*

Sessions

Social Programme

The students at the BSMS thought of organising a parallel social programme based almost exclusively on donations and free activities. Please feel free to join us in any of the event planned for the Autumn School's week!

Monday 9th October

17:00 to 20:30 **Welcome and thank you party**
"Alte Schmiede" building in the Campus Nord
With live music by "Never rewind"
Philippstr. 13, Haus 10, 10115 Berlin – *Meeting point*

Tuesday 10th October

16:30 to 17:30 **Meet our department: the EMG lab**
Philippstr. 13, Haus 11, 10115 Berlin – *Meeting point*

Wednesday 11th October

16:30 to 18:30 **A walk through history: the Berlin wall**
Philippstr. 13, Haus 11, 10115 Berlin – *Meeting point*

Thursday 12th October

16:30 to 17:30 **Meet our department: the gait lab**
Philippstr. 13, Haus 11, 10115 Berlin – *Meeting point*

Monday 9th October
Scientific Programme

Humboldt-Universität zu Berlin | Invalidenstr. 42 | Lecture Hall 1

09:15 to 09:30	Welcome and introduction
09:30 to 10:30	Manual dexterity across the lifespan **Roger Enoka** – *University of Colorado*
10:30 to 11:00	Coffee break
11:00 to 12:00	Proprioceptive control of locomotion in mice **Turgay Akay** – *Dalhousie University*
12:00 to 13:30	Break
13:30 to 14:30	Ageing effects on the neuromuscular system: some facts and hopes **Caroline Nicol** – *Aix-Marseille Université*
14:30 to 15:00	Coffee break
15:00 to 16:00	Functional and neuromuscular characteristics with advancing age and disuse **Masaki Ishikawa** – *Osaka University*

Social Programme

17:00 to 20:30	**Welcome and thank you party** "Alte Schmiede" building in the Campus Nord With live music by "Never rewind" Philippstr. 13, Haus 10, 10115 Berlin – *Meeting point*

Monday 9th October

Abstracts

Manual dexterity across the lifespan

Roger Enoka – *University of Colorado*

Manual dexterity refers to an individual's ability to coordinate the fingers and manipulate objects in a timely manner. It can be quantified as the time it takes a person to complete a pegboard test, such as the Rolyan 9-hole peg test or the Lafayette 25-hole grooved pegboard test. In general, the pegboard times are fastest for young adults, slowest for old adults, and intermediate for middle-aged adults. According to Lawrence et al. (2015), differences in hand function are attributable to three latent domains: muscle strength, coordinated upper extremity function, and sensorimotor processing. Consistent with this framework, our studies have identified sets of predictor variables that can explain significant amounts of the variance in pegboard times for young, middle-aged, and old healthy adults, and persons with multiple sclerosis (MS). The predictor variables for each group of individuals often include measures of force steadiness (force fluctuations during steady isometric contractions) and time to match a target force during a rapid isometric contraction. In one of our studies (Almuklass et al. 2016), for example, a multiple regression model was able to explain most of the variance in grooved pegboard times (R2 = 0.70) for 30 young adults (15 women). The model comprised two predictor variables: (1) time to match a pinch-grip target force of 10% MVC (partial r = 0.78); (2) force steadiness for the wrist extensors during an isometric contraction at 10% MVC (partial r = -0.48). These results indicated that pegboard times were slower for young adults who took longer to match the pinch-grip target and exhibited superior force steadiness. In a subsequent study on middle-aged and old adults (Hamilton et al. 2017), we performed an independent component analysis to reduce the many outcome variables into sets of latent variables for the two pegboard tests and two age groups. With the exception of the grooved pegboard test for old adults, the models all included several measures derived from force-matching tasks involving submaximal isometric contractions with index finger abductors and wrist extensors. For example, the model for the 9-hole test of middle-aged adults, which explained 87% of the covariance, comprised time to match a 5% target force during index finger abduction and force steadiness for the wrist extensors when matching a target of 10% MVC force. The independent component analysis yielded models that were unique for each age group and pegboard test. To determine which features of the pegboard test changed with advancing age, we measured the times it took individuals to perform the four phases of single peg manipulation: (1) select a peg; (2) transport it to the hole; (3) insert it into the hole; and (4) return the hand to the well to select the next peg. Based on these phase durations, multiple-regression models were able to explain significant amounts of the variance in grooved pegboard times for all three age groups, but the explanatory power of the models was greater for middle-aged adults (R2 = 0.78) than for young (R2 = 0.33) and old (R2 = 0.49) adults (Almuklass et al. in press). A similar approach was used to compare the grooved pegboard times of persons with MS and healthy age- and sex-matched control subjects. Time to complete the grooved pegboard test was longer for the MS group (104 ± 40 s) than the Control group (61 ± 15 s). Regression analysis indicated that the pegboard times for the MS group could be predicted by the time for the peg-selection phase (R2 = 0.78), whereas the predictors for Control group (R2 = 0.77) were the times for the peg-transport (partial r = 0.80) and selection (partial r = 0.58) phases. These findings indicate that the most consistently challenging aspect of the grooved pegboard test for the MS participants was selecting a peg, whereas it was transporting the peg for the Control group.

