PrimCorNet: Characterization and layer-specific modeling of fronto-parietal dynamics in primate cortical networks

Main area: Testing neuronal models at multiple scales
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Abstract

Understanding the human brain and its dysfunctions constitutes a core objective of the Human Brain Project (HBP). One of the greatest challenges is to understand how differences in the anatomy and organization of local circuits and large scale networks across brain areas give rise to neuronal activity profiles that mediate successful behavior.

Studies of the visual pathways in non-human primates (NHPs) have provided the most comprehensive models of network organization involving multiple cortical areas and integrating local and long-range connectivity constraints. Although these models greatly improve our understanding of the cortical circuitry for visual information processing, they cannot readily generalize to other functional networks with distinct structural and functional properties.

Notably, it is unknown whether the experimentally observed and modeled patterns of interactions can be generalized to include the fronto-parietal network, which is considered the core coordinator of activity of other networks in a task- and state-dependent manner in primates.

In the proposed project we will combine experimental and modeling work to explore how local and large-scale dynamics are shaped within and across distinct fronto-parietal and visual areas. To this end, we will employ large-scale, layer-resolved, simultaneous recordings across frontal, parietal and visual areas of NHPs during different states of arousal and predictability. Our goal is to examine the effect of different states at multiple levels of neuronal activity ranging from spiking activity of neurons in different cortical layers to inter-areal interactions. Specifically, we will (i) ask how layer- and frequency-specific network dynamics underlie communication between prefrontal, parietal and motor areas; (ii) compare with described neuronal interactions across visual areas, and (iii) ask whether different brain states ranging from anesthesia and resting state, to selective attention and different levels of anticipation/predictability affect the dynamics of local and long-range circuits. Importantly, the experimental data will be directly employed to refine and extend a recently developed multi-scale spiking network model of macaque visual areas to include motor and premotor areas, using layered microcircuits of simplified neuron models with the full density of neurons and synapses for all areas. This will result in a model including visual, motor and prefrontal areas in one hemisphere of macaque cortex, constrained with multi-scale electrophysiological activity data from multiple areas across several brain states. This combined experimental and modeling effort will clarify the organization of neural circuits that involve the fronto-parietal network and its contribution to different states of consciousness in order to facilitate a better understanding of how distinct functional architectures shape cognition.

Consortium

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