Abstracts

Friday

Session 1: Body awareness in music performance

„Science & Society Session of the Schering Stiftung“

Chairman: Dr. Boris Kleber (Aarhus)

„Fingers falling asleep on stage“. Limits and awareness of ranges of motion in joints.

Ulrike Wohlwender: State University of Music and the Performing Arts Stuttgart (Germany)

Mostly, when looking for the causes of overuse syndromes such as ganglia, tenosynovitis, fingers falling asleep or even focal dystonia little attention is paid to the individuality of the musician’s hand. Perhaps due to the underestimation of this factor? Who e. g. would take into consideration interindividual differences of more than 9 cm in span width 2-5, or 60° in supination?

In the case of a piano student with “fingers falling asleep on stage” the Pragmatic Hand Evaluation (PHE), a simplified version of the Biomechanical Hand Measurement (BHM), was applied. The pianist´s playing technique was observed, focusing on his (awareness of) limits of range of motion in joints, and discussed in knowledge of the pianist´s individual hand profile. This produced reasonable and revealing indicators of causes and provided answers to the problem.

No pain, no gain: Maladaptive behaviors in professional musicians

Anna M. Zamorano: University of the Balearic Islands, Majorca (Spain)

It is known that pain is an important signal from the body that helps to protect us from and alert us to possible injuries. Nevertheless, if pain persists for more than three months after the initial damage or when it exists in the absence of any past body damage, this important signal becomes a pathological one that leads to numerous maladaptive anatomical and functional changes in the brain. Most musicians spend an incredible amount of training with their instrument, often under unnatural and non-ergonomic body positions in the pursuit of perfection. The difficult techniques together with the extensive and high-intensity practice routines have been associated with a higher prevalence of pain in professional musicians compared to non-musicians. Indeed, several studies have estimated that about 80% of professional musicians experience playing-related pain syndromes within their musculoskeletal system during the course of their professional career, compared to a prevalence of chronic pain in general population that is around 20%. This leads us to the question why so many musicians suffer of pain syndromes and, importantly, if musicians differ from non-musicians with respect to pain perception? In order to address these questions, my talk will mainly focus on our scientific evidence as well as my clinical experience as a specialized physiotherapist to provide potential explanations.

Embodied Perception and Action: Musical Applications

Hong Yu Wong: Werner Reichardt Centre for Integrative Neuroscience (CIN), Tübingen (Germany)

In my talk I will explore themes from the neuroscience and philosophy of embodied perception and action and consider applications of these results to musical perception, action, and cognition.

18:45 **Opening ceremony**: Prof. Dr. Dr. h.c. mult. Niels Birbaumer, Institut für Medizinische Psychologie, Tübingen

19:00 – 20:00 **Schering Keynote Lecture**: Prof. Dr. Robert Zatorre, McGill University, Montreal

Perception, Production, Pleasure: How our Brain Makes Music and Make us Love it

Robert Zatorre: McGuill University, Montral (Canada)

Saturday

Session 2: Singing and the brain

Chairman: Prof. Dr. Hans-Ulrich Schnitzler (CIN, Tübingen)

Vocal motor control mechanisms in primates, or why monkeys do not sing

Steffen Hage: Werner Reichardt Centre for Integrative Neuroscience (CIN), Tübingen (Germany)

The human language faculty vastly outperforms mammalian vocal communication systems in scope and flexibility. Even vocal utterances of our closest relatives, non-human primates, lack essential linguistic characteristics obscuring the evolutionary origins of human speech and singing. Volitional control of vocal utterances is one such indispensable feature of human speech. However, communication systems of non-human primates consist of stereotyped and innate calls that are almost exclusively uttered affectively. In addition, nonhuman primates lack the neural machinery endowing modern humans with outstanding cognitive abilities such as language.

Here, I will give insights into vocal motor brain networks in monkeys and into how the limitations of these networks might prevent the production of sophisticated speech patterns and singing. I will point out potential neural pre-adaptations that are deemed critical and sufficient for the

development of flexible communicative systems and how these pre-cursors might have promoted the evolution of human speech in the primate lineage.

