

Aging and the Chemical Senses  
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Everyone is aware that the visual and auditory senses dim with age, and expects the elderly to need reading glasses and hearing aids. What about the chemical senses of smell and taste? In what ways do our perceptions of the volatile and water-soluble molecules we smell and taste change? How pronounced is that change? And how early in life does it begin?

Before addressing these questions, it is important to recognize that smell (olfaction) and taste (gustation) are distinct physiological systems. They have different receptor types and peripheral neural pathways, and they respond, by and large, to different types of chemical stimuli. On the other hand, brain responses to many smell and taste stimuli overlap. Thus, when food is eaten—simultaneously releasing some molecules that stimulate taste receptors in the oral cavity and some that flow through the throat to the nose and stimulate olfactory receptors—it is perceptually very difficult to distinguish which components of the resulting flavor perception are smells and which are tastes. In fact, however, research at Monell and other institutions has shown that these two aspects of food flavors are not equally affected by ageing: diminutions in olfactory sensitivity are more pronounced than diminutions in gustatory sensitivity.

### Olfaction

Olfactory receptors are found on primary olfactory receptor neurons (ORNs) located in a relatively small patch of tissue high in the nasal cavity. These neurons extend through the nasal tissue and, thus, are uniquely exposed to the external environment and subject to a constant barrage of potentially toxic chemicals and particulates, as well as being susceptible to direct injury from microbes. Although ORNs are also highly unusual in that there is ongoing replacement of these neurons throughout life, this is a complex process requiring reinnervation of the olfactory bulb (the first brain relay in the olfactory pathway), and it is often imperfect. Degeneration of the olfactory neural tissue, and patchy replacement by respiratory tissue, is seen even in young adults and becomes more pronounced with aging.

Olfactory function is most often assessed using tests of threshold sensitivity (the lowest concentration of an odorant that can be detected) or of the ability to identify more concentrated odors (e.g., is this orange, licorice, grass or banana?); less frequently, ratings of the perceived intensity of suprathreshold odors are obtained. Almost uniformly, studies using all of these measures have shown a significant decline with age, typically beginning in the 7th or 8th decade of life. Age-related olfactory loss appears to develop gradually and is rarely complete, except in extreme old age. Nonetheless, it is often of sufficient magnitude to render older people vulnerable to chemical hazards such as gas leaks and to greatly diminish olfactory food flavor perception, reducing food enjoyment.

Despite extensive documentation of age-related decline in average olfactory sensitivity, there continue to be debates regarding the uniformity of that decline, both across different odors and across individuals. Although there is little variation in the degree of loss reported for different odors, most studies have simply contrasted the performance of an elderly group with that of a group of young adults. As a result, possible differences in the onset or rate of decline in sensitivity to specific odors have not been examined, although the results from the National Geographic Smell Survey conducted by Monell scientists suggest perception of some odors does decline earlier than others. In addition, at the individual level, extreme differences among elderly subjects in olfactory abilities have frequently been noted, with some older individuals performing as well as the average young person. However, specific genetic, medical and/or environmental factors that underlie this variation have not been identified.

### Gustation

Taste receptors (responding to sweet, salty, sour, bitter and umami stimuli) are also subject to damage from the chemicals they are designed to detect, as well as from viral, bacterial and fungal species that often find a home in the oral cavity. However, taste receptors are not found on neurons, but on modified epithelial cells that turn over rapidly (~ every two weeks). Moreover, these receptors are scattered over a large portion of the tongue surface, as well as being found on the soft palate, esophagus, pharynx and epiglottis, and their responses are transmitted to the brain by multiple branches of three cranial nerves. These characteristics protect the taste system against extensive damage.

In fact, taste appears to be relatively stable across the lifespan. The measures used to assess gustatory function are similar to those used in studies of olfactory function. Some age-related declines in both taste threshold sensitivity and the perceived intensity of suprathreshold tastes are typically observed; however, these declines are quality- and, in the case of bitter, compound-specific, as was shown in a joint study by scientists from Monell and Kirin. The majority of modern studies have found no age-related decline in sensitivity to sweet (as exemplified primarily by sucrose), and declines in sensitivity to salty, sour and bitter tastes, at either threshold or suprathreshold levels, are modest relative to those observed in smell. Because umami has only recently gained wide acceptance as a 5th basic taste in the West, few studies have examined how it is impacted by age. There are also few large, lifespan studies of taste, but as is the case in smell, average declines appear to be significant only in the 7th and 8th decades.

All of the above findings, however, are based on the whole-mouth presentation of taste stimuli. Several studies suggest the elderly are particularly prone to spotty losses of function affecting circumscribed areas of the tongue. In general, this has little impact on the whole-mouth experience of taste, as other areas appear to compensate, but work in the Monell Taste & Smell Clinic suggests it may render elderly individuals more vulnerable to taste dysfunctions that lead them to seek medical assistance, including both whole-mouth loss of taste and the development of chronic, phantom taste sensations.

### Further Readings:

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