8th International Autumn School on Movement Science

Berlin, 30th Sept. to 2nd Oct. 2024

Programme

BSMS
Berlin School of Movement Science

8th International Autumn School on Movement Science

Berlin, 30th Sept. to 2nd Oct. 2024

Programme

Hosted by

Humboldt-Universität zu Berlin, Institute of Sports Science

BSMS – Berlin School of Movement Science
Organisation

Scientific Coordination
Prof. Adamantios Arampatzis (Spokesperson)

Administrative Coordination
Sebastian Bohm, Falk Mersmann

Executive Committee
Prof. Adamantios Arampatzis
Prof. Georg Duda

Scientific Advisory Board
Prof. Vasilios Baltzopoulos (GBR)
Prof. Walter Herzog (CAN)

General Information

Venues

Lectures will take place from Monday 30th September to Wednesday 2nd October.

Address (map at page 24).

Humboldt-Universität zu Berlin
Department of Training and Movement Sciences
Philippstr. 13, building 11, lecture Hall 5 (Room 1.26)
10115 Berlin
Web: www.dtms.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.

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

Day 1 - Monday 30th September

Muscle and connective tissues

14:00 to 15:00 **Tobias Siebert** [University of Stuttgart, DEU]

15:30 to 16:30 **Chloé Yeung** [Institute of Sports Medicine Copenhagen, DNK]

17:00 to 18:00 **Dominic Farris** [University of Exeter, GBR]

18:30 to 19:30 **Owen Beck** [University of Texas at Austin, USA]

19:45 **Get together & Barbecue**

Day 2 - Tuesday 1st October

Muscle and connective tissues / control and mechanics of steady & unsteady locomotion

09:30 to 10:30 **Huub Maas** [Vrije Universiteit Amsterdam, NLD]

11:00 to 12:00 **Christian Couppé** [Institute of Sports Medicine Copenhagen, DNK]

13:30 to 14:30 **Kiros Karamanidis** [University of Koblenz, DEU]

15:00 to 16:00 **Syn Schmitt** [University of Stuttgart, DEU]

16:30 to 17:30 **Ramona Ritzmann** [AO Foundation, CHE]

18:00 **Lab Tour**

19:30 **Food & Drinks**

Day 3 - Wednesday 2nd October

Motor control in healthy and pathological conditions

09:30 to 10:30 **Vivian Weerdesteyn** [Radboud University, NLD]

11:00 to 12:00 **Marco Taubert** [Otto von Guericke University Magdeburg, DEU]

13:30 to 14:30 **Hendrik Schmidt** [Charité Universitätsmedizin Berlin, DEU]

15:00 to 16:00 **Alessandro Del Vecchio** [Friedrich-Alexander-Universität Erlangen, DEU]

Sessions
Social Programme

The students at the BSMS thought of organising a parallel social programme. Please feel free to join us in any of the events planned for the Autumn School!

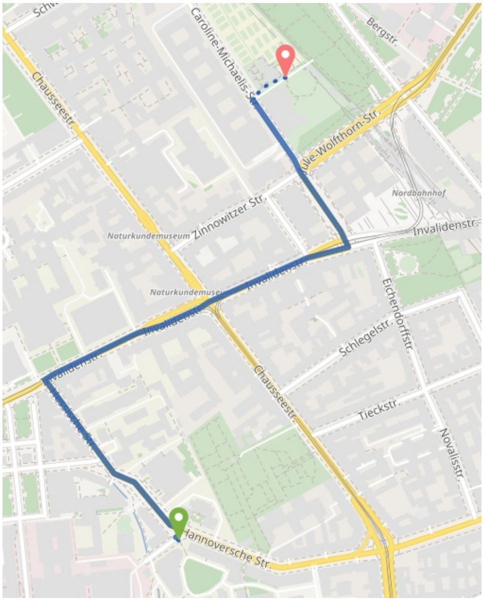
Monday 30th September
Day 1

19:45 **Get Together & Barbecue**
Institut für Sportwissenschaft, 10115 Berlin
Philippstraße 13, building 11, area in front of the venue

Tuesday 1st October
Day 2

18:00 **Lab Tour**

19:30 **Food & Drinks**
BeachMitte, Caroline-Michaelis-Str. 8, 10115 Berlin
(15min walk from venue)