The Voice: Insight Views

Matthias Echternach: University of Freiburg, Freiburg (Germany)

The voice production system is a complex mechanical system which involves many separate modules producing or modifying the human vocal sound. Such systems involve the establishment of subglottal pressure by the lungs and the vocal folds, the fragmentation of the air flow by the oscillating vocal folds and articulatory sound modifications within the cavities above the vocal folds, often denoted as the vocal tract. Most of these systems are inside the human body and therefore primarily not visible. During the past years, innovative technologies have been applied for analysing vocal physiology in professional singers.The presentation shows studies in porfessional opera singers and offer inside views at all stages of the voice production system using innovative technological applications such as real-time magnetic resonance imaging and flexible transnasal high speed digital imaging with a frame rate of up to 20,000 frames per second

Do we feel what we hear? A critical role of kinesthesia in vocal motor control.

Boris Kleber: Center for Music in the Brain, Aarhus (Denmark)

It is now widely accepted that we learn and maintain vocal motor control based on the careful monitoring of auditory feedback. Any discrepancy between intended and actually perceived acoustic consequences of vocal utterances my result in corresponding corrective motor responses until the system produces no or only little error. This is particularly evident in the context of music, where deviations from rhythmic, melodic, or harmonic expectations will be immediately identified as error. However, studies concerned with auditory-motor interactions in

vocal production typically neglect that the motor system also develops accurate kinesthetic percepts that eventually become highly associated with the acoustic goals. To address the question to what extend the auditory and somatosensory modalities may contribute to motor control and what role experience might play in this equation, I will present several studies performed with classically trained singers, which allows us to understand how sensorimotor control may change with vocal training. Results suggest that the kinesthetic motor-control loop becomes increasingly important for the fine-tuning of vocal motor control with increasing singing experience. In contrast, auditory feedback may change its original role and will then mainly be used to calibrate and update the already educated system.

Session 3 – Motor learning in music performance

Chairman: PD Dr. Christiane Neuhaus (Hamburg)

Musical rhythms and auditory-motor integration in the brain

Virginia Penhune: Concordia University, Montreal (Canada)

Music is a complex system of auditory communication found in all human societies. Musical structures of all kinds, from an Indian rag to a Bach fugue, are complex, rule-based systems. The perception of musical structure arises from two basic features: melody and rhythm. Melody is perhaps the most obvious, but music relies on rhythm as a vital part of its power to communicate. Perceiving musical rhythm requires structuring sounds in time. Producing musical rhythms requires the timing, coordination and sequencing of motor actions – the vocal chords, lips and tongue for singing; the fingers, hands and arms for playing an instrument, or the entire body for dance. This lecture will describe the brain mechanisms important for both rhythm perception and production, and discuss how musical rhythm links the auditory and motor regions of the brain. In addition, I will present work describing how early musical training impacts brain structure and sensorimotor integration.

Sleep on it! – The role of sleep for motor learning

Susanne Diekelmann: University Tübingen, Tübingen (Germany)

Sleep supports the stabilization and strengthening of newly acquired memories for the long-term. For some procedural memories and motor skills, sleep is particularly effective, with even short sleep periods leading to substantial performance improvements that are not seen after equal intervals of wakefulness. Specific sleep interventions, like the presentation of learning-associated tones or odors during sleep, can even enhance this effect further. Studies in rats as well as in humans have shown that this effect relies on the 'replay' of learning-associated neuronal activity during sleep periods following learning. This evidence suggests that sleep plays a major role in the effective formation of motor skills for the long-term.

