MSc in Computational Cognitive Neuroscience

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Neural mechanisms of transient neocortical beta rhythms and their alterations in anxiety

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Abstract

Anxiety involves anticipatory changes in physiological and psychological responses to an uncertain future threat. In this project, we are focused on effects of sub clinical anxiety in reward-based motor learning, Investigations have found that in anxiety during initial exploration, the amplitude and the rate of long bursts of sensorimotor and prefrontal beta oscillations (13–30 Hz) was increased. Beta is observed using scalp EEG, MEG, intracranial electro- corticography, and local field potentials (LFPs).

This project aims to combine computational modelling and new recordings of magnetoencephalography (MEG) data to understand the circuit mechanisms underlying alterations in beta oscillations in subclinical anxiety. A major limitation is that it is often difficult to connect the macroscopic scale measured signals to the underlying cellular and circuit level neural generators. This difficulty limits the translation of EEG/MEG studies into novel principles of information processing, or into new treatment modalities for neural pathologies.

We are planning to cover this gap using Human Neocortical Neuro solver (HNN). It is a software tool that is used to test and develop hypotheses on the circuit mechanism underlying them from MEG data. We will use HNN to investigate the mechanisms giving rise to alterations in brief events and waveforms of beta rhythms in subclinical anxiety and link them to impairments in decision-making.

Research Goals

- find sensor-regions that are relevant to the study of development of beta oscillations during tasks.
- Examine the difference in distribution of beta power in scenarios where there is a successful outcome and an unsuccessful one during the tasks.
- Study the relationships between the degree of trait anxiety and distribution of beta band power.
- Macroscopic study involving the data exploration of MEG data and evaluating the features of oscillations in context with the decision model.
- Using Human Neuro cortical Neuro Solver to study the circuit mechanisms giving rise to beta oscillations.
- Data analysis on the available data, and isolating beta burst cases in context of decision model and events.

Data Analysis and Methods

- MNE Python, an open source python package for analysis of human neurophysiological data is used for analysis.
- MEG data is down sampled and was analyzed for removing ICA components corresponding to eye blinking, saccades or heart beats.
- Event library was used to get the context of decision making model during the experiment.
- Sensors corresponding to the sensorimotor region of the brain was identified, data streams from those regions were picked for the analysis.
- Band pass filters corresponding to the beta band is used to isolate the beta bursts.
- Waveforms corresponding to beta bursts are used to investigate the circuit mechanisms underlying with the help of HNN

Preliminary Results

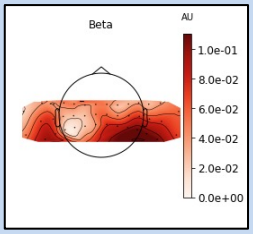

Fig 1

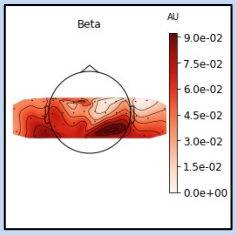

Fig 2

Figure 1 shows the topological graph of a person on Beta power distribution during a 'loss' situation and Figure 2 shows the distribution during a 'win' situation.

Hypothesis and Expected Results

- Sub clinical anxiety will impair decision making and abnormal changes in the beta oscillations can be used for explaining this behavior.
- We are expecting beta bursts in the time period of 2 second along the actual decision making.
- We are also expecting a relationship between the trait anxiety levels and pattern of beta oscillations.

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