Olfaction and Social Communication

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When you sit down with a friend for dinner, you rarely just eat a meal. The experience is filled with opportunities for social communication. Obviously, language is immensely useful for communicating both simple and complex ideas. However, gestures, facial expressions and tone of voice carry critical information, as well, and can help us to relate to each other in a more nuanced way. For example, if your companion smiles, takes a big bite of food, leans back in his chair, looks around and says, “I’m glad we decided to come here,” he is likely commenting on the quality of the restaurant and his appreciation for your selecting it. However, if she smiles, leans forward, looks directly at you and says those same words, she is more likely showing her appreciation of you than for the venue.

The importance of these messages for humans may be best illustrated by individuals for whom social communication is the most challenging. A hallmark of autism spectrum disorders (Chapter 59) is a deficit in social communication. Individuals on the autism spectrum often have difficulties in recognizing tone of voice or facial expressions and so fail to grasp the full context of their communication with others. This impairment of social communication can negatively affect the formation of relationships and interactions with peers in social or work environments.

Of course, most animals do not use spoken language to communicate. Even so, they depend on the ability to recognize, interpret and respond to social signals in order to effectively reproduce, establish social hierarchies and find food. In many mammals, the production and recognition of olfactory cues is a primary means of communicating critical social information. A number of volatile, peptide and protein compounds found in breath, urine or glandular secretions can act as olfactory stimuli in the recipient and can elicit learned (e.g., acquisition of a food

preference) or innate responses (e.g., the promotion of mating behaviors) (Stowers & Logan, 2010). They can even communicate genetic identity, fitness or compatibility.

Many of our insights into the molecular basis of olfactory-mediated social communication come from studies of specialized olfactory subsystems found in mice (and many other lower mammals). Vomeronasal sensory neurons (VSNs) respond to a number of compounds, produced by a conspecific, that elicit stereotyped behaviors or physiological changes in the recipient animal. These include mating and aggression behaviors as well as hormonal changes that accelerate puberty onset or promote estrus synchronization. For example, VSNs expressing the vomeronasal receptor V2Rp5 are activated by a peptide, exocrine gland-secreted peptide 1 (ESP1), secreted from the lacrimal glands of male mice. V2Rp5-dependent detection of this peptide by VSNs of female mice enhances lordosis behaviors, a response to male mounting that facilitates successful copulation (Haga, et al., 2010). In this species, at least, successful olfactory-mediated social communication provides a clear reproductive advantage.

The main olfactory system also detects social stimuli. For example, olfactory sensory neurons (OSNs) that express the guanylyl cyclase GC-D are highly sensitive to the social odor carbon disulfide (Munger et al., 2010), which is found in the breath of mammals. This compound, when paired with a food odor, lets the recipient animal know that the food he just smelled on his friend's breath is safe to eat (as the friend is obviously still breathing).

Interestingly, many genes that are important for olfactory-mediated social communication in lower animals, including most vomeronasal receptor genes, as well as the genes encoding GC-D and the vomeronasal transduction channel TRPC2, became pseudogenes in the primate line. This suggests that vomeronasal function became less important as mammals moved into the trees, where they are often physically separated and forced to rely on visual and auditory cues for

communicating across distances. Do these genetic and olfactory differences between rodents and primates mean that olfactory-mediated social communication is irrelevant for studying human social communication? This seems unlikely. We rely heavily on our sense of smell when it comes to interacting with our fellow humans, as the fragrance industry knows well. But more importantly, many of the neural circuits that process information about social odors are highly conserved across species. Thus, understanding the molecular and neural mechanisms by which mammals use olfaction and other sensory modalities to communicate important social information should help elucidate the way humans recognize and process critical sensory cues that enrich our lives and help us to relate to others.

References

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