**DFG-project entitled:**
Multi-channel transcranial direct current stimulation (mc-tDCS): a novel approach to modulate smooth pursuit eye movement control in healthy individuals and patients with psychotic disorders.

**Funding period:**
2021-2024

**Available positions:**
2 PostDoc positions or 4 PhD positions

**PIs:**
Prof. Dr. rer. nat. Joachim Gross, Institute for Biomagnetism and Biosignalanalysis and Otto Creutzfeldt Center for Cognitive and Behavioral Neuroscience, University of Münster, Münster, Germany

Prof. Dr. med. Rebekka Lencer, Department of Psychiatry and Psychotherapy, University of Lübeck, Lübeck, and Institute of Translational Psychiatry and Otto Creutzfeldt Center for Cognitive and Behavioral Neuroscience, University of Münster, Münster, Germany

Prof. Dr. rer nat. Carsten Wolters, Institute for Biomagnetism and Biosignalanalysis, Department of Mathematics and Otto Creutzfeldt Center for Cognitive and Behavioral Neuroscience, University of Münster, Münster, Germany

**Summary:**
The neural networks subserving smooth pursuit eye movement control provide an ideal model for investigating the interaction of sensory processing and motor control during ongoing movements. In psychotic disorders, deficits of smooth pursuit represent one of the oldest neurophysiological biomarker. Despite intense research using behavioral measurements and functional magnetic resonance imaging (fMRI) the nature of these deficits and their relation to disease mechanisms of psychosis are still unclear. Specifically, to what extent impaired visual motion information processing in occipito-temporo-parietal networks, i.e. visual area V5, and disturbances in prefrontal areas, i.e. frontal eye fields (FEF), represent causes of pursuit disturbances in patients is still an open question. Alternatively, patients may rely even more than controls on prefrontal input (FEF) to compensate for visual motion processing deficits (V5), a hypothesis derived from our own previous studies. Given this ambiguity, the major aim of this study is to determine the specific functional contributions of V5 and the FEF to smooth pursuit control in psychosis patients.
We will use novel individually-optimized multi-channel transcranial direct current stimulation (mc-tDCS) to specifically manipulate neural activity in V5 and FEF. Our mc-tDCS approach will use novel finite element method (FEM) based current flow optimization approaches for computing individualized stimulation currents based on calibrated realistic head models that achieve highest intensity and directionality in V5 and FEF. Individual targeting for mc-tDCS and head model calibration will incorporate multimodal information from FEM-based combined electro- (EEG) and magnetoencephalography (MEG) source analysis and structural MRI and fMRI recordings to reconstruct V5 and FEF in each participant individually.
We hypothesize that inhibitory individual mc-tDCS of V5 and FEF in healthy participants will mimic smooth pursuit impairments as typically observed in patients. These only temporary impairments include a disturbance of smooth pursuit initiation due to disturbed motion information processing in V5 and a pursuit maintenance deficit elicited by disturbed generation of the oculomotor command in FEF. Accordingly, excitatory mc-tDCS of V5 and FEF in patients should attenuate these deficits. Furthermore, excitatory mc-tDCS of FEF will increase otherwise slow eye velocity during smooth pursuit of invisible targets in both healthy participants and patients by supporting the recruitment of extraretinal predictive mechanisms.
Our results will provide a functional model not only for alterations but also for relevant compensatory

mechanisms in neural networks for sensorimotor processing and motor control. This should pave the way for novel approaches using mc-tDCS to modulate and improve sensory integration impairments associated with psychosis, and potentially other neuropsychiatric disorders.