

Section: Behavioral/Systems/Cognitive

Title: Reconciling Coherent Oscillation with Modulation of Irregular Spiking Activity in Selective Attention: Gamma-Range Synchronization between Sensory and Executive Cortical Areas

Abbreviated title: Attentional modulations and inter-areal synchrony

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Abstract

In this computational work, we investigated gamma-band synchronization across cortical circuits associated with selective attention. The model explicitly instantiates a reciprocally connected loop of spiking neurons between a sensory-type (MT) and an executive-type (prefrontal/parietal) cortical circuit (the source area for top-down attentional signaling). Moreover, unlike models in which neurons behave as clock-like oscillators, in our model single cell firing is highly irregular (close to be Poisson) while local field potential exhibits a population rhythm. In this 'sparsely synchronous oscillation' regime, the model reproduces and clarifies multiple observations from behaving animals. Top-down attentional inputs have a profound effect on network oscillatory dynamics while only modestly affecting single-neuron spiking statistics. In addition, attentional synchrony modulations are highly selective: Inter-areal neuronal coherence occurs only when there is a close match between the preferred feature of neurons, the attended feature and the presented stimulus, a prediction that is experimentally testable. When inter-areal coherence was abolished attention-induced gain modulations of sensory neurons were slightly reduced. Therefore, our model reconciles the rate and synchronization effects, and suggests that coherence contributes to large-scale neuronal computation in the brain through modest enhancement of rate modulations.