Taken together, the results of these studies are beginning to identify the neuromuscular attributes responsible for differences in manual dexterity between individuals.

REFERENCES

Almuklass AM, Feeney DF, Mani D, et al. Exp Brain Res in press.
Almuklass AM, Price RC, Gould JR, et al. J Appl Physiol 120: 1410, 2016.
Hamilton LD, Thomas E, Almuklass AM, et al. Exp Gerontol 97: 9, 2017.
Lawrence EL, Dayanidhi S, Fassola I, et al. Front Aging Neurosci 7: 108, 2015.

Monday 9th October

Abstracts

Proprioceptive control of locomotion in mice

Turgay Akay – *Dalhousie University*

Terrestrial locomotion in legged animals depends on the coordinated contraction of multiple muscles that function to move the three leg joints. The contraction of these muscles is controlled by precisely timed activity patterns of multiple motor neuron pools in the spinal cord. The patterned activity of these multiple motor neuron pools (locomotor pattern) is driven by an interconnected network of spinal interneurons often referred to as the central pattern generator (CPG). It is established that terrestrial locomotion is the result of the integrated action of the CPG and the sensory feedback from the periphery. However, the precise contribution of the CPG and the sensory feedback to a functional locomotion is still obscure. Using a combination of in vivo physiological experiments and motion analysis with mouse genetics, we show that proprioceptive sensory feedback from the muscle spindles (MSs) and the Golgi Tendon Organs are required to generate a normal locomotor pattern. Furthermore, selective removal of inputs from MSs only causes subtle changes in the locomotor pattern but has a substantial effect on precise foot placement at the end of swing phase during walking. Finally, the MS removal impairs speed dependent regulation of extensor muscle activity during walking. Our results provide new insights on the precise role of proprioceptive feedback from the MSs in i) the generation of the locomotor pattern that underlies walking, and ii) the speed dependent regulation of the amplitude of muscle activity.

Monday 9th October

Abstracts

Ageing effects on the neuromuscular system: some facts and hopes

Caroline Nicol – *Aix-Marseille Université*

Understanding the biologic changes that occur with age is essential for maximizing quality of life and functional independence in the elderly. A clear benefit is reported between sedentary adults and normally active adults, indicating that even a slight increase in physical activity can produce large functional gains. Although the intensive physical training performed by elite master athletes is beyond the scope of most sedentary elderly people, their records show that athletic performances may be remarkably preserved at elevated levels while ageing. The capacity for both structural and functional improvements is thus preserved in later life, so that modifying the age-associated decline in the various aspects of performance may be considered as a reality rather than as a myth, only.

This presentation focuses on the underlying (muscle, tendon and neural) mechanisms of the functional drops in maximal (isometric, concentric and eccentric) force, velocity and power while advancing in age. Nowadays, it is clearly established that sarcopenia (reduction in muscle mass and quality) alone does not fully account for the ageing-induced muscle weakness. The observed functional reductions in force, velocity and power (dynapenia) are greater than those accounted for by the decrease in muscle size and architecture. Part of the functional reductions result from the combined ageing effects on the tendon mechanical properties as well as on the motor units and neural drive that will be further described with potential countermeasures by other speakers.

Monday 9th October

Abstracts

Functional and neuromuscular characteristics with advancing age and disuse

Masaki Ishikawa – *Osaka University*

Recent advances of musculoskeletal ultrasonography have led to better understanding of age-specific muscle and tendon behavior during human movements. The question we have to ask here is how can elderly adults compensate the neuromuscular interaction during dynamic movements. The purpose of the present lecture was focused (1) to discuss muscle and tendon architectures of general elderly adults as well as masters' athletes for considering the effects of ageing and disuse, (2) to discuss the behavior of gastrocnemius muscle fascicle and the Achilles tendon during running and hopping in elderly adults for age-specific neuromuscular modulation during dynamic movements and (3) to discuss effects of short and long term training intervention on muscle activation profiles and fascicle-tendon interaction for elderly adults.

Based on the results of our studies, it seemed that young and elderly adults have different activation strategy when force requirements increase. Age-specific muscle activation together with possible changes in muscle and tendon properties with advancing age may modulate muscle-tendon interaction for economical movements.