Monday 30th September
Scientific Programme

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

13:30 to 14:00	Welcome and introduction
14:00 to 15:00	The relationship between muscle structure, force generation, and muscle function **Tobias Siebert** – University of Stuttgart, DEU
15:00 to 15:30	Coffee Break
15:30 to 16:30	Circadian clock regulation of tendon matrix homeostasis and its disruption with tendinopathy **Chloé Yeung** – Institute of Sports Medicine Copenhagen, DNK
16:30 to 17:00	Break
17:00 to 18:00	Unwinding the windlass: examining active and passive tissue contributions to human foot mechanics **Dominic Farris** – University of Exeter, GBR
18:00 to 18:30	Break
18:30 to 19:30	Stiffen up for more economical locomotion **Owen Beck** – University of Texas at Austin, USA

Monday 30th September

Abstracts

The relationship between muscle structure, force generation, and muscle function

Tobias Siebert – University of Stuttgart, DEU

Muscles are the motors of locomotion. To understand their function and force-generating properties, one must examine their microstructure in combination with the biomechanical properties. This presentation will deal with the 2 fundamental properties of skeletal muscles: the force-length dependence and the force-velocity dependence with the focus of the latter being on the eccentric force generation. The lecture will provide a historical overview from the first experiments to determine the force-length relationship, through problems with previous explanatory approaches, to new ideas for the model-based description of the entire FLR based on microstructural and kinetic evidence [1]. The second part of the lecture will focus on the force generation of the muscle during eccentric contractions [2]. Previous Huxley-type models are not able to describe the increasing muscle forces during long eccentric muscle contractions. Recent experimental and modelling studies indicate the importance of the muscle filament titin for the generation of eccentric forces. In particular, the velocity-dependent contributions of cross-bridge and non-cross-bridge (e.g. titin) structures to eccentric force generation will be presented. The experimental data have great significance for our structural understanding of muscle force development as well as the development and parameterization of realistic muscle models. These models are needed, for example, to predict the outcome of medical surgeries, stress on the musculoskeletal system in car accidents, or predictions about the efficiency of movements in everyday life and in sports.

References

[1] Tomalka, A., Heim, M., Klotz, A., Rode, C., & Siebert, T. (2022). Ultrastructural and kinetic evidence support that thick filaments slide through the Z-disc. Journal of the Royal Society Interface, 19(197), 20220642.

[2] Weidner, S., Tomalka, A., Rode, C., & Siebert, T. (2022). How velocity impacts eccentric force generation of fully activated skinned skeletal muscle fibers in long stretches. Journal of Applied Physiology, 133(1), 223-233.

[3] Rode, C., Siebert, T., Tomalka, A., & Blickhan, R. (2016). Myosin filament sliding through the Z-disc relates striated muscle fibre structure to function. Proceedings of the Royal Society B: Biological Sciences, 283(1826), 20153030.

Monday 30th September

Abstracts

Circadian clock regulation of tendon matrix homeostasis and its disruption with tendinopathy

Chloé Yeung – Institute of Sports Medicine Copenhagen, DNK

Tendon overuse injuries (tendinopathies) are caused by excessive overloading of the tendon extracellular matrix (ECM) and are characterized by pain, inflammation, and loss of function. My research focuses on understanding the role of the circadian rhythm in regulating ECM homeostasis in connective tissues. We discovered in mice that tendons have endogenous circadian rhythms that dampen with aging [1] and established that the tendon clock regulates collagen secretion and "chronomatrix" assembly [2] and removal [3]. More recently, we found that human tendon is a peripheral circadian clock tissue with diurnal expression of genes related to collagen I fibrillogenesis [4], and we demonstrated that day-night differences in circadian clock and collagen gene expression are reduced with tendinopathy [4]. My work has elucidated a novel mechanism of ECM homeostasis in connective tissues, provides important insights into a possible mechanism of disease pathogenesis, and has the potential to inform the development of new interventions for tendinopathy development and progression. We are now investigating if physical exercise can resynchronize the circadian rhythm and enhance collagen turnover in human tendinopathy and in mouse and tissue culture models [5].

References

[1] Yeung, C. Y. C., Gossan, N., Lu, Y., Hughes, A., Hensman, J. J., Bayer, M. L., Kjær, M., Kadler, K. L., & Meng, Q. J. (2014). Gremlin-2 is a BMP antagonist that is regulated by the circadian clock. Scientific Reports, 4(1), 5183.