Cortical and basal ganglia contributions to the acquisition and monitoring of piano sequences

Maria Herrojo Ruiz: Goldsmiths University of London, London (UK)

Singing, music performance and speech rely on the retrieval of complex sounds, which are generated by the corresponding actions and are organized into sequences. It is crucial in these forms of behavior that the serial organization (i.e., order) of both the actions and associated sounds be monitored and learned. In this talk I will discuss the neural mechanisms across cortical and subcortical brain areas engaged in monitoring errors during music performance and in learning novel sensorimotor (piano) sequences, with an emphasis on the encoding of sequence boundaries. Finally, I will present new data from two experiments with magnetoencephalography and local field potential recordings demonstrating the role of

cingulate, cerebellar and basal ganglia oscillatory activity in the integration of sequential motor and auditory information during skill acquisition in music performance. The results have potential implications for singing and speech.

Session 4: Mental imagery in music performance

Chairman: Dr. María Herrojo Ruiz (London)

From action intention to sight-reading and beyond: The Posterior Parietal Cortex and its role in music performance

Christiane Neuhaus: University of Hamburg (Germany)

Anybody engaged in the performing arts, be it a dancer, a conductor, or an instrumentalist uses the posterior part of the parietal cortex (PPC) in a natural way. The PPC is considered to be one of the core regions of the human brain for planning and preparing a motor task as well as for processing spatial information. However, since many results are based on invasive single-cell recordings having a long tradition in monkey research many scientists are not fully aware of the multifarious roles of the PPC which also seems to play a role in musical composition.

I will give a short overview of its anatomy and function with special emphasis on action intention, sight-reading, body posture, and active mental imagery.

Auditory Imagery in Singing

Peter Q. Pfordresher: University at Buffalo, State University of New York (USA)

Research on the neural bases of musical imagery reveals that these mental images are multi-modal. For instance, mental imagery of a melody (auditory imagery) typically activates motor planning areas of the brain. I will consider the role of such multi-modal associations in singing; in particular the problem of “poor pitch” singing. In so doing, I will describe a computational model of imagery-based associations that simulates features of poor singing, as well as recent research designed to test the assumptions of this model.

Groove on the brain: rhythmic complexity and predictive coding

Peter Vuust: Center for Music in the Brain, Aarhus (Denmark)

Musical rhythm has a remarkable capacity to move our minds and bodies. I will describe how the theory of predictive coding can be used as a framework for understanding how rhythm and rhythmic complexity are processed in the brain. This theory posits a hierarchical organization of brain responses reflecting fundamental, survival-related mechanisms associated with predicting future events. I review empirical studies of the neural and behavioral effects of syncopation, polyrhythm and groove, and propose how these studies can be seen as special cases of the PC theory. Overall, musical rhythm exploits the brain’s general principles of prediction and that the pleasure and desire for sensorimotor synchronization from musical rhythm could be a result of such mechanisms.

Sunday
Session 6: Strategies towards performance excellence „Science & Society Session of the Schering Stiftung“ **Chairmen**: Dr. Maria Herrojo Ruiz & Dr. Boris Kleber

Strategies towards performance excellence.

Robert Sutherland: Metropolitan Opera, New York (USA)

This talk will provide a musician’s perspective on the topics discussed in the previous sessions. I will begin by talking about my experience as a professional performer. I will then discuss the importance of learning body awareness and motor control. This will be followed by a foray into the realm of opera and the importance of solfège, mental preparation and bringing them all together to establish a pattern of excellence in all aspects of musical performance.

Enhancing performance with neurofeedback

John Gruzelier: Goldsmiths University of London, London (UK)

Feeding back in real time an index of neurophysiological function enables the participant to learn to control it. Despite a chequered scientific history there is now an established body of validation studies, especially with EEG and fMRI methods. The speaker has undertaken controlled studies demonstrating improvements in elite and novice musical abilities in conservatoire students and school children, with performance abilities categorised in domains of musicality, communication and technique. The arts of dancing and acting have also shown gains, and the with latter assessment extended to self-reports of flow which corresponded with expert evaluation. In the field of creativity research the methods have the advantage of ecological validity: see Gruzelier, 2014, Neuroscience and Biobehavioural Reviews.