Tuesday 10th October

Scientific Programme

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

09:30 to 10:30	Gait stability and adaptability in older adults: effects of lower limb muscular capacities and perturbation exposure **Kiros Karamanidis** – *London South Bank University*
10:30 to 11:00	Coffee break
11:00 to 12:00	Age-related changes in the neuromuscular system and the influence of regular physical activity **Jacques Duchateau** – *Université libre de Bruxelles*
12:00 to 13:30	Break
13:30 to 14:30	Monitoring corticospinal function in children, adults and elderly. **Jens Bo Nielsen** – *University of Copenhagen*
14:30 to 15:00	Coffee break
15:00 to 16:00	Tendon adaptability and ageing **Stig Peter Magnusson** – *University of Copenhagen*

Social Programme

16:30 to 17:30	**Meet our department: the EMG lab** Philippstr. 13, Haus 11, 10115 Berlin – *Meeting point*

Tuesday 10th October

Abstracts

Gait stability and adaptability in older adults: effects of lower limb muscular capacities and perturbation exposure

Kiros Karamanidis – *London South Bank University*

Gait stability declines and falls incidence increases with age. Most falls among older people occur during gait, often due to tripping or slipping, as a result of sudden external changes in the environment. Thus, the ability to respond appropriately to unexpected disturbances during gait is important for preventing a fall and there is a need to prepare older adults to cope with such unexpected disturbances. In a series of studies, we investigated how gait stability and adaptability during perturbed walking are affected by age and muscle strength, in order to better understand the underlying mechanisms of the decline in locomotor stability across the adult lifespan. We found that the ability to control dynamic stability in response to a single perturbation during walking has already begun to deteriorate in middle age, but that even in old age, the ability to adapt gait and improve stability following repeated tripping perturbations is preserved, although the rate of adaptation may be diminished. Further, triceps surae (TS) muscle weakness and a more compliant Achilles tendon seem to partly limit gait stability during recovery from a trip, as stronger older adults require fewer recovery steps to regain stability after a sudden perturbation while walking. However, the potential for adaptive improvement after repeated perturbations during walking does not appear to be related to muscle strength in older adults. In a further set of experiments we investigated whether medium (months) or long-term (years) exercise-induced enhancement of TS muscle-tendon unit capacities affects older adults' ability to retain improvements in reactive gait stability during perturbed walking acquired from previous experience of the perturbation. Our observations give evidence to suggest that older adults' neuromotor system shows rapid plasticity to repeated unexpected perturbations and an ability to retain these adaptations in reactive gait stability over a long time period, but an additional exercise-related enhancement of TS capacities seems not to further improve these effects.

Tuesday 10th October

Abstracts

Age-related changes in the neuromuscular system and the influence of regular physical activity

Jacques Duchateau – *Université libre de Bruxelles*

Ageing is accompanied by various changes affecting the neuromuscular system that contribute to the decline in functional performances of old individuals. Although the most visible alteration is a loss in muscle mass (i.e., sarcopenia), these changes are associated with a profound reorganisation of the motor unit structure (i.e., a motor neurone and the muscles fibres it innervates). Due to the apoptosis of some motor neurones in the spinal cord, the muscle fibres that lose their innervation either degenerate or are reinnervated by the axons of surviving motor neurones. The result is a reduction in the number of functioning motor units in a muscle and the development of "giant" motor units. This age-related motor unit remodelling has functional implications for the neural control of muscle force and, hence, muscle function. In addition, some of the decrease in maximal force and rate of force development may be due to a decline in motor unit discharge frequency and an intensified antagonist muscle coactivation leading to an incomplete activation of the agonist muscles.

The decline in performance of the neuromuscular system with advancing age is not only related to biological ageing but is also partly due to reduced physical activity. Recent studies have shown that regular physical activity may counteract or reverse some of the age-related alterations. In addition to an increase in muscle mass, strength and balance training can increase the maximal force and rate of force development in old individuals through enhanced motor unit discharge rate and reduced coactivation. Recent experiments on master athletes even suggest that long-term aerobic training might have a neuroprotective effect on the loss of motor neurones and the functional capacities of active individuals.

The objective of this presentation is to describe the main age-related changes in the neuromuscular system with a particular focus on motor unit characteristics and to emphasize the importance of regular physical activity in limiting these alterations.

