Circuit principles of neuronal processing in larval drosophila melanogaster thermotaxis

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The goal of systems neuroscience is to understand the computational process by which neural circuits use sensory information to generate adaptive behaviors. *Drosophila* larvae avoid excessively cool temperatures using a small set of sensorimotor transformations that regulate the frequency and outcome of navigational decisions. Navigational decisions separate successive periods of forward movement. During each navigational decision, larvae sweep their head from side to side, gathering thermal information that informs the choice of a new direction for forward movement.

Automated trajectory and posture analysis of individual animals navigating linear temperature gradients enables us to quantify each navigational decision along the trajectory of each animal. Statistical analysis of transgenic strains with defined lesions to specific parts of the larval nervous system from the Rubin Gal4 collection allowed us to define neurons that participate in information processing during thermotaxis.

We have identified two distinct groups of projection neurons that when inactivated exclusively modulate individual navigational decisions, such as turn direction and run length. We mapped the upstream partners using electron microscopy reconstruction and found they receive direct synaptic inputs from the cold sensing neurons. Furthermore we show these neurons respond to cooling using calcium imaging. We are currently characterizing in more detail the computational dynamics of these neurons by measuring and manipulating neuronal activity in freely moving and/or restrained animals using novel methods in optical neurophysiology. Combining behavioral analysis, EM reconstruction of behaviorally important neurons and functional imaging will allow the complete identification of circuits underlying thermotaxis from sensory inputs to motor outputs.