A battle of timing vs amplitude: signal competition in the olfactory networks

Alla Borisyuk | University of Utah

Sensory inputs to the olfactory system are periodically modulated by sniffing. Each odor can activate multiple input lines (glomeruli), each with its own onset latency, mean and modulation amplitude. A popular theory, "primacy coding", suggests that inputs with shorter latencies get amplified through olfactory processing and determine the perceived odor identity, while later inputs get suppressed. However, recent data shows that this is not always the case. It is proposed instead that the depth of the modulation of inputs might be playing a crucial role in determining the odor identity. In this work we use both biologically-constrained spiking models and idealized firing rate models to understand the interplay of timing and amplitude of signals in the olfactory system and their role in odor coding. First, we propose that a local excitatory-inhibitory network in the piriform cortex can suppress less-modulated inputs to the system (even if these inputs have a shorter latency or higher mean) by, essentially, acting as a slope detector. Further, we find in the spiking model that, when the two inputs have similar amplitude and are phase-shifted, the responses organize in an anti-phase fashion. This indicates that slightly delayed inputs are not suppressed. Instead, both inputs robustly alternate at driving network activity. To understand the underlying mechanism, we again resort to analysis of firing-rate model dynamics. As a result of reduced model analysis, we predict specific changes in network dynamics as parameter values are varied. We verify the predictions in the spiking model, and provide ground for future experiments.