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Introduction

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The goal of this special issue is to highlight how active odorant sampling by animals serves as an essential component in odorant discrimination and perception. Odorant sampling behavior, leading to the delivery of temporally dynamic and spatially differentiating odorant pulses to olfactory receptors, takes many forms in the animal kingdom. Respiratory sniffing by terrestrial vertebrates, antennule flicking by crustaceans, surging and casting by flying insects, and wing fanning by walking insects are some of the examples that have been studied and are explored here. In addition to obvious differences in the morphology of olfactory organs in different phylogenetic groups and in the fluid medium (air or water) that carries odorants to olfactory receptors, there is a basic difference among these behaviors in whether the olfactory organ is drawn or moved across an odorant plume (flicking, casting, and surging) or the odorant plume is drawn across or into the olfactory organ (sniffing, wing fanning, and nasal sac compression by fish). Despite such variations in form, odorant sampling, in all cases, must adhere to the same canonical principles of fluid mechanics and thermodynamics, governing the processes of turbulent and laminar flow, diffusion, solubility, and vaporization among others. These dictate how odorant molecules move through fluid media necessarily prior to their chemospecific binding to molecular receptors on olfactory receptor neurons. Evidence for the capture or creation by sampling of distinct spatiotemporal patterns of odorant movement and distribution within a plume, for the spatial alignment of some receptor neurons with odorant gradients typically created during such sampling, for the dynamic regulation of sampling in response to variations in stimulus properties, for the temporal entrainment of central neuronal responses to the frequency of sampling, and for variations in neuronal activity and perception introduced by variations in sampling indicates that sampling itself is a critical factor in the information that is encoded by olfactory neurons.

In the articles that follow, M.A.R. Koehl and K. Zhao *et al.* introduce us to the physicochemical principles of fluid flow and molecular diffusion that govern the delivery of odorant molecules to olfactory receptors during sampling, using arthropod antennules and antennae and mammalian noses as model systems, respectively. J. Scott highlights evidence that the responsiveness of olfactory receptor neurons to different classes of odorants varies in spatially distinct regions of the rodent nose according to the chromatographic properties of those odorants and the patterns of inspiratory airflow that deliver them to the sensory neurons. T. Schoenfeld and T. Cleland then describe how the anatomical arrangement of these sensory neurons in the nose and their axonal projections to the olfactory bulb serve to represent to the brain predictable and differentiating patterns of odorant behavior in the nose during sampling. N. Buonviso *et al.* and N. Vickers illustrate the temporal synchrony that occurs between the pulsatile delivery of odorants to olfactory receptors and the odorant-induced activity of olfactory neurons in the brain and discuss its relevance for odorant perception and odor-guided behavior, focusing on respiratory sniffing in rodents and pheromone-mediated flight in moths, respectively. A. Kepecs *et al.* build on this theme by discussing how the temporal framework of the respiratory cycle makes it possible for rodents to make rapid perceptual decisions in the discrete sample of a single sniff. Finally, J. Mainland and N. Sobel argue that sniffing in humans is a dynamically controlled sensorimotor behavior that has a powerful influence in determining and modifying odorant perception.

We dedicate this special issue to the late Vincent G. Dethier, whose timely essay, ''Sniff, flick, and pulse: an appreciation of interruption'' (Dethier 1987), captured the essential stimulus for our investigations, leaving us to connect the epochs, er, dots.

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opportunity to explore a critical question in olfaction. My own interest in sniffing clearly dates to my first reading of W.I. Welker as an undergraduate and has been deepened significantly since by the work of Editor Ache, Maxwell Mozell, Steven Youngentob, and Foteos Macrides.

Reference

Dethier, V.G. (1987) *Sniff, flick, and pulse: an appreciation of interruption.* Proc. Am. Philos. Soc., 131, 159–176.

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