Isolating Single Cycles of Neural Oscillations in Spiking Activity

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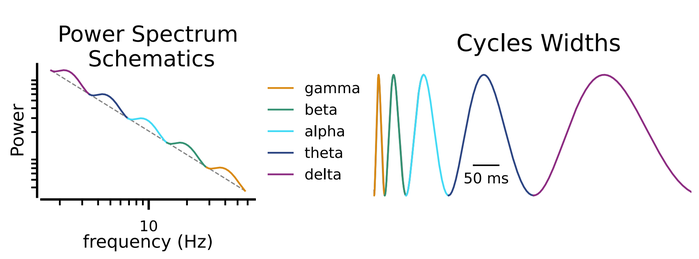
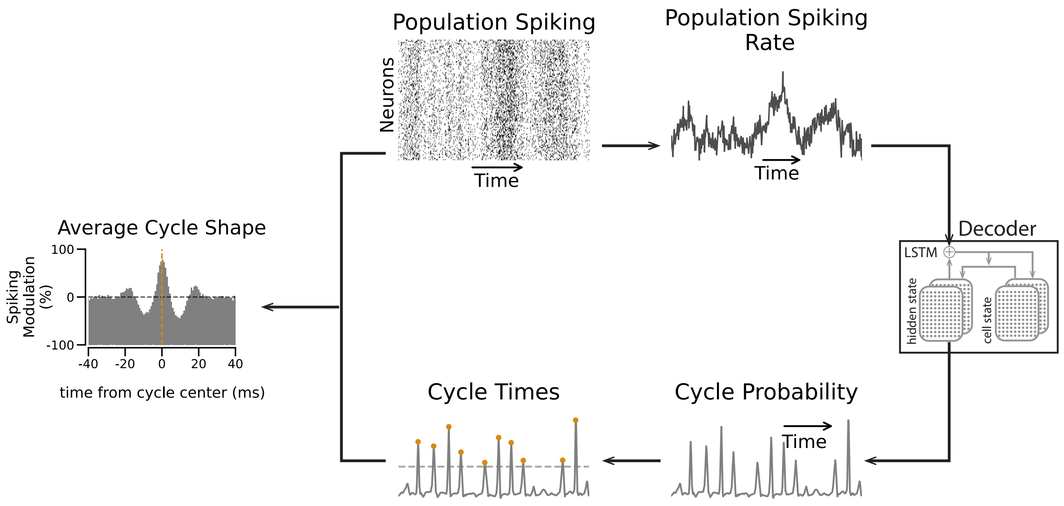
Abstract

While identifying neural oscillations has primarily relied on Local Field Potentials (LFP), the intrinsic relation between neural oscillations and neuronal ***spiking*** remains noteworthy. We investigate the possibility of detecting single cycles of neural rhythms solely through the spiking activity of neurons, using recent advancements in densely recording large populations of neurons within a local network. Many spikes from neurons in a local network provide an estimation of the network activity across time, which we can use to investigate the existence of cyclic patterns. Here, we employ recurrent neural networks to robustly isolate individual cycles of neural oscillations from the spiking of a densely recorded population of neurons. This isolation occurs in the time domain, where cycles from different time scales may combine in various ways to shape the network's spiking probability.

