MSc-project

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Title: Advanced signal processing of brain activity – investigation of novel approaches to treatment of depression

Description:

Major depressive disorder (MDD) is a severe psychiatric disorder. Faster and more effective antidepressant treatments are needed to overcome the limitations of current treatments. Interestingly, sub-anesthetic doses of ketamine have been shown to produce immediate and persistent antidepressant effects. However, the use of ketamine is limited by its abuse potential and because it is mimicking symptoms of psychosis. For the development of novel antidepressants without ketamine's side effects it is now crucial that the mechanism(s) underlying ketamine's therapeutic effects become better understood. Therefore, we investigated the actions of ketamine on thalamo-cortical networks in the brain, which have been suggested to play an important role in the treatment of major depression.

Using microelectrode arrays, we conducted recordings in the thalamo-cortical network of awake and freely moving rats. The recorded data consists of single unit activity, which indicates the activity of single neurons very close-by the tip of the recording electrode, and of local field potentials (LFPs), which represent the activity of large neuronal populations in vicinity of the recording electrode. Analysis of the acute effects on the activity of single neurons as well as larger neuronal populations will provide insights on the neurobiological changes that occur following the injection of ketamine. Of special interest is a very prominent high-frequency neuronal oscillation that we can reliably observe from the LFPs following the injection of ketamine, indicating that larger neuronal populations become active in a rhythmic fashion.

A major challenge is the complexity of the resulting dataset, which contains video and accelerometer data capturing the locomotor activity of the animals, neural data in form of continuous data (LFPs) and point processes (unit activity), and event data (large parts of the experiment are done with a stimulation paradigm that consists of paired sound pulses that are played to the animal). We are aiming to investigate

several questions which require the application of advanced signal processing methods:

- What is the effect of the locomotor state, i.e. rest vs. movement, as well as the compound on the frequency content of the LFPs? Technically, this requires among other things to build a classifier for the locomotor activity, to analyze the frequency content of the LFPs, and to detect neuronal oscillations.
- What are the effects of the stimulation on the LFPs and the activity of the single neurons? Technically, this requires an event-related analysis of both the continuous data and the point processes. We are furthermore interested in classifying the single neurons into subpopulations, for which one needs to apply feature extraction and a classifier.
- What neural mechanisms are underlying the observed high-frequency neuronal oscillation? This is a very exploratory question which allows for a large freedom in the choice of methods, but would likely include both the continuous and the point-process data.

Required qualifications: Advanced MATLAB programming skills.

Responsible institution: DTU

Contact information: Maria Amat Foraster maaf@lundbeck.com; Ulrike Richter URIC@lundbeck.com; Kjartan Frisch Herrik KFH@Lundbeck.com.

Allowed no of students per report (1-2): 1

Suggested KU supervisor:

Suggested DTU supervisor: Morten Mørup morten.morup@gmail.com.

The project description may be published on the website (yes/no): YES
(Title and responsible institution are always published)