Tuesday 10th October

Abstracts

Monitoring corticospinal function in children, adults and elderly

Jens Bo Nielsen – *University of Copenhagen*

Oscillatory activity in specific frequency bands is an important feature of communication in the nervous system. Oscillatory activity in the alpha (5-15 Hz), beta (15-35 Hz) and gamma (35-65 Hz) frequency ranges has been shown to be transmitted to the muscles and may therefore be measured in the EMG activity. This provides a possibility of studying functional connectivity between different parts of the motor system using coherence and correlation analysis. Coupling between the motor cortex (EEG measurements) and the muscle activity (EMG measurements) – corticomuscular coherence (CMC) - may therefore be used to monitor functional changes in corticospinal activity throughout the life time. The corticospinal tract establishes connections with spinal motor neurons shortly prior to birth and CMC is absent or very weak at this time. During what may be a sensitive period from 6-25 weeks after birth, very significant CMC is seen. This may be linked to re-organization of synaptic connections in the corticospinal pathways and may be related to development of goal-directed control of the extremities. Following this brief period, CMC is absent or difficult to determine, but re-occurs in children older than 4-5 years during voluntary motor tasks. In the following years it increases in magnitude until adult levels are reached around 10-12 years of age. This parallels maturation of the corticospinal tract and optimization of key aspects of voluntary motor control. In children with early brain lesion (cerebral palsy) CMC is generally absent – both during the early presumed sensitive period shortly after birth as well as later in life. This is closely related to abnormal development of motor abilities. In adults, CMC may be observed during a range of motor activities including walking where it has been shown to provide evidence of a contribution of the corticospinal tract to the muscle activity. This contribution is especially significant during visually controlled walking where subjects need to use visual information to steer around obstacles or place their feet carefully. CMC is increased in relation to motor learning, which may possibly be related to consolidation of a lasting motor memory of new motor skills. In elderly subjects CMC decreases significantly in parallel with degeneration of the corticospinal tract and reduction in motor abilities. Following stroke and spinal cord injury CMC is absent or greatly reduced, but may be increased in relation to motor recovery. CMC is thus a sensitive measure of plastic changes in the corticospinal tract.

Tuesday 10th October

Abstracts

Tendon adaptability and ageing

Stig Peter Magnusson – *University of Copenhagen*

It is well known that muscle mass and function declines with ageing, and although tendon properties influence the overall function of the muscle-tendon unit much less is known about how ageing affects tendon. How forces are transmitted within a tendon remains an enigma, and the fibril, which is the smallest functional unit, has for long been considered discontinuous. However, recent data suggest that fibrils may be continuous throughout the tendon. Some recent data suggest that turnover of the human tendon after maturity is very slow or absent, although there are some discordant data. Tendon collagen content, enzymatic cross-links and whole tendon size appear to be largely unchanged with aging while habitual loading can augment the cross-sectional area of the whole tendon. In contrast non-enzymatic cross-links appear to increase substantially with ageing. Mechanically, aging as well as short periods of immobilization appears to be associated with a reduction in modulus and strength.

Wednesday 11th October

Scientific Programme

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

09:30 to 10:30	Fast reactions to gait perturbations **Jaak Duysens** – *Katholieke Universiteit Leuven*
10:30 to 11:00	Coffee break
11:00 to 12:00	How to improve balance recovery during loss of balance in older adults – Compliance with principles of training and motor learning **Itshak Melzer** – *Recanati School*
12:00 to 13:30	Break
13:30 to 14:30	Biomechanics and computational sensory-motor control **Heiko Wagner** – *University of Münster*
14:30 to 15:00	Coffee break
15:00 to 16:00	Lifespan balance control: a premier quality for motor competence **Albert Gollhofer** – *Albert Ludwigs University of Freiburg*

Social Programme

16:30 to 18:30	**A walk through history: the Berlin wall** Philippstr. 13, Haus 11, 10115 Berlin – *Meeting point*

Wednesday 11th October

Abstracts

Fast reactions to gait perturbations

Jaak Duysens – *Katholieke Universiteit Leuven*

Walking and running are very common motor activities and it is therefore not surprising that there have been many efforts to study its neural basis. It makes sense that locomotion is already organized at a low level in the central nervous system (spinal central pattern generators) but the question remains whether higher cortical levels are needed to adjust to gait perturbations. Several types of disturbances will be discussed, including stepping unexpectedly in a hole ("foot-in-hole" experiments), stepping over obstacles and stepping while being pushed from the side. Some of these perturbations elicit short-latency stretch reflexes but these are usually so small that they are not functionally relevant. It will be seen that the truly important reactions to perturbations fall into 2 categories. One group is related to protective responses. For example, in many instances the first reaction is a "braking response" allowing the subject to slow down before taking any further action. Sometimes it takes the form of a cocontraction leading to a stiffening of a joint (mostly the ankle). This is usually followed by responses which are appropriate for the type of perturbation ("corrective responses"). Most work has focused on the second group of responses but this may have been an artefact, due to the use of perturbations that are more or less predictable. If the stimuli are unpredictable there is an increased chance of seeing a brief "startle-like" response ("first trial response"). Most of these responses are fast enough to be labelled involuntary (<150 ms). Because responses are so fast it is tempting to consider them as being programmed in open-loop mode. However, there is evidence to the contrary since feedback seems to be able to change these fast responses. It can be concluded that many adaptations to gait perturbations are subconscious and involve either subcortical or fast cortical circuits.