[2] Chang, J., Garva, R., Pickard, A., Yeung, C. Y. C., Mallikarjun, V., Swift, J., Holmes, D. F., Calverley, B., Lu, Y., Adamson, A., Raymond-Hayling, H., Jensen, O., Shearer, T., Meng, Q.J., & Kadler, K. E. (2020). Circadian control of the secretory pathway maintains collagen homeostasis. Nature Cell Biology, 22(1), 74-86.

[3] Yeung, C. Y. C., Garva, R., Pickard, A., Lu, Y., Mallikarjun, V., Swift, J., Taylor, S. H., Rai, J., Eyre, D. R., Chaturvedi, M., Itoh, Y., Meng, Q. J., Mauch, C., Zigrino, P., & Kadler, K. E. (2023). Mmp14 is required for matrisome homeostasis and circadian rhythm in fibroblasts. Matrix Biology: Journal of the International Society for Matrix Biology, 124, 8-22.

[4] Yeung, C. Y. C., Svensson, R. B., Yurchenko, K., Malmgaard-Clausen, N. M., Tryggedsson, I., Lendal, M., Jokipii-Utzon, A., Olesen, J. L., Lu, Y., Kadler, K. E., Schjerling, P., & Kjær, M. (2023). Disruption of day-to-night changes in circadian gene expression with chronic tendinopathy. The Journal of Physiology, Epub ahead of print.

[5] Steffen, D., Kjær, M., & Yeung, C. Y. C. (2024). Exercise entrainment of musculoskeletal connective tissue clocks. American Journal of Physiology-Cell Physiology, 327, C270–C277.

Monday 30th September

Abstracts

Unwinding the windlass: examining active and passive tissue contributions to human foot mechanics

Dominic Farris – University of Exeter, GBR

As humans, our feet have evolved to be our main point of contact with the ground when moving around. As such, the shape, size, and strength of the foot's bones and muscles reflect the need to bear our weight and push us from step-to-step. Key features noted by evolutionary studies include the arrangement of bones into load-bearing arches, an adducted great toe, slender calcaneus bone, and strong-elastic structures to add a spring in our step. However, despite this adaptation our feet remain one of the most common sources of musculoskeletal problems, with foot and ankle pain prevalence between 13-36% in the general population. Therefore, it is important that we pursue an understanding of mechanical function of the human foot in-vivo. Over the last decade, we have worked towards this more complete picture of foot mechanics, combining fine wire intramuscular EMG, 3D foot modelling, ultrasound imaging, anaesthetic nerve blocks, peripheral nerve stimulation and other techniques in the process. Our work has highlighted that intrinsic foot muscles are more important than previously thought, and play a key role in load-bearing and making our feet mechanically versatile enough to cope with the varied demands of locomotion. In my talk, I will overview this research and introduce our most recent work on the topic.

References

[1] Farris, D. J., Kelly, L. A., Cresswell, A. G., & Lichtwark, G. A. (2019). The functional importance of human foot muscles for bipedal locomotion. Proceedings of the National Academy of Sciences, 116(5), 1645-1650.

[2] Farris, D. J., Birch, J., & Kelly, L. (2020). Foot stiffening during the push-off phase of human walking is linked to active muscle contraction, and not the windlass mechanism. Journal of the Royal Society Interface, 17(168), 20200208.

[3] Birch, J. V., Kelly, L. A., Cresswell, A. G., Dixon, S. J., & Farris, D. J. (2021). Neuromechanical adaptations of foot function to changes in surface stiffness during hopping. Journal of Applied Physiology, 130(4), 1196-1204.

Monday 30th September

Abstracts

Stiffen up for more economical locomotion

Owen N. Beck – University of Texas at Austin, USA

Walking and running performance depends on whole-body metabolism. Reducing a person's metabolic rate enables them to locomote faster or farther over prolonged periods. As such, interventions that reduce the metabolism of active leg muscles improve walking and running ability [1]. Through a series of studies, I will demonstrate that stiffening structures in human feet and legs via biomechanical interventions decrease whole-body locomotor metabolism. Among these studies, I will show that stiffening foot arches reduce user metabolic rate during running. Further, stiffening user ankles via exoskeletons [2] and custom footwear [3] yield more economical leg muscle contractile dynamics. I will also discuss the role of muscle length on metabolism [4], including how we can modify this parameter to augment locomotion performance. Overall, my presentation will suggest that stiffening human foot arches, tendons, and triceps surae muscles can each improve locomotion performance by reducing whole-body metabolism.