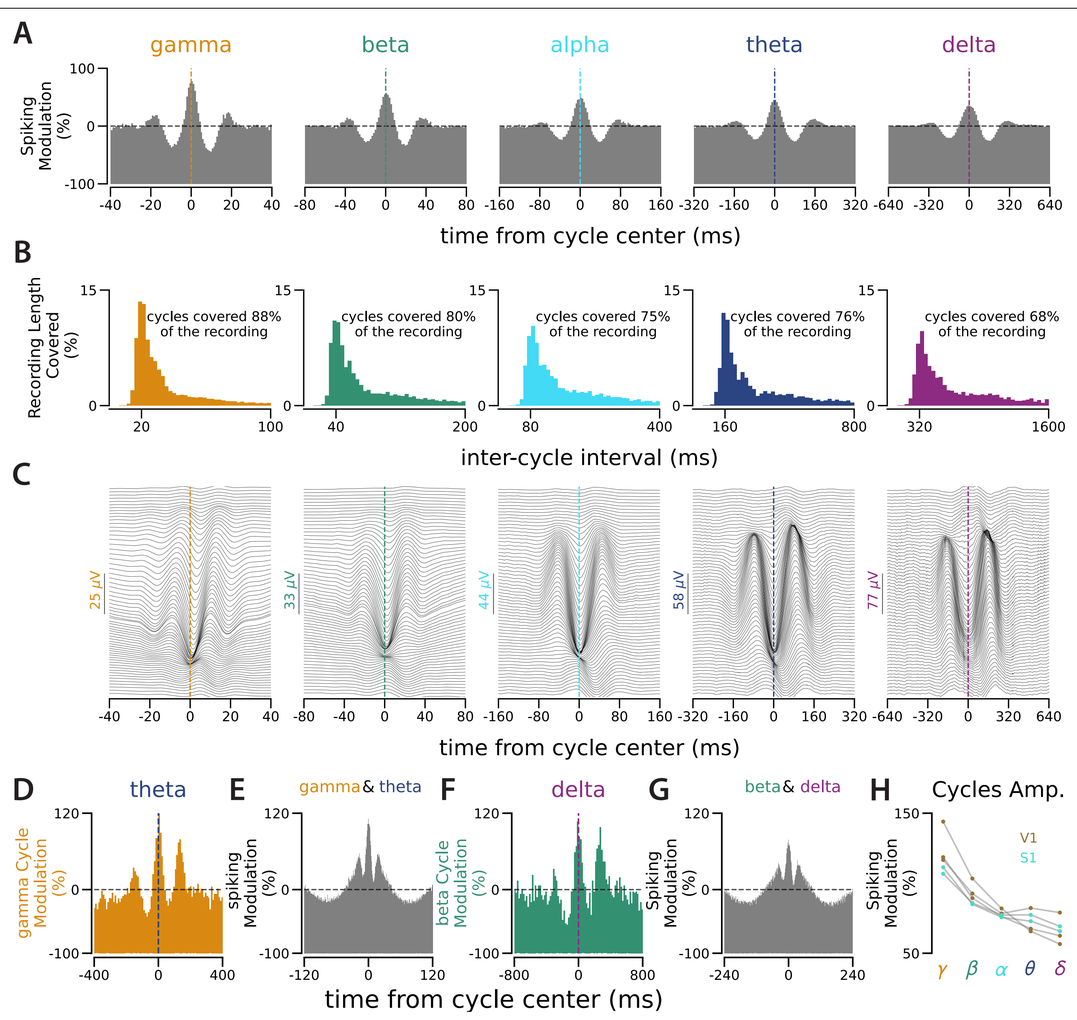
Introduction



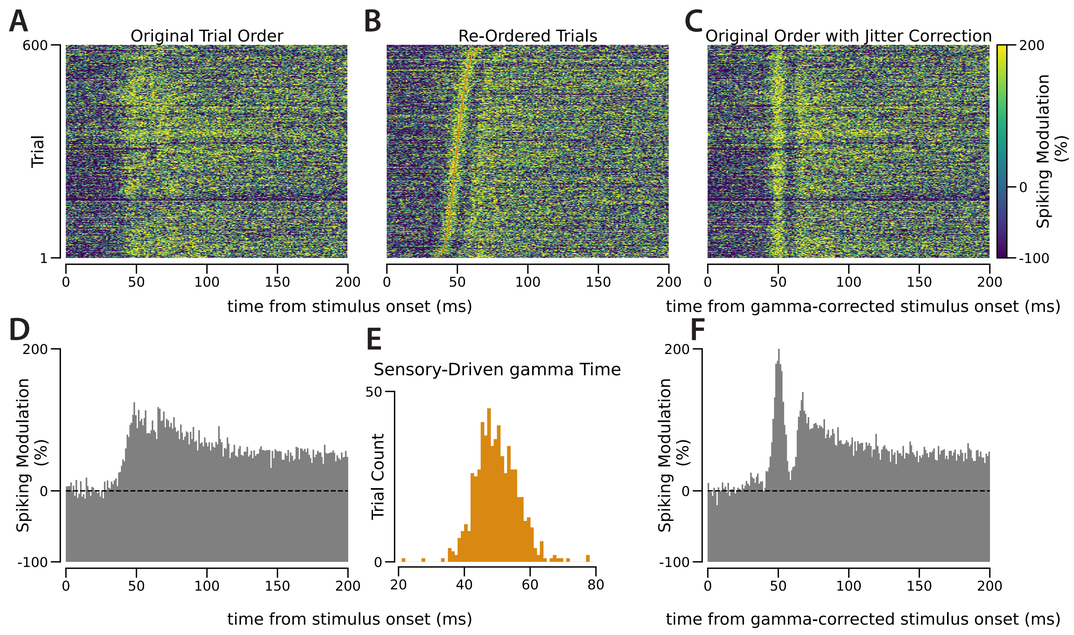
Cycle	Duration
gamma	20 ms
beta	40 ms
alpha	80 ms
theta	160 ms
delta	320 ms



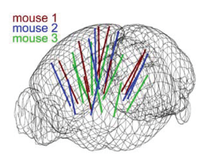
Cycle Detection in Population Spiking of Mouse Primary Sensory Cortex



