Chen Institute Retreat 2023

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Poster title: Encoding of olfactory stimulus, value, and behavior in dopaminergic populations

Abstract: The ability of animals to flexibly change their behavior is key to their ability to thrive in complex and dynamic environments. In many species, dopamine is a key neuromodulator that mediates the formation of associations between stimuli and their survival value. However, dopaminergic signaling has many other roles, for example, in signaling novelty, regulating motivation, and gating activity. In the Drosophila mushroom body, a center of associative learning, dopamine has primarily been studied for its role in reinforcement learning but may also provide a window into the role of dopaminergic activity beyond signaling rewards. We recorded the patterns of activity elicited by odors with varying valence in the outputs of PAM cluster dopaminergic neurons in the mushroom body of behaving flies. We found that odor-evoked dopaminergic activity in the mushroom body carries information about both the identity of the odor stimuli and the behavior of the animal. We computed the amount of dopaminergic activity that can be accounted for by behavioral responses during odor-evoked walking, and observed that, even discounting the behavioral contribution, information about the identity of the odor stimulus is preserved. Dopaminergic activity carries information about characteristics of the odor stimulus independent of behavioral response. Additionally, dopaminergic responses evolved over time in a stimulus- and compartment- specific manner. These results demonstrate the complexity of dopaminergic coding and motivate future investigation of the role of dopamine in updating the stimulus-to-behavior transformation beyond simple reinforcement learning conceptualizations. Understanding the origins of stimulus-specific dopaminergic response may help explain how animal behavior evolves over time, even in the absence of explicit reward or punishment.