Laboratory title  :  CNRS UMR 5297 - Daniel Choquet

Supervisor

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Thesis title :

Neural coding of associative learning in the dorsal prefrontal cortex of behaving mice

Keywords :  Plasticity and computation of neuronal network, Fear learning, LTP and spine plasticity, Chronic, in vivo 2-photon imaging, In vivo/awake optogenetics and electrophysiology

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Abstract

Neocortical function and plasticity underlie the remarkable adaptive and associative learning skills of mammals. For example, predictive learning allows an animal to anticipate biologically important events by detecting and learning about signals of their occurrence. Interestingly, predictive behaviors have been shown to be strongly affected by focal lesions of the dorsomedial prefrontal cortex (dmPFC). Learning-dependent cortical plasticity is supposed to rely on subtle changes in the spatial pattern and level of neuronal activity that likely depend on connectivity rearrangement through synapses turnover and/or changes in pre-existing synapses. The goal of the current proposal is to monitor the structural dynamics and functional plasticity of pyramidal neurons located in the supragranular layer 2 (L2) of the dmPFC in relation to goal-directed learning and behaviors. This will be done by using sophisticated strategies and state-of-the-art techniques such as optical, electrophysiological, and optogenetic tools in vivo. We will first image dendritic spines of dmPFC pyramidal neurons that express fluorescent synaptic marker through high-resolution 2-photon laser scanning microscopy (2PLSM)-based time lapse imaging. This will be achieved over long time frames in living mice through a cranial window chronically implanted over the dmPFC. Then, we will combine chronic 2PLSM-based calcium imaging of large-scale neuronal activity with in vivo patch-clamp recordings while the mouse learns/performs a goal-directed task. This challenging project will help us to understand how the prefrontal cortex computes and adapts its strategies through experience and learning to optimally select the sequence of actions that is expected to produce the most beneficial outcome.

Qualification required

Background in neuroscience/neurophysiology mandatory. Programming will be necessary during the project.