

2023 Annual Research Day – Oral session
April 19th, 2023, 2:00 p.m. – 4:30 p.m., PHAB 2A

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Data-driven Multiscale Model of Macaque Auditory Thalamocortical Circuits Reproduces In Vivo Dynamics

We developed a biophysically-detailed model of macaque auditory thalamocortical circuits, using the NEURON simulator and the NetPyNE multiscale modeling tool. This model contained a simulated column of primary auditory cortex (A1), along with corresponding portions of the medial geniculate body and thalamic reticular nucleus. The simulated thalamic structures included core and matrix thalamocortical pathways with layer-specific projection patterns to A1. The A1 column contained over 12k neurons and 30M synapses distributed over 6 cortical layers. Cell densities, laminar locations, biophysics, and connectivity were all derived from published experimental data. The model accurately simulated local field potentials (LFPs), current source density (CSD), and electroencephalogram (EEG) signals when compared to spontaneous macaque recordings made in A1. Physiological oscillations in CSD also emerged spontaneously across frequency bands and were comparable to those recorded in vivo. We have examined the circuit activity underlying several of these oscillation events, by determining which cell populations contributed most to the overall CSD signal, then examining the pattern of presynaptic activity onto these populations before and during the event. We have done this as proof of concept for several individual events, and aim to generalize this information to create specific testable hypotheses regarding oscillation generators in A1. Overall, this computational model provides a quantitative theoretical framework to integrate and interpret a wide range of experimental data in auditory circuits. It also constitutes a powerful tool to evaluate hypotheses and make predictions about the cellular and network mechanisms underlying common experimental measurements.