Smell and Taste in Aging[a]

Understanding the ways in which age affects olfactory and gustatory sensitivity differently, and how individual olfactory sensitivities may diminish at varying rates

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"But Barzillai answered the king, 'How many more years will I live, that I should go up to Jerusalem with the king? I am now eighty years old. Can I tell the difference between what is good and what is not? Can your servant taste what he eats and drinks?…' "

2 Samuel 19:34-35 (NIV)

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? The opening quotation shows that a decline in the ability to appreciate ("taste") food and drink in old age was recognized thousands of years ago. But 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 nasopharynx 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. However, research at Monell and other institutions has shown that these two aspects of food flavors are not equally affected by aging: 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 cilia along the epithelial surface 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 age.

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 intensities of suprathreshold odors are obtained. Almost uniformly, studies using all of these measures have shown a significant decline with age, typically beginning in the seventh or eighth decade of life. A recent population-based epidemiological study of olfactory impairment in the United States found the prevalence of loss to be only 6% among 50-year-olds, but 17% among 60-year-olds, 29% among 70-year-olds, and more than 60% in those 80–97 years of age.[1] While age-related olfactory loss appears to develop gradually and is rarely complete, except in extreme old age, 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.[2,3]

Despite extensive documentation of age-related decline in average olfactory sensitivity, there continue to

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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 rarely been examined. However, results from the National Geographic Smell Survey conducted by Monell scientists suggest perception of some odors does decline earlier than others. Notably, the ability to detect a mixture of mercaptans (sulfur compounds added to natural gas as a warning agent) began to decline abruptly in the fifth decade, whereas for several other odors included in the survey (eugenol, isoamyl acetate and rose), declines in performance first became evident in the sixth decade and did not accelerate steeply until the eighth.[4]

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, or "savory," 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 expressed on neurons, but on modified epithelial cells that turn over rapidly (~ every 10 days). Moreover, these receptors are scattered over a large portion of the tongue dorsum, 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. Nonetheless, there is evidence of reductions in the number of taste buds with age and reduced neural responsiveness to tastes, and it is possible that the cell proliferation and turnover processes are adversely impacted by aging.

However, taste does appear to be relatively stable across the lifespan. The measures used to assess gustatory function are similar to those used in studies of olfactory function, although few studies have included an assessment of the ability to identify the qualities of suprathreshold taste stimuli, at least in part because taste quality confusions (sour-bitter, sour-salty and salty-bitter) are common even in healthy young subjects. Some age-related declines in both taste threshold sensitivity and the perceived intensity of suprathreshold tastes are typically observed; however, these declines are often found to be quality, and in the case of bitter, compound-specific, and they are not always observed in both threshold and suprathreshold measures within a quality.[5,6] 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 fifth basic taste in the West, very 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 seventh and eighth 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.[7,8] In most cases, this has little impact on the whole-mouth experience of taste, as other areas appear to compensate, but it may render elderly individuals more vulnerable to taste dysfunctions that lead them to seek medical assistance. Consistent with this, research at the Monell-Jefferson Taste & Smell Clinic has found elderly patients ($\geq$ 65 years of age) to be significantly more likely than young or middle-aged patients to complain of the persistent presence of an unpleasant, phantom taste sensation and to evidence diminished taste sensitivity, relationships not seen in not seen in patients with comparable olfactory dysfunctions.[9] This raises the concern that as our population ages, the prevalence of taste problems may as well, and these problems are particularly significant because they have a greater negative impact on food intake than do smell problems.[10,b]

Summary

Aging takes a toll on the chemical senses of smell and taste, just as it does on the visual and auditory senses. Given that the olfactory and gustatory systems are constantly exposed to potentially toxic chemicals and particulates, and that receptors for these systems must interact directly with them in order to protect the rest of our bodies from them, it is perhaps surprising that there are not early and devastating losses in function. The unique the regenerative capacities of these sensory systems provide a protective mechanism. Nonetheless, measurable losses do eventually occur. These appear more uniformly, profoundly and, at least for some stimuli, earlier in the olfactory than in the taste system, due no doubt in part to the complexity of neuronal regeneration in olfaction and the fact that we have less control over what the olfactory receptors are exposed to than we do for taste receptors. Still, dysfunctions in smell impact safety, food enjoyment and general quality of life, and when they occur, dysfunctions in taste can have a major impact on eating behavior and nutriture.

[b] *www.dana.org/news/cerebrum/detail.aspx?id=788*

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