

Development of methods for studying the interareal communication between frontal cortex and striatum during learning

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Task-specific changes in interareal communication between distinct brain regions is a widely observed phenomenon in many different brain functions. Numerous studies have revealed increased coherent rhythmic activity between the striatum and frontal cortex during learning. However, it is still unknown whether the enhanced coherence between the cortex and striatum is causal to learning or simply a by-product. To answer this question, we established a behavioral task, namely an olfactory Go/No-Go learning task, in which water-deprived mice learn to associate different odors with Go or No-Go action. This task is known to involve both the striatum and prefrontal cortex. With this model, we aim to utilize open- and closed-loop optogenetic stimulation using custom, multi-element implantable recording/stimulation devices to investigate the role of corticostriatal coherence in learning.

Here we also report our approach to develop such implantable devices. Our goal is to identify an inexpensive and durable electrode configuration, suitable for making custom arrays with characteristics that allow for both single-unit activity and local field potential (LFP) recordings. Major factors that will affect the performance are the electrode material and size, the ease of fabrication, as well as the resulting impedance. In our investigation, we used tungsten wires as electrode material and compared their performance with the “gold-standard” commercial platinum/iridium electrodes. Our preliminary data showed that the tungsten wires of 30 μ m diameter have an acceptable signal-to-noise in acute conditions. Next, we will implant these wires together with commercial electrodes in mice and collect daily recordings in awake mice to determine and compare the rate of signal loss and the viability of signals after at least four weeks which is the required time for our learning studies. Once the performance of tungsten wires are confirmed, we will design electrode arrays to address our main question on the role of interareal coherence in learning.