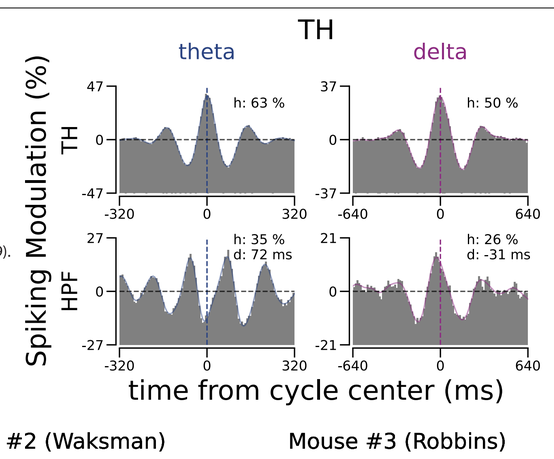
Sensory-Driven gamma Cycles Help to Compensate for the Variation in Signal Transfer Time between Retina and V1 across Trials

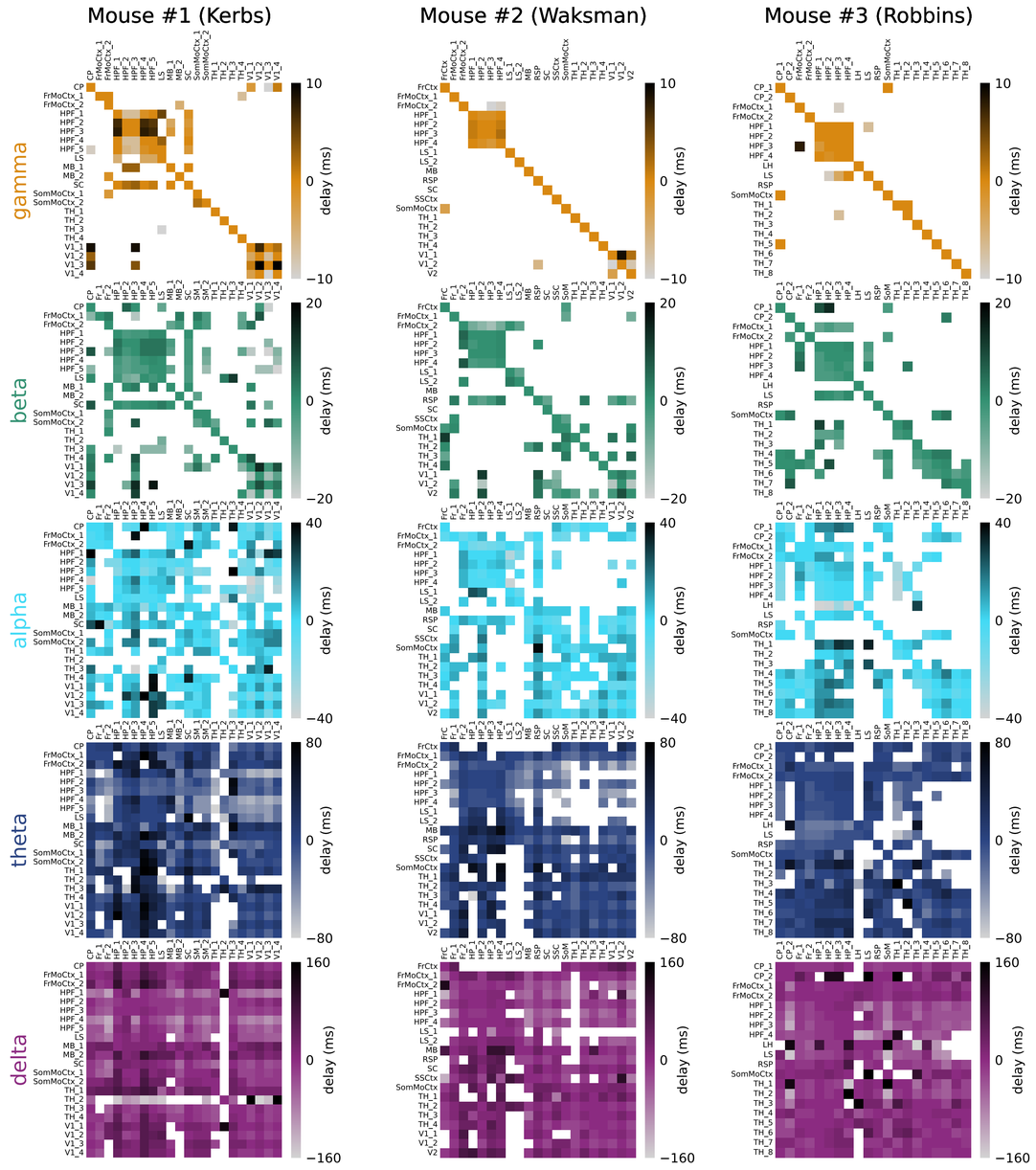


Correlated Activity across Brain Regions in Different Time Scales



Steinmetz, N., Pachitariu, M., Stringer, C., Carandini, M., and Harris, K. (2019). Eight-probe Neuropixels recordings during spontaneous behaviors.





Isolating Ultra Slow Cycles in Population Spiking, Pupil Size, and Facial Motion: Similar Basis Functions?

Cycle Name	Duration
quarter e	640 ms
half e	1.25 s
e	2.5 s
2e	5 s
4e	10 s