Symposium

Title: Transcranial brain stimulation in biological psychology

Chair: *Dr. Til Ole Bergmann, Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, Nijmegen, The Netherlands*

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Summary: Transcranial brain stimulation techniques such as transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (tDCS) are important tools to study causal structure-function relationships beyond the correlational nature of functional neuroimaging. We will introduce a variety of techniques and experimental approaches that can be used in biological psychology to tackle a wide range of research questions. Example studies will be presented, ranging from basic neurophysiological research on neuronal oscillations and cortical excitability via visual perception, proprioception and visuospatial attention to complex cognitive functions such as language processing and planning. The symposium will complement a young scientists methods workshop on transcranial brain stimulation techniques which will be held in the run-up to the conference.

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Title: Combined TMS-EEG to study the function of neuronal oscillations

Abstract: The first part of this talk will start with a brief introduction into the techniques of transcranial magnetic stimulation (TMS) and transcranial direct/alternating current stimulation (tDCS/tACS). I will then define the general principles by which these techniques can be incorporated in experimental designs of biological psychology (i) to measure cortical excitability and effective connectivity, (ii) to disrupt or facilitate ongoing neuronal processing, or (iii) to induce transient changes in cortical excitability in an LTP- or LTD-like fashion. Finally, going beyond behavioural and peripheral electrophysiological measures, I will outline how TMS/tDCS can be combined with functional imaging techniques such as EEG and fMRI. In the second part of this talk, I will focus on the combined application of TMS and EEG to study how neuronal oscillations organize information flow in the brain during sleep and wakefulness. Jointly oscillating neurons increase their impact on other neurons by synchronous firing but also regulate their own responsiveness to synaptic input (‘rhythmic input gain modulation’). I will give examples for TMS-EEG experiments studying the function of spindles (10-16 Hz) and slow oscillations (< 1 Hz) in cortical plasticity and system memory consolidation during sleep. I will further present results from ongoing TMS-EEG work during wake to unravel the mechanism by which the alpha oscillation (8-12 Hz) mediates the impact of spatial attention on visual perception.

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Title: Beyond Virtual lesion: TMS & Cognition

Abstract: Transcranial magnetic stimulation (TMS) is a unique method to study cognitive functions. By bypassing the correlative approaches of other imaging techniques, it is possible to establish a causal relationship between brain areas and cognition. In analogy with lesion studies, TMS can provide information about where a particular process occurs. However, one of the most interesting questions in neuroscience may not be where, but how cognitive activity occurs. Beyond localization approaches, TMS can be employed to study brain mechanisms. To use TMS in cognition, it is important to understand not only how TMS functions but also the brain mechanisms being studied and the features of the area of interest. To better describe the advanced knowledge provided by TMS, we will outline the hypotheses beyond TMS applications.

Dr. Daniela Balslev

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Title: The role of eye proprioception in visual localization and visuospatial attention

Abstract: Without knowledge of eye position it would be difficult to extract the layout of a visual scene from retinal snapshots, to reach to visual objects or to match the location of an image and a sound. Both the corollary discharge of the oculomotor command and eye muscle proprioception provide information about the eye position to the brain. I will present findings in healthy subjects after TMS over the eye proprioceptive area in the somatosensory cortex as well as in a stroke patient with a focal lesion in a postcentral gyrus which suggest that although proprioception is continuously monitored, it becomes incorporated into the eye position estimate only when a mismatch with the efferent copy of the motor command is detected. Whereas the link between eye movments and attention shifts is well known, it is still unclear whether eye proprioception too can influence the prioritization of the visual space. Using behavioral and fMRI data acquired after TMS over the eye proprioceptive area I will argue that visual detection and the neural activity evoked by a visual stimulus increases nearer the proprioceptively signaled direction of gaze.

Dr. Christoph P. Kaller

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Title: Differential impact of continuous theta-burst stimulation over left and right dlPFC on planning

Abstract: Previous evidence from neuroimaging indicates that concurrent activations of left and right dorsolateral prefrontal cortex (dlPFC) during planning double dissociate with different cognitive demands imposed by the task: Higher demands on the extraction of task-relevant information are associated with stronger activation in left dlPFC whereas higher demands on the integration of interdependent information into a coherent action sequence entail stronger activation of right dlPFC.

In my talk, I will present a study that used continuous theta-burst stimulation (cTBS) to investigate the supposed causal structure-function mapping behind this double dissociation. Subjects were tested on a variant of the Tower of London task following either real cTBS over dlPFC or sham stimulation over parietal cortex. Results revealed that, irrespective of task demands, cTBS over left and right dlPFC was associated with a global decrease and increase, respectively, in initial planning times compared to sham stimulation. Against expectations, no interaction between task demands and side (left vs. right hemisphere) and/or type (real vs. sham) of stimulation was found. This global asymmetry in the absence of any task-parameter specific impact of cTBS suggests that different levels of information processing may span co-localized but independent axes of functional lateralization in the dlPFC. Probing neuroimaging results with stimulation approaches may hence reveal new insights – and also new questions.

Dr. Gesa Hartwigsen

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Title: Modulating language functions in the healthy brain with TMS

Abstract: Using non-invasive stimulation techniques in the healthy human brain allows for the investigation of acute focal “lesion” effects that are not confounded by chronic processes mediating functional recovery. In this talk, I will outline how TMS can be used to characterize the involvement of homologous right hemisphere brain regions in language. The first part of my talk focuses on the use of a multifocal dual-site “online” TMS approach in which TMS is applied either unilaterally over homologous areas in the left or right hemisphere or simultaneously to both hemispheres during different language comprehension tasks. Here, online TMS is used to characterize the contribution of the stimulated area to a specific language function. The dual-site TMS approach further offers the possibility to study interhemispheric compensation by comparing the effects of unilateral TMS over either hemisphere with the effects of bilateral stimulation. The second part of my talk focuses on the combination of offline TMS (i.e., TMS before a task) and functional MRI to investigate compensatory short-term reorganisation in the language network. Finally, I will introduce the “condition-and-perturb” TMS approach which combines the application of offline and online TMS over different nodes within a functional network. This approach allows for the investigation of intact interactions and adaptive short-term reorganisation processes within intrahemispheric language networks.