EXTERNAL SEMINAR

INMED Conference Room

Friday, 30th June 2017 - 11 a.m

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Neural circuitry for context-dependent behavior and learning

Sensory stimuli convey critical information about various types of opportunities and threats, including access to nourishment, the presence of predators, or the needs of infants. The same sensory stimulus, however, can have different interpretations based on learned associations and the contexts within which it is presented. How does the brain enable such interpretation of sensory cues based on behavioral context? A major challenge in neural systems is to provide logic to complex neural dynamics. In this talk, I will present a cohesive model, based on experiments in mice and theory, which shows how parallel processing of cholinergic modulation by diverse cortical interneurons enables the same sensory stimuli to trigger different behaviors depending on context. Surprisingly, excitatory synaptic inputs themselves are only modestly affected by context. Instead, during active engagement, cholinergic input co-activates multiple interneurons thereby adjusting inhibitory synaptic inputs and consequently modulating neuronal output. A network model captured these dynamics across neuronal subtypes only when neuromodulation coincidently drove inhibitory and disinhibitory circuit elements, ruling out either as sole computational responses to cholinergic modulation.

I will then share preliminary data and modeling related to the neural circuits that control associative learning. My central hypothesis is that neural activity in auditory cortex promotes associative learning and performance by relating three distinct features: sensory inputs, reward, and context. I propose that identifying the neural substrates of learning, therefore, demands an experimental and theoretical approach that dissociates these aspects and explores their discrete contributions.

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