Wednesday 11th October

Abstracts

How to improve balance recovery during loss of balance in older adults – Compliance with principles of training and motor learning

Itshak Melzer – *Recanati School*

Most balance training regimens for elderly individuals focus on self-controlled exercises although automatic postural responses following a balance perturbation are not under direct volitional control. In the presentation I will review past studies on this topic and notice that several studies fail to comply with basic principles of training and therefore show little improvement in function. Some present the view that physical function in the "too frail and too fit cannot be improved", which we instead argue would be the effect of non-specific training programs. I propose a concept for balance training that incorporates gait training as well as unexpected and random perturbations to improve balance control during unexpected loss of balance. The program focus on the skill to recover balance and avoid fall . RCT and the feasibility of the concept will be demonstrated on older adults and a randomized control trial is underway on stroke survivors as well.

Wednesday 11th October

Abstracts

Biomechanics and computational sensory-motor control

Heiko Wagner – *University of Münster*

In this lecture I would like to show some examples for how computational modelling can explain experimental findings, and how models can be the basis to develop new conceptual models and theories. Self-stability and Motor Control: do they know each other? If the biomechanical system changes its stability, do the motor control system can react upon this changed situation?

We measured EMG-signals of elbow flexors in a self-stable and a more unstable situation. Assuming that the EMG is characterized by drift and diffusion, we found that the drift values were linearly related to the elbow angles, and that the slope of this relation changed depending on the self-stability.

Why do many pregnant women develop low back pain? Maybe the answer is a stability problem. The influence of stability and biomechanical properties on mechanical loads will be discussed based on simple models and complex computational models.

The causes of chronic pain, chronic unspecific pain and phantom pain often remain mysterious. Here again, computational models could help to develop a hypothesis to apparently contradictory experimental findings. A self-organizing neural network coupled with a physiologically realistic, computational model resolved such conflicting findings. Both, the amount of reorganization and the level of cortical activity during phantom movements were reported to be enhanced by strong phantom pain. Phantom pain, maladaptive reorganization, and persistent representation may all be caused by the same underlying mechanism.

Finally, I will present a new unified inverse and forward model of ideomotor control. This model is supported by simulations of a complex recurrent neural network. It serves simultaneously as a controller for the muscular activity and as a predictor of the corresponding sensory feedback. The advantage of such a unified circuit is that both, the inverse and forward direction are intimately linked, potentially increasing its efficiency and power.

Wednesday 11th October

Abstracts

Lifespan balance control: a premier quality for motor competence

Albert Gollhofer – *Albert Ludwigs University of Freiburg*

The ability of balance and the control of posture is a basic requirement for human movement, especially for locomotion and stance. Adequate postural strategies to modulate this control depend on the integration of the sensory information provided from proprioceptors in the peripheral limbs and from visual and vestibular receptors into the ongoing motor processing. Depending on the orientation of the body in space and on the environmental constraints the neuronal system provides the appropriate efferent muscular activity. Neuromuscular activation provided by internal modelling is largely dependent on the accuracy of sensory input and on their interpretation by the motor system. From a biomechanical point of view the force vector of the body's center of mass (=center of gravity) must point towards the support area of the feet to secure a stable upright posture (Winter et al. 2001). Studies dealing with static upright posture demonstrated that the human body thereby acts as an inverted pendulum, consisting of a multi-segmental system controlled by muscle forces and interlinked by flexible joints.

Several experiments have examined the maturation of the postural system during human motor development and the degrading effects seen in aging. It has been shown that postural control is drastically changing during life span: Babies need approximately one year to stand upright independently, before they are able to walk. A series of preceding developmental steps must "be learned" or acquired and experimental data show that children need more than seven years before they are able to demonstrate adult-like postural control. On the other side, aging is associated with multiple impairments of the sensory feedback systems. Visual, vestibular as well as proprioceptive information is affected and thus central processing might be compromised. In consequence, internal modelling is suboptimal. In line with maturation in the youth and with degradation in aging the number of unintentional falls is strongly related (Granacher et al. 2008). Specifically, in aging unintentional falls are severe risk factors and a series of research has been conducted in the past decades to investigate proper and suitable intervention countermeasures to either minimize age related degradations or to compensate by preventive training.

Thursday 12th October

Scientific Programme

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

09:30 to 10:30	Myotendinous plasticity to ageing, disuse and exercise training **Constantinos Maganaris** – *Liverpool John Moores University*
10:30 to 11:00	Coffee break
11:00 to 12:00	Age related changes in muscle-tendon interaction and its influence on neural activation **Andrew Cresswell** – *The University of Queensland*
12:00 to 13:30	Break
13:30 to 14:30	Muscle weakness treatment in elderly with knee osteoarthritis: neuromuscular electrical stimulation and photobiomodulation **Marco Aurelio Vaz** – *Federal University of Rio Grande do Sul*
14:30 to 15:00	Coffee break
15:00 to 16:00	The aging tendon **Michael Lavagnino** – *Michigan State University (videoconf.)*

Social Programme

16:30 to 17:30	**Meet our department: the gait lab** Philippstr. 13, Haus 11, 10115 Berlin – *Meeting point*