References

[1] Beck, O. N., Punith, L. K., Nuckols, R. W., & Sawicki, G. S. (2019). Exoskeletons improve locomotion economy by reducing active muscle volume. Exercise and Sport Sciences Reviews, 47(4), 237-245.

[2] Nuckols, R. W., Dick, T. J., Beck, O. N., & Sawicki, G. S. (2020). Ultrasound imaging links soleus muscle neuromechanics and energetics during human walking with elastic ankle exoskeletons. Scientific Reports, 10(1), 3604.

[3] Beck, O. N., Schroeder, J. N., & Sawicki, G. S. (2024). Habitually wearing high heels may improve user walking economy in any footwear. Journal of Applied Physiology, 136(3), 567-572.

[4] Beck, O. N., Trejo, L. H., Schroeder, J. N., Franz, J. R., & Sawicki, G. S. (2022). Shorter muscle fascicle operating lengths increase the metabolic cost of cyclic force production. Journal of Applied Physiology, 133(3), 524-533.

Monday 30th September

19:30 **Get together & Barbecue**

Tuesday 1st October
Scientific Programme

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

09:30 to 10:30	Sensory consequences of muscle mechanical conditions **Huub Maas** – Vrije Universiteit Amsterdam, NLD
10:30 to 11:00	Coffee break
11:00 to 12:00	Tendon plasticity and exercise in tendon overuse **Christian Couppé** – Institute of Sports Medicine Copenhagen, DNK
12:00 to 13:30	Break
13:30 to 14:30	Locomotor adaptations from mechanical- and virtual-based perturbation exercises, ageing and disease **Kiros Karamanidis** – University of Koblenz, DEU
14:30 to 15:00	Coffee break
15:00 to 16:00	Autonomous muscle-driven motion in neuromechanics and biorobotics - learning to point, balance, walk, jump, reduce tremor, flex the spine and fall into the bathtub **Syn Schmitt** – University of Stuttgart, DEU
16:00 to 16:30	Break
16:30 to 17:30	Neuromuscular adaptation to disuse - from space to clinic **Ramona Ritzmann** – AO Foundation, CHE

Tuesday 1st October

Abstracts

Sensory consequences of muscle mechanical conditions

Huub Maas – Vrije Universiteit Amsterdam, NLD

Skeletal muscle embed two sensory organs that are critical in the neural control of movement: muscle spindles and Golgi tendon organs. Muscle spindles lie in parallel with the extrafusal muscle fibers. Golgi tendon organs are located at the junction between muscle fibers and aponeurosis or tendon. Classically, muscle spindles are associated with signaling muscle length and velocity, while tendon organs are associated with signaling muscle force. Skeletal muscles do not have only one of each sensor but many, which are spatially distributed with the muscle volume. Why? This is still an unanswered question in neurophysiology. An answer to this question might be found in the structural organization of the muscular system. In the past 25 years, we have shown that within muscles, muscle fibers are linked to each other via the connective tissue network, and also that muscles are mechanically linked to each other and to non-muscular surrounding structures. Such structural organization has been shown to result in the presence of non-uniform strains and stresses within muscles. There are several conditions either pathological, such as muscle injury, or non-pathological, such as growth or aging, that involve changes in mechanical properties of skeletal muscles, including the connective tissue network, which will likely affect sensory feedback. Such altered sensory feed-back most likely steers adaptations in neuromuscular control. Despite a century of movement science, it is unclear how. I will discuss current efforts to address this question's importance for the mechanistic understanding of neuromuscular diseases involving impairments in motor control (e.g. joint hyper-resistance), as well as for the development of biomimetic neuroprosthetic systems and for brain-computer interfaces to restore movement.

References

[1] Maas, H., & Noort, W. (2024). Knee movements cause changes in the firing behaviour of muscle spindles located within the mono-articular ankle extensor soleus in the rat. Experimental Physiology, 109(1), 125-134.

