



Angular Self-Motion Estimation for Action Selection in Walking *Drosophila*

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Circuits involved in self-motion estimation provide a unique opportunity to understand how various aspects of walking control - from rapid course adjustments to slower navigational decisions - are implemented by distributed yet interconnected networks. Recently, we found that in darkness, exploratory walking flies (*Drosophila melanogaster*) select the direction of their turns based on the drift direction of a preceding forward run, a phenomenon we termed drift-to-saccade (DTS). DTS shows that flies use angular estimation to plan a future action.

Previous work in the lab identified a visuomotor network in flies that monitors rotations during walking. One branch of this network projects to the ventral nerve cord (VNC) to mediate real-time steering adjustments. The other branch projects to central regions intimately connected with the central complex, the insect's navigational center. In addition to processed visual inputs, this central network receives ascending inputs from the VNC and feedback from the central complex. This suggests it serves as a key integrative node for angular state estimation. Indeed, individually silencing identified neurons within this network disrupts DTS without impairing forward runs or rapid body turns.

Using whole-cell patch clamp recordings in walking flies, we are currently characterizing a central population of neurons within this network. We found that these neurons are sensitive to both instantaneous angular velocity and cumulative orientation within a walking bout. Moreover, their activity resets following rapid, direction selective turns, suggesting the network monitors left-right asymmetries during forward runs that are reset after rapid changes in course direction. Together, our findings reveal a multilayer network likely responsible for encoding angular state estimation by integrating diverse sensory and motor-related signals from visual, VNC, and central complex inputs. We are currently analysing how different network components shape these signals and contribute to turning decisions. Our goal is to provide a detailed functional map of a circuit involved in state estimation for continuous movement control and discrete action selection.

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