Making Sense of Scents

Most people would say that they rely more on vision and hearing than they do on their sense of smell, yet the perception of odors is one of the brain's dominant windows on the outside world. And what an emotionally charged window it is. We hardly ever perceive odors in a purely neutral and objective way. They are often loaded with attractive or repellent feelings, and in some cases they can instantaneously make us recall memories of past events. This emotional component is not lost on the still-growing multi-billion-dollar fragrance industry.

These emotional responses may explain why olfaction, recognized as one of the five senses by ancient natural philosophers, was long considered to belong more to the realm of artists and poets than to that of thorough neuroscientific investigation. Enormous progress has nonetheless been made in recent years at every step of the olfactory pathway—from the first contact of an odor molecule with a receptor in the olfactory epithelium, to the coding and processing of this information in the peripheral and central nervous system, to the arousal of feelings and the storage of memories.

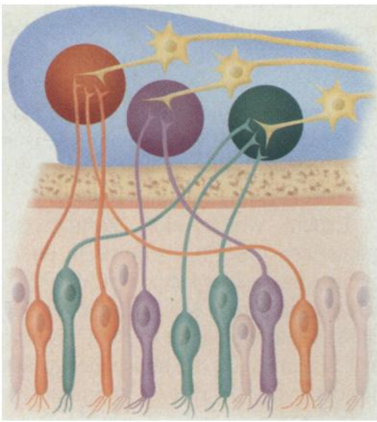
This special issue of *Science* presents the central developments that have recently occurred in this exciting field of neuroscience. It also shows where our understanding is still far from complete and where the emphasis of future research should lie. Mombaerts (p. 707) gives an overview of the recent explosion of our knowledge concerning the molecular and cellular biology of odorant and chemosensory receptors. The activation of intracellular signaling pathways that occurs when the odor molecules bind to those receptors is the starting point in the coding of smells. Mori *et al.* (p. 711) describe the next step in the sequence of events after the message has arrived in the olfactory system via the axons of the sensory neurons. These researchers focus on the analysis of odor information in the olfactory bulb, the first processing station in the mammalian brain. Many animals have an additional chemosensory organ besides the main olfactory epithelium. This is the vomeronasal organ, which responds to a completely different set of odorant receptors and sends its neuronal projections to different parts of the brain. Keverne (p. 716) describes the vomeronasal organ's function in the regulation of reproduction and neuroendocrine secretion and how it influences different types of animal behavior.

Large parts of the neuroscientific community are accused of "speciesism": the neglect of important discoveries outside a small group of animals, all of which are mammals. Krieger and Breer (p. 720) give us an update on discoveries concerning olfactory reception in invertebrates, notably insects, crustaceans, and (last but not least) nematodes.

All of the different systems of olfaction that have evolved face similar challenges. The information they detect must in some way or another be coded and sent as electrical impulses to other parts of the nervous systems, where they have to be reliably decoded and properly analyzed in order to be of any value to the individual organism. Laurent (p. 723) examines coding strategies from a systems perspective and how they may be implemented for the processing of olfactory information.

Finally, the News component of this special issue (p. 704) includes two articles. One deals with recent discoveries showing that, contrary to what was previously thought, olfaction is important for birds, who use it for finding food and navigating over long distances. The second article outlines new findings about how salmon become imprinted with the odors of their home streams; this information could help save endangered salmon species.

—PETER STERN AND JEAN MARX



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