[2] Maas, H., Noort, W., Smilde, H. A., Vincent, J. A., Nardelli, P., & Cope, T. C. (2022). Detection of epimuscular myofascial forces by Golgi tendon organs. Experimental Brain Research, 1-12.

[3] Maas, H. (2019). Significance of epimuscular myofascial force transmission under passive muscle conditions. Journal of Applied Physiology, 126(5), 1465-1473.

Tuesday 1st October

Abstracts

Tendon plasticity and exercise in tendon overuse

Christian Couppé – Institute of Sports Medicine Copenhagen, DNK

In recent years, loading-based rehabilitation has emerged as one of the most efficient treatment modalities for chronic tendinopathy when evaluated in clinical and structural/biomechanical terms. However, despite evident positive clinical effects, some athletes still do not recover/achieve clinically relevant improvements following loading-based rehabilitation. Current evidence of loading-based rehabilitation and other add-on modalities in the management of tendinopathy are also presented and discussed. The overall intention of the talk is to provide knowledge that should be beneficial to clinicians, researchers, educators, and students.

References

[1] Kongsgaard, M., Kovanen, V., Aagaard, P., Doessing, S., Hansen, P., Laursen, A. H., Kaldau, N. C., Kjær, M., & Magnusson, S. P. (2009). Corticosteroid injections, eccentric decline squat training and heavy slow resistance training in patellar tendinopathy. Scandinavian Journal of Medicine & Science in Sports, 19(6), 790-802.

[2] Kongsgaard, M., Qvortrup, K., Larsen, J., Aagaard, P., Doessing, S., Hansen, P., Kjær, M., & Magnusson, S. P. (2010). Fibril morphology and tendon mechanical properties in patellar tendinopathy: effects of heavy slow resistance training. The American Journal of Sports Medicine, 38(4), 749-756.

[3] Skovlund, S. V., Aagaard, P., Larsen, P., Svensson, R. B., Kjær, M., Magnusson, S. P., & Couppé, C. (2020). The effect of low-load resistance training with blood flow restriction on chronic patellar tendinopathy—A case series. Translational Sports Medicine, 3(4), 342-352.

[4] Agergaard, A. S., Svensson, R. B., Malmgaard-Clausen, N. M., Couppé, C., Hjortshoej, M. H., Doessing, S., Kjær, M., & Magnusson, S. P. (2021). Clinical outcomes, structure, and function improve with both heavy and moderate loads in the treatment of patellar tendinopathy: a randomized clinical trial. The American Journal of Sports Medicine, 49(4), 982-993.

Tuesday 1st October

Abstracts

Locomotor adaptations from mechanical- and virtual-based perturbation exercises

Kiros Karamanidis – University of Koblenz, DEU

Daily-life locomotion constantly challenges the human neuromotor system to respond to changing environments. Thus, the ability to select and execute appropriate motor actions to counteract disturbances during gait, as well as to improve and retain such skills are important for providing safe locomotion. Understanding the factors that enable the neuromotor system to improve, retain, and transfer these stability mechanisms across different perturbations and environmental conditions is key to enhancing fall resilience. In this lecture, we will discuss how gait stability and adaptability during trip-like perturbations are affected by age and determine the impact of neuromuscular function on adaptation, retention, and transfer of improved stability recovery mechanisms to novel perturbations [1,2]. We will further elaborate on whether repeated visual gait perturbations in virtual reality stimulate motor skill learning and benefit gait in physical environments [3].

References

[1] Karamanidis, K., Epro, G., McCrum, C., & König, M. (2020). Improving trip-and slip-resisting skills in older people: perturbation dose matters. Exercise and Sport Sciences Reviews, 48(1), 40-47.

[2] König, M., Epro, G., Seeley, J., Potthast, W., & Karamanidis, K. (2019). Retention and generalizability of balance recovery response adaptations from trip perturbations across the adult life span. Journal of Neurophysiology, 122(5), 1884-1893.

[3] Weber, A., Hartmann, U., Werth, J., Epro, G., Seeley, J., Nickel, P., & Karamanidis, K. (2022). Limited transfer and retention of locomotor adaptations from virtual reality obstacle avoidance to the physical world. Scientific Reports, 12(1), 19655.