Thursday 12th October

Abstracts

Myotendinous plasticity to ageing, disuse and exercise training

Constantinos Maganaris – *Liverpool John Moores University*

By virtue of their anatomical location, tendons make it possible to convert muscle forces to locomotion. However, in acting as force transmitters tendons behave more like springs rather than rigid links, impacting on the behaviour and mechanical output of the in-series muscle. Traditionally, the mechanical characteristics of tendons have been studied using in vitro isolated tissue, but in the late 90s, advancements were made in the application of ultrasound scanning that allowed quantifying the tensile deformability and mechanical properties of human tendons in vivo. Since then, the main principles of the ultrasound-based method have been applied by numerous research groups throughout the world and showed that tendons increase their tensile stiffness in response to exercise training, and decrease their stiffness in response to ageing and disuse. The stiffness changes caused by alterations in mechanical loading occur quite rapidly, however, in some studies the stiffness changes can be entirely attributed to tendon size adaptations, in some other studies entirely to material adaptations, and yet in other studies to both size and material adaptations. In my presentation, I will explore potential explanations for these discrepancies and suggest future research directions for improving our understanding of the relation between myotendinous structure and function and the adaptations underpinning the changes in the mechanical outcome of muscle with conditions of use, disuse and ageing.

Thursday 12th October
Abstracts

Age related changes in muscle-tendon interaction and its influence on neural activation

Andrew Cresswell – *The University of Queensland*

With advancing age, there are many degenerative changes associated with the neuromuscular system. A decline in force producing capacity is generally associated with a loss of muscle mass, predominantly with the larger, fast twitch, muscle fibres being involved. There are also accompanying changes in force steadiness, rate of force development and an overall poorer control of movement. Changes are also known to occur in tendinous tissue, with a decrease in tensile strength and an increase in compliance. As a result of the changing mechanical interactions between muscle fibres and tendinous tissue, changes in neural activation and sensory input are likely to occur. Innovative methods of measuring muscle fibre dynamics and single motor unit behaviour will be described. The presentation will explore how the mechanical interaction between tendon and muscle influences the firing properties of motoneurons and the resulting force development. How ageing affects these properties will be also be presented. In particular, I will focus on how the rate of force development and associated fascicle dynamics influences the firing properties of motor units. I will then explore the firing behaviour of motor units during sustained fatiguing contractions and ballistic contractions and how firing behaviour differs between young and old. Finally, I will discuss how changes in series elastic compliance with ageing affects force summation as measured during stimulated contractions, which resemble high-frequency motor unit discharge activity at the initiation of ballistic contractions. In summary, age related changes in muscle mechanics and neural activation will be presented which may be of particular consequence to balance recovery and preventing falls.

Thursday 12th October

Abstracts

Muscle weakness treatment in elderly with knee osteoarthritis: neuromuscular electrical stimulation and photobiomodulation

Marco Aurelio Vaz – *Federal University of Rio Grande do Sul*

Knee osteoarthritis (OA) is the most prevalent type of osteoarthritis. This chronic degenerative disease determines morning stiffness, reduced range of motion, chronic joint pain and muscle weakness. We have shown that quadriceps muscle weakness decreases muscle thickness and fascicle length in women with knee OA. These changes in muscle architecture lead to decreased functionality due to decreased maximal muscle strength and maximal shortening velocity. Neuromuscular electrical stimulation (NMES) has been recommended for quadriceps strengthening when chronic pain and joint stiffness prevent patients from engaging in a voluntary exercise programme. Low- level laser therapy (LLLT) is a new biophotomodulation therapy for treating knee OA because of its cell bio-stimulating action and its regenerative, analgesic, and anti- inflammatory effects. We tested the isolated and combined effects of NMES and LLLT on quadriceps muscle structure and function, on pain and on functionality of OA patients. Muscle architecture was assessed by ultrasonography, knee extensor torque through isokinetic dynamometry, muscle activation by surface electromyography and functional capacity by the 6-minute walk test and by the Timed Up and Go Test. NMES reduced the deleterious effects of OA on quadriceps structure. In addition, NMES increased health status, electrical activity and functionality. LLLT did not potentiate the NMES effects on the evaluated parameters, but increased health status and quadriceps electrical activity. We conclude that NMES with progressive volume and intensity promotes incremental changes in quadriceps muscle structure and function. The combination of LLLT and NMES did not produce any additional benefits in muscle structure and function.

Thursday 12th October
Abstracts

The aging tendon

Michael Lavagnino – *Michigan State University (videoconference)*

Aging induces many specific, but related alterations in the compositional, structural, cellular, and material properties of tendons. These physical changes in the aged tendon may explain why aging is a predisposing factor in the occurrence of overuse injuries of tendons as well as a risk factor for impaired healing after tendon repair. However, the precise alteration(s) by which age may lead to these poor outcomes are unclear. As the population ages and remains active, there is a greater impetus to understand how age-related changes affect the tendon's ability to respond to alterations in loading that accompany injury and repair.

