ORAL SESSION: Brain Stimulation

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Oral Sessions

Presentations

Low Intensity Focused Ultrasound Selectively Increases Regional Perfusion

Neurostimulation is an emerging therapy in treating psychiatric and neurological disorders via methods such as TMS and ECT (Nahas et al. 2003; Fox, Liu, and Pascual-Leone 2013). However, most non-invasive transcranial stimulation techniques are limited to the range of disorders they can treat due to their inability to reach deeper brain regions (George 2003), which is currently only achieved by invasive, high-risk and surgery-intensive deep brain stimulation (Rabins et al. 2009; Chan et al. 2009). Validating a novel tool for modulation of deeper brain structures relevant to neurologic diseases, such as the entorhinal cortex (affected in Alzheimer's disease), and in psychiatric disorders, such as the amygdala (involved in anxiety spectrum diagnoses). This study sought to determine whether low intensity focused ultrasound pulsation (LIFUP) can selectively increase blood flow in these two targeted brain regions using LIFUP sonication. This is a very preliminary step towards validating LIFUP as a non-invasive treatment tool for a wide range of psychiatric and neurologic disorders.

Presenter

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Optogenetic stimulation of the mouse entorhinal cortex reshapes whole brain dynamics

While much of fMRI research has investigated the spatial organisation of brain activity, the temporal architecture arising from its dynamics remains unclear. Although some recent work has provided new understanding of the temporal organisation of the human brain, showing transient, repeating patterns of activity and their relationship with cognition (Vidaurre et al., 2017, 2018), little is known about the biological drivers underlying such temporal architecture. Here we combined optogenetic stimulation of the mouse entorhinal cortex together with resting-state fMRI in order to study: 1) How global brain dynamics are influenced by localised neuronal activity, as induced through optogenetic activation of the entorhinal cortex. 2) How these dynamics are compromised during various stages of neurodegeneration in a mouse model of Alzheimer's Disease-like pathology.

Presenter

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Electroconvulsive therapy treatment responsive multimodal brain networks

Though depressive episodes (DEP) is typically treated with different forms of psychotherapy or pharmacotherapy, electroconvulsive therapy (ECT) is regarded as the most effective treatment for severe and treatment-resistant DEP for both major depressive and bipolar disorders [1]. Despite the efficacy of ECT, the neurobiological underpinnings and the mechanisms underlying symptom improvement of ECT-induced antidepressant response remains unclear. Two recent mega-analysis of structural imaging investigations confirmed that ECT induced broadly gray matter volume increase [2], including hippocampus [3], but neither of them found association with treatment outcome. These results suggest that the efficacy of ECT is unexplained by hippocampal enlargement or single gray matter modality, which alone might not serve as a viable biomarker for treatment outcomes.

Presenter

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An optimization approach to TMS targeting of functional ROIs informed by field modelling

Application of TMS to higher-level brain regions is affected by large variation in measured outcomes (Nettekoven et al. 2015). Thus, it is critical to design TMS stimulation protocols that address potential sources of variability across individuals. TMS modelling work has shown that individual cortical topography influences induced electric fields (E-Fields), causing variation in effective TMS dose magnitude and localization (Thielscher, Opitz & Windhoff, 2011). In addition, evidence from fMRI show that higher level multimodal cortical regions, such as prefrontal cortex, often targeted clinically, vary in their structure-function coupling across individuals (Mueller et al. 2013). Solutions such as neuronavigation, target a single gyrus, but do not directly address functional ROIs (Ruohonen & Karhu, 2010). Individual fMRI-guided TMS was found to yield the largest effect size compared to structural MRI or scalp-based targeting strategies (Sack et al. 2009). Thus, it is critical that TMS coil positioning be defined not only on anatomy, but on function as well. As functional ROIs may spread across various cortical features, explicit E-field modelling and optimization is required.

Presenter

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Entrainment of theta oscillations with visual rhythmic stimulation boosts auditory working memory

Rhythmic TMS protocols have recently demonstrated that theta oscillations in the Central Executive Network (CEN, or dorsal stream (Foster et al., 2013)) are causally related to the manipulation of auditory information in working memory (Albouy et al., 2017). In the present study we benefited from the multimodal role of CEN (notably during visual mental rotation, see Figure 1A) to test the power of visual rhythmic stimulations on auditory working memory performance. Indeed in addition to rhythmic non-invasive brain stimulation (rhTMS, tACS) another well-known approach for driving brain oscillations is the use of steady state stimulations. It is now largely admitted that external (visual, auditory, tactile…) stimulations at a periodic frequency rate lead to a high signal-to-noise ratio response in the human electroencephalogram, at the exact frequency of stimulation (Norcia et al., 2015; Regan, 1966). In the present study, using MEG recordings, we first investigated whether the CEN could be entrained by a periodic visual stimulation that induces visual mental rotation (Experiment 1, Figure 1B). We then tested, using EEG, whether such periodic visual stimulation presented before auditory memory (on a trial by trial basis) could specifically enhance the oscillatory dynamics in the CEN and in consequence, causally boost participants' behavioral performance (Experiment 2)

Presenter

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