Tuesday 1st October

Abstracts

Autonomous muscle-driven motion in neuromechanics and biorobotics - learning to point, balance, walk, jump, reduce tremor, flex the spine and fall into the bathtub

Syn Schmitt – University of Stuttgart, DEU

Biological motion is fascinating. Especially locomotion plays a crucial part in the evolution of life. Highly evolved structures, like bones connected by joints and soft tissues and contracting proteins in a muscle-tendon unit, enable and prescribe the respective species' specific locomotion pattern. Most importantly, biological motion is autonomously learned, it is untethered as there is no external energy supply and typical for vertebrates, it's muscle-driven. We approach this fascinating topic from a modelling and simulation perspective. This talk will give three recent examples of our work in the following fields: spine biomechanics, motor control, forensic neuromechanics.

References

[1] Badie, N., & Schmitt, S. (2024). Enhancing stance robustness and jump height in bipedal muscle-actuated systems: a bioinspired morphological development approach. Bioinspiration & Biomimetics, 19(3), 036012.

[2] Bunz, E. K., Haeufle, D. F., Remy, C. D., & Schmitt, S. (2023). Bioinspired preactivation reflex increases robustness of walking on rough terrain. Scientific Reports, 13(1), 13219.

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Tuesday 1st October

Abstracts

Neuromuscular adaptation to disuse - from space to clinic

Ramona Ritzmann – AO Foundation, CHE

The long-term unloading of the neuromuscular system during spaceflight has detrimental functional and morphological effects. Chronic changes in the structural and mechanical properties of the musculature as well as neuroplastic changes at the spinal and supraspinal level have been identified in pivotal studies over the last decade. Deficits in sensorimotor control and atrophy of the load-bearing musculature are the most striking symptoms that demonstrate the inevitable interactions between the neural and muscular systems during adaptation to weightlessness in space.

Space science and medical science do not have an obvious connection although the conjunction holds the promise to drive valuable synergies: transfer effects from highly controlled space analog studies (i.e. bed rest, dry immersion, leg immobilization) are of paramount importance to the clinical domain, and the results can be applied to hospitalized or immobilized patients following indication-specific medical treatments or surgery. Evidence generation includes a pathway-specific understanding of the mechanism underlying degeneration due to chronic disuse, effects of duration and recovery that improves patient care through innovative research and countermeasure development. Transfer effects further describe the significant progress made towards the goal of minimizing the functional impact of stimuli that induce neuromuscular adaptations to spatial and clinical conditions.

References

[1] Marusic, U., Narici, M., Simunic, B., Pisot, R., & Ritzmann, R. (2021). Nonuniform loss of muscle strength and atrophy during bed rest: a systematic review. Journal of Applied Physiology, 131(1), 194-206.

[2] Ritzmann, R., Centner, C., Hughes L., Waldvogel, J., Marusic, U. (2024). Neuromuscular changes in postural control following bed rest. Journal of Physiology, in revision.

[3] Lundbye-Jensen, J., & Nielsen, J. B. (2008). Immobilization induces changes in presynaptic control of group Ia afferents in healthy humans. The Journal of Physiology, 586(17), 4121-4135.

Wednesday 2nd October
Scientific Programme

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

09:30 to 10:30	Reactive balance control in health and disease **Vivian Weerdesteyn** – Radboud University, NLD
10:30 to 11:00	Coffee break
11:00 to 12:00	Computational neuroanatomy of motor learning **Marco Taubert** – Otto von Guericke University Magdeburg, DEU
12:00 to 13:30	Break
13:30 to 14:30	FOR5177 - The dynamics of the spine: mechanics, morphology, and motion towards a comprehensive diagnosis of low back pain **Hendrik Schmidt** – Charité Universitätsmedizin Berlin, DEU
14:30 to 15:00	Coffee break
15:00 to 16:00	Neural control of synergistic motor neuron pools: implications for health and disease **Alessandro Del Vecchio** – Friedrich-Alexander-Universität Erlangen, DEU

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Wednesday 2nd October

Abstracts

Reactive balance control in health and disease

Vivian Weerdesteyn – Radboud University, NLD

When we lose our balance, reactive stepping is a key saving strategy to prevent us from falling. Indeed, a recent meta-analysis demonstrated that impaired reactive stepping is a significant risk factor for falling in older adults. Such stepping impairments are not only prevalent in older adults, but even more so in people with neurological disorders, such as stroke or Parkinson’s disease. For targeted intervention, it is important to have a thorough understanding of the highly time-critical processes that dictate successful balance recovery. In my talk, I will discuss neurotypical and pathological characteristics of reactive stepping at the behavioral, neuromuscular and cortical level. Furthermore, I will discuss current insights and open questions regarding perturbation-based training for improving reactive stepping, as a task-specific intervention that is gaining popularity in the field of falls prevention.