The maintenance of healthy tendon tissue occurs through the ability of tendon cells to sense and respond to mechanical load through the process of cellular mechanotransduction. The aging induced alterations in tendon properties may also change the cellular mechanotransduction capabilities and thus tissue homeostasis. A diminished viscoelastic behavior is one specific alteration of aged tendon properties, making an older tendon less prone to elongation. However, as these age-related changes in composition affect the viscoelastic response of tissues to loading, they may also affect the recovery of these tissues following mechanical loading. Indeed, aged tendons have a lower cellular density that leads to a diminished cell-based tendon contraction rate.
A reduced contraction rate may decrease the ability of elongated tendons to re-establish normal tensional homeostasis. These, and other, age-related changes in the properties of tendons require further research to understand their role in the occurrence of injuries and poor repair on both a larger scale of the muscle-tendon-bone complex as well as the smaller scale of the cellular mechanotransduction response. Understanding the aged cell's response to various states of loading or unloading may help in developing protocols for injury prevention and rehabilitation of older athletes during training and endurance sports with repetitive cyclic loads.

Friday 13th October
Scientific Programme

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

09:30 to 10:30	Life in rough terrain: integration of biomechanics and sensorimotor control for agile and robustly stable bipedal locomotion **Monica Daley** – *Royal Veterinary College*
10:30 to 11:00	Coffee break
11:00 to 12:00	Motor imagery in elderly: its similarity with actual movements and its role on motor learning **Charalambos Papaxanthis** – *University of Burgundy*
12:00 to 13:30	Break
13:30 to 14:30	Supraspinal control of challenging locomotor tasks **Daniel Ferris** – *University of Florida*
14:30 to 15:00	Coffee break
15:00 to 16:00	Biologically-inspired concepts guiding lower-limb exoskeleton design **Gregory Sawicki** – *North Carolina State University*

Friday 13th October

Abstracts

Life in rough terrain: integration of biomechanics and sensorimotor control for agile and robustly stable bipedal locomotion

Monica Daley – *Royal Veterinary College*

Animals must precisely control limb-substrate interactions to move effectively over varied and uncertain terrain while avoiding injury. One key source of uncertainty for animals is sensorimotor delay that limits feedback response times. This delay is a fundamental constraint in animal locomotor control. In this talk, I will discuss several examples from our recent studies of bird and human locomotion that highlight the challenges and elegant solutions for adaptive and robustly stable locomotion in bipedal animals. I will discuss some similarities and differences in control strategies between human and avian bipeds, which highlight different solutions to the fundamental problem of sensorimotor delay.

My research team use comparative biomechanics, neuromuscular physiology and reduced-order theoretical models to investigate control strategies dynamically stable locomotion. We often use ground birds a study animals, because they are diverse bipedal athletes that span >1000-fold range in body mass, yet retain consistent morphology. Many of our recent studies have focused on locomotion over simple terrain features, such as obstacles and potholes. Recently, we have also observed locomotor dynamics of ostriches freely moving in an open field, to observe preferred gait-speed distributions and gait-transition dynamics. By comparing steady and transient locomotor behaviours, we gain insight into functional trade-offs among factors such as stability, injury risk, and economy.

Friday 13th October

Abstracts

Motor imagery in elderly: its similarity with actual movements and its role on motor learning

Charalambos Papaxanthis – *University of Burgundy*

Motor imagery is a state of mental rehearsal during which a subject replicates a motor action without moving the limbs involved in the execution of the same action. Motor imagery recruits neural networks overlapping with those activated during overt movement performance. Furthermore, several studies have shown that imagined actions preserve the same temporal characteristics and obey the same motor rules as their overt counterparts. Lastly, it has been shown that mental training by motor imagery significantly improves motor performance. These similarities between sensorimotor and mental states highly support the idea that imagined actions are part of motor representations and are related to the higher levels of the central nervous system involved in motor planning and prediction. However, while there is an abundant literature in young individuals, little information is available about motor imagery process in normal/healthy aging. Here, I'll present data from several experiments in elderly people showing that imagined actions show the same temporal features as actual actions for relatively simple tasks. For more complicate tasks, such as those requiring a compromise between speed and accuracy (speed-accuracy trade-off), imagined movement do not preserve the temporal features with actual actions. Although, there is a decline in movement representation in elderly for relatively complex motor tasks, as revealed by the motor imagery studies, mental training by motor imagery can improve motor performance in this population. In a recent experiment, we found that mental training in a clinical task (Nine Hole Peg Test, NHPT), can improve movement speed in both the trained dominant-arm and the non-trained non-dominant arm. There results needs further exploration and open interesting perspectives for the use of mental training technique for the rehabilitation of elderly people.

