

CONTROLLED DYNAMIC STIMULATION OF DROSOPHILA OLFACTORY RECEPTORS

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Perception of a large number of volatile chemicals, or odorants, allows animals from invertebrates to mammals to orient themselves in their chemical environments. The *Drosophila melanogaster* olfactory system provides an excellent model for studying mechanisms of olfactory perception because of the availability of a wide repertoire of experimental tools including genetics, behavior and electrophysiology. Time-dependent properties of chemical signals are probably crucially important to many animals, but relatively little is known about the dynamics of chemoreceptor neurons or the components that control their dynamic properties. Behavioral evidence of dynamic sensitivity has been found in several insect species. Male moth flight is controlled by the spatio-temporal structure of pheromone plumes from females. In mosquitoes, the fine time scale of the carbon dioxide plume leading to a host strongly influences the behavioral response of the animal. These natural odor plumes are shredded into discrete filaments of varying concentration because of variable wind directions and velocity fractions, producing complex, time dependent odor concentrations.

Characterizing the dynamic properties of sensory receptors requires control and measurement of the stimulus over a frequency bandwidth that equals or exceeds the receptor response. Techniques for dynamic stimulation of olfactory receptors have lagged behind other major sensory modalities because of difficulties in controlling and measuring the concentration of odorants at the receptor. We used a new servo-controlled laminar flow system, combined with photoionization detection of a surrogate tracer gas, to characterize the electroantennogram of *Drosophila* antennae during stimulation with four different fruit odorants and a pheromone. Frequency response functions and coherence functions measured with a bandwidth of 0-100 Hz were well characterized by first-order low-pass linear filter functions. Filter time constants varied over almost a ten-fold range, and was characteristic for each stimulant, indicating that several dynamically different chemotransduction mechanisms are present. Response amplitudes, and consequently signal-to-noise ratios, also varied consistently with different stimulants. Accurate dynamic characterization promises to provide important new information about chemotransduction and the resulting behavioral

responses to time varying chemical signals.