References

[1] Staring, W. H., Zandvliet, S., de Kam, D., Solis-Escalante, T., Geurts, A. C., & Weerdesteyn, V. (2024). Age-related changes in muscle coordination patterns of stepping responses to recover from loss of balance. Experimental Gerontology, 191, 112424.

[2] Okubo, Y., Schoene, D., Caetano, M. J., Pliner, E. M., Osuka, Y., Toson, B., & Lord, S. R. (2021). Stepping impairment and falls in older adults: a systematic review and meta-analysis of volitional and reactive step tests. Ageing Research Reviews, 66, 101238.

[3] Stokkermans, M., Solis-Escalante, T., Cohen, M. X., & Weerdesteyn, V. (2023). Midfrontal theta dynamics index the monitoring of postural stability. Cerebral Cortex, 33(7), 3454-3466.

Wednesday 2nd October

Abstracts

Computational neuroanatomy of motor learning

Marco Taubert – Otto von Guericke University Magdeburg, DEU

For the clinical application of movement interventions as well as basic research on neuroplasticity, it is relevant to know which brain networks are involved in motor learning and what impact learning can have on the structure and function of these networks. In my research I focus on non-invasive MR imaging of the brain and the changes in central nervous tissue properties during training of complicated balance tasks. In my talk I will provide an insight into the approach to analyzing microstructural neuroplasticity and cortical folding and suggest ways in which these results could be translated into practice.

References

[1] Taubert, M., Ziegler, G., & Lehmann, N. (2024). Higher surface folding of the human premotor cortex is associated with better long-term learning capability. Communications Biology, 7(1), 635.

[2] Lehmann, N., Aye, N., Kaufmann, J., Heinze, H. J., Düzel, E., Ziegler, G., & Taubert, M. (2023). Changes in cortical microstructure of the human brain resulting from long-term motor learning. Journal of Neuroscience, 43(50), 8637-8648.

Wednesday 2nd October

Abstracts

FOR5177 - The dynamics of the spine: mechanics, morphology, and motion towards a comprehensive diagnosis of low back pain

Hendrik Schmidt – Charité Universitätsmedizin Berlin, DEU

Low back pain (LBP) represents a significant social and economic burden, with an increasing number of patients requiring both surgical and non-surgical interventions. The success rates of existing clinical treatments for LBP vary widely, reflecting a fundamental gap in the understanding of the mechanisms underlying disease onset, progression, and therapeutic modulation. Enhancing our mechanistic understanding of LBP is essential for effective patient stratification and the development of personalized treatment approaches. Currently, clinical decisions regarding conservative or surgical interventions are primarily based on patients' physical history, spinal pathology visible in static imaging (X-ray, CT, MRI), and brief physical examinations. These snapshot analyses often fail to capture the natural postures of patients in daily life, overlook the dynamics of spinal mobility and loading, and typically do not account for psychosocial factors. Consequently, they inadequately characterize the underlying processes of tissue degeneration, local inflammation, and pain. Notably, international guidelines do not yet incorporate pathogenesis concerning mechanics, morphology, and motion. The DFG (German Research Foundation)-funded Research Unit comprises orthopedic surgeons, imaging specialists, biomechanics experts, computer modelers, pain specialists, health psychologists, and material and training scientists, working collaboratively to explore the interrelationships among spinal shape and geometry (MORPHOLOGY), physical activity and spino-pelvic kinematics (MOTION), and lumbar spinal loading (MECHANICS) in relation to chronic LBP. This presentation highlights the initial findings from the largest study conducted to elucidate chronic low back pain in Germany, involving comprehensive medical examinations, functional tests, and detailed morphological and mechanical analyses. The results indicate a complex interplay between pain intensity and chronicity, where intensity significantly affects functional aspects such as mobility and spinal loading, while the duration of pain (chronicity) appears to influence morphological parameters. Psychosocial aspects seem to play a subordinate role in the studied cohort. These findings underscore the intricate relationships between pain intensity, chronicity, and physical function in chronic LBP patients. Understanding these dynamics may facilitate more effective patient stratification and lead to the development of personalized treatment strategies, ultimately improving clinical outcomes for individuals suffering from chronic low back pain.