Friday 13th October

Abstracts

Supraspinal control of challenging locomotor tasks

Daniel Ferris – *University of Florida*

The brain and body work together to achieve locomotion in the real world. Challenging locomotor tasks can require concerted attention and involvement of many brain areas. Traditionally, it has been very difficult to quantify brain activity related to human locomotor control because most brain imaging modalities require individuals to remain motionless while seated or supine. Those modalities also have relatively poor temporal resolution, requiring many seconds worth of data to determine the average brain activity. Recent developments in high-density electroencephalography (EEG) are now enabling us to probe different brain areas involved in locomotor control with better temporal resolution. Prof. Ferris will discuss how EEG can provide new insight into brain activity during human locomotion and discuss how the technology will continue to advance in the near future.

Friday 13th October

Abstracts

Biologically-inspired concepts guiding lower-limb exoskeleton design

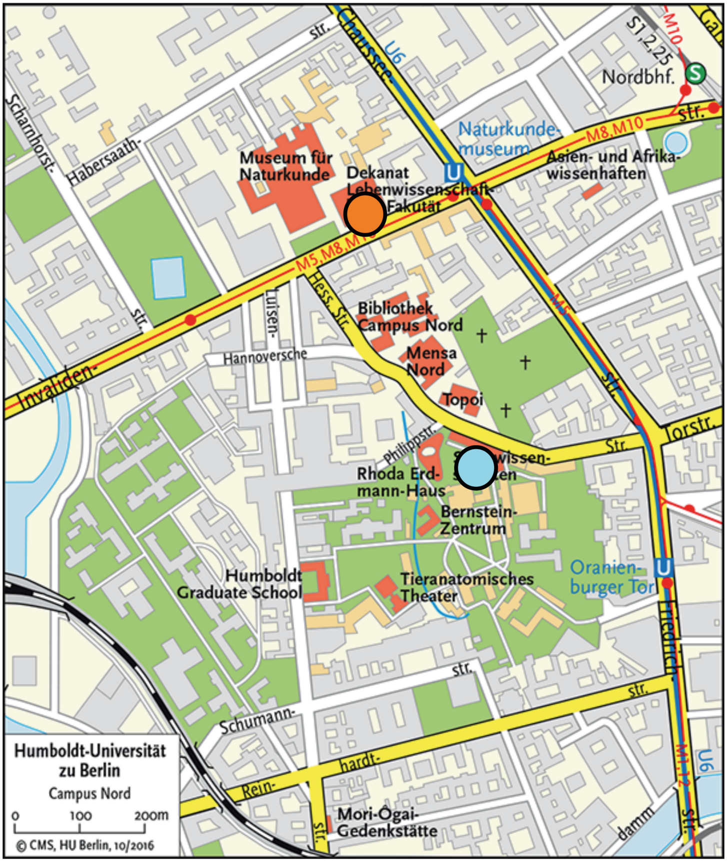
Gregory Sawicki – *North Carolina State University*

Animals, including humans, can utilize elastic mechanisms to enhance muscle performance during locomotion. I will present some of our work highlighting how, at distal limb joints such as the ankle, long, compliant series tendon and aponeurosis can decouple joint and muscle displacements -- allowing muscles to operate at lengths and velocities that are favorable for economical force production, (i.e., during steady movements like constant speed running) or high power outputs (i.e., during accelerative movements like maximum distance jumps). Then, I will describe how we translated our understanding of elastic mechanisms to build a passive elastic exoskeleton and novel clutching mechanism that can provide 'a spring in your step' by storage and release of elastic energy in a parallel elastic element worn about the ankle (i.e., an exo-tendon) during human walking. This device can reduce the metabolic cost of walking by ~7% below normal without adding any external energy from batteries or motors. We contend that simple, bio-inspired designs promise more functional assistive technology than current passive AFO product lines; and could provide a cheaper, more practical alternative to fully powered lower-limb exoskeletons now coming to market. Finally, I will introduce the idea of mechanical resonance as a guiding principle that can be used to inform modifications in the structure of the human foot-ankle system to achieve desired functional outcomes during locomotion. Using healthy aging as a case study, I will motivate the potential for elastic ankle exoskeletons to 're-tune' the structure and function of the plantarflexors in order to improve walking performance later in life. If there is time, I will briefly touch on some exciting new work using isolated muscle-tendons (e.g., an in situ rat preparation) in combination with a novel, benchtop bio-robotic interface to explore the fundamental rules of optimal neuromechanical interaction in hybrid bio-robotic systems.

Lecture hall locations

Mon

Tue-Fri



Addresses and GPS coordinates

Monday
Invalidenstraße 42, 10115 Berlin
52°31'49.2"N 13°22'50.3"E

Tuesday to Friday
Philippstr. 13, Haus 11, 10115 Berlin
52°31'36.8"N 13°23'00.7"E

4th International Autumn School on Movement Science

Berlin, 9th to 13th October 2017

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