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Sensory processing in the *Drosophila melanogaster* larva

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Correct sensory processing is crucial for animal survival, correlated with the ability to adapt to the environment, to identify nourishing food and other vital parameters. Therefore, complex sensory systems for an optimal integration of sensory information have developed in all organisms from insects to mammals, including in the *Drosophila* larva, an animal with relatively simple neuronal organization.

Equipped with roughly 30 neurons in the primary taste organ, fruit fly larvae are able to discriminate between a large palette of tastes, making it an intriguing system for the study of peripheral taste coding principles. We used a customized imaging technique and a tailored data analysis approach that allowed recording neuronal activity of all sensory taste neurons while stimulating with various substances. We have calculated a large proportion of responding neurons to be activated by more than one substance per animal, contouring a combinatorial model of taste sensing in the larva. Moreover, we have dissected the single-cell molecular profiles of chemosensory neurons, identifying promising neuronal markers for a further characterization of their development and physiology.

Numerically simple if compared to adult *Drosophila*, the visual system in the fruitfly larva is seemingly more complex than predicted. With only 12 photoreceptors detecting environmental light, these animals are able to compute temporal and spatial information to efficiently photo-navigate. Within a collaborative project for reconstructing the entire connectome of the larval brain, we have undergone the challenge of assembling the visual circuitry downstream of photoreceptors. We have identified and traced less than 15 visual interneurons per hemisphere, which are distinct partners for the two different photoreceptor types, suggesting a functional segregation. Moreover, we could describe modulatory feedback motifs delineated by the visual interneurons, which have presumed opposite valence by means of distinct neurotransmitter expression.

Our data bring insights on both peripheral and central sensory processing in the fruit fly larva – taste sensory coding and respectively visual central connectivity – as a case of neuronal physiology and circuitry underlying sensory processing. Altogether, this study demonstrates a high degree of complexity for sensory processing in the fruit fly larva despite the relative numerical simplicity of its nervous system.

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