Wednesday 2nd October

Abstracts

Neural control of synergistic motor neuron pools: implications for health and disease

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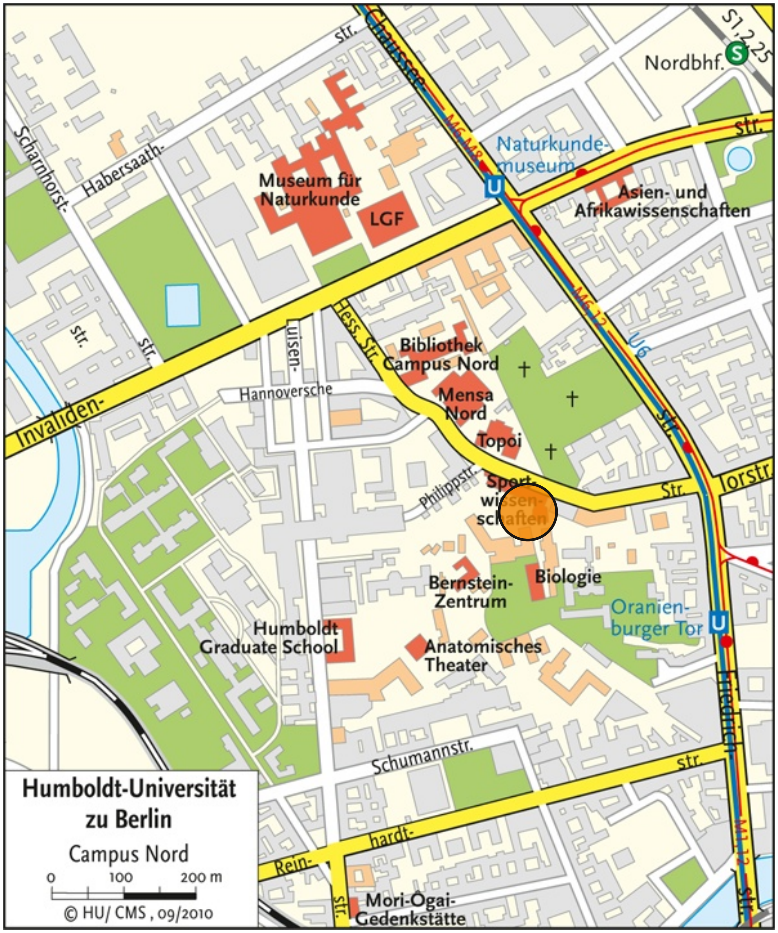
Motor neurons represent the final pathway for movement. We have discovered that motor neurons in both upper and lower limb muscles receive divergent common inputs during synergistic tasks [1]. These activations are specific to individual motor nuclei and generate distinct movements. Each movement is created by a unique set of motor neurons, corresponding to the specific number of agonist muscles involved in the task [2]. In the second part of the talk, I will demonstrate how these motor neuron ensembles can be utilized to reconstruct movement in the paralyzed hand and foot of individuals living with complete motor paralysis [3].

References

[1] Del Vecchio, A., Germer, C. M., Kinfe, T. M., Nuccio, S., Hug, F., Eskofier, B., Eskofier, B., Farina, D., & Enoka, R. M. (2023). The forces generated by agonist muscles during isometric contractions arise from motor unit synergies. Journal of Neuroscience, 43(16), 2860-2873.

[2] Oßwald, M., Cakici, A. L., Oliveira, D. S. D., Braun, D. I., & Vecchio, A. D. (2023). Mechanical hand synergies during dynamic hand movements are mostly controlled in a non-synergistic way by spinal motor neurons. bioRxiv, 2023-07.

[3] Oliveira, D. S., Ponfick, M., Braun, D. I., Osswald, M., Sierotowicz, M., Chatterjee, S., Weber, D., Eskofier, B., Castellini, C., Farina. D., Kinfe, T. M., & Del Vecchio, A. (2024). A direct spinal cord–computer interface enables the control of the paralysed hand in spinal cord injury. Brain, awae088.



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