C. elegans Topic Meeting: Neuronal Development, Synaptic Function & Behavior

C. elegans can Learn to Modulate its Feeding Behavior by Associating a Noxious Stimulus with Odor

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Flexibly adapting to the environment is crucial to an animal's survival. One aspect of this adaptation is associative learning. *C. elegans* can be trained to associate multiple cues (chemicals, odors, etc.) and exhibit learned locomotor responses, but whether other behaviors can be conditioned is unknown. Feeding behavior is fundamental to survival and sensitive to multiple environmental conditions. The pharyngeal nervous system is a simple 20-neurons defined circuit that is distinct from the rest of the somatic system, making it a powerful tool for circuit analyses. Our laboratory has previously shown that the noxious stimulus of short-wavelength light inhibits pharyngeal pumping. Here we describe a novel associative-learning paradigm in which *C. elegans* learns to modulate its feeding (pharyngeal pumping) rate after trial-by-trial classical conditioning. While the pumping rate of naïve worms does not change in response to the presentation of an odor, isoamyl alcohol at 10^{-2} dilution (IAA), the pumping rate of worms trained by co-presentation of IAA with noxious light is inhibited by the odor. Furthermore, optogenetic activation of the nociceptive ASH neurons as an unconditioned stimulus is sufficient to induce learning. Both training paradigms also produce locomotor reversals. Interestingly, the locomotor response is acquired with fewer training sessions than pumping inhibition, suggesting that a specific light-odor pairing protocol can influence multiple distinct circuits over different timescales. Because pharyngeal pumping has a high temporal resolution, future studies using this trial-by-trial learning paradigm should allow us to probe the dynamic processes underlying associative learning in a precise temporal manner.

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