PhD position on underlying mechanisms on the physiology and pathophysiology of motivation and its neuromodulation

The Laboratory of Clinical Neuroengineering, directed by Friedhelm Hummel (https://www.epfl.ch/labs/hummel-lab), has an open position for a PhD student on the topic of motivation and symptoms of impaired motivation like apathy on learning and memory. The PhD will focus on underling neural mechanisms of physiological and pathophysiological aspects of motivation and on non-invasive brain stimulation of deep brain structures such as the striatum critically involved in motivation behavior by means of transcranial temporal interference electric stimulation (tTIS). To address this question multimodal systems neuroscience methods by means of structural and functional magnetic resonance imaging (s/fMRI), and M/EEG combined with behavioral evaluations will be used.

Project description:

Changes in motivational states, reward processing and respective learning and memory is impaired in several neurological and psychiatric disorders such as Parkinson's disease, traumatic brain injury, dementia, schizophrenia or addiction with currently no established treatment strategy of them. Thus, there is a strong need for innovative neurotechnological interventional strategies to develop novel efficient treatments. These symptoms are associated with dysfunction in deep brain structures and subcortical-cortical circuits with the striatum as a core hub. The present project focuses on developing interventions and technologies that non-invasively allow to target the subcortical dysfunctional circuits to improve symptoms of impaired motivation or reward processing leading to e.g., apathy. To this end, transcranial temporal interference electrical stimulation (tTIS) offers a novel, innovative neurotechnology to target safely and focally deep brain structures. Here, we will develop and evaluate tTIS as a novel treatment strategy to improve symptoms of impaired motivation and reward processing.

Non-invasive neuromodulation by means of brain stimulation (TMS, tDCS) has been developed in the last years as a treatment strategy for neurological and psychiatric disorders (for review e.g., Coscia *et al.* 2019 Brain; Kan *et al.* 2023 Lancet Psychiatry). However, these techniques have the significant limitation that they cannot reach deep brain structures such as the striatum without stimulating the whole overlying cortical areas that renders them not feasible for deep brain stimulation leaving only invasive deep brain stimulation methods with all potential risks as the only current opportunity.

Recently we were able to pioneer a novel deep brain stimulation technology described in rodents (Grossman et al. 2017 Cell) towards human application to neuromodulate non-invasively and topographical specific the striatum. Here we demonstrated for the first time in humans modulation of activity of the striatum with respective changes in behaviour by transcranial temporal interference stimulation (tTIS) (Wessel, Beanato *et al.* 2023 Nature Neuroscience, Vassiliadis *et al.* accepted Nature Human Behavior).

These findings open exciting novel opportunities for translational neuroscience as a novel innovative treatment strategy for neurological and psychiatric disorders where the striatum plays a key role in the pathophysiology of the disorder. Here we are interested in transdiagnostic symptoms, i.e., symptoms that are common in different neurological and psychiatry diseases (e.g., apathy), determine their underlying subcortico-cortical network mechanisms and develop and apply novel non-invasive

deep brain stimulation to ameliorate the symptoms. The present PhD position is dedicated to achieve these goals.

Project description

Specifically, the project plans to investigate the effects of theta-burst deep brain stimulation by means of tTIS (see Wessel, Beanato *et al.* 2023 Nature Neuroscience) applied to the striatum during motivation-related learning tasks in healthy subjects and patients suffering from apathy. The PhD will further develop this neurotechnology, add to the better understanding and treatment of motivation, reward-associated impairments in neurological patients.

The ideal candidate should have a Master's degree (or equivalent degree) in neuroscience, medicine or psychology, computer science, engineering, be strongly motivated with a keen interest in translational systems neuroscience especially brain stimulation, modelling, ML and AI and neurotechnology. (1) Strong neuromodulation background, especially non-invasive brain stimulation, (2) strong neuroimaging background, especially in MRI, (3) Strong programming skills in machine learning and modelling or (4) previous research experience in the experimental trnslational neuroscience are a plus.

Working environment:

The successful applicant will join the EPFL Defitech Chair of Clinical Neuroengineering which is led by Prof. Friedhelm Hummel and focuses on translational human neuroscience and neuroengineering with a focus learning and memory in healthy aging and in patients suffering from stroke, traumatic brain injury or dementia. The Lab is based in Geneva's beautiful Campus Biotech, right next to Lake Geneva and with a second strategic Lab hub in an hospital environment in Sion in the heart of the beautiful area of Valais. The Ph.D. candidate will be enrolled in the EPFL Ph.D program Neuroscience (EDNE).

Start of position:

Spring 2024

Application procedure:

Interested candidates must submit their application to the EDNE doctoral school

(https://www.epfl.ch/education/phd/edne-neuroscience/edne-how-to-apply/)