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Sensory functioning in older adults: relevance for food preference

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The world's population is aging and older adults represent the fastest growing segment of the consumer market. Changes in sensory, perceptual and cognitive function in this segment of the population have been described psychophysically, however, more is known about the young-old than the old-old or oldest-old. Only now are we exploring the potential for neuroimaging tools to probe the changes in central nervous system function related to taste and smell that are relevant to sensory perception, reward value, anticipation of and consumption of food stimuli. There is real potential for brain imaging to provide a greater understanding of older adults' consumer behavior.

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Introduction

More than 15% of the US population is over 65 and that proportion is expected to increase to 22% by 2050 [1]. Similar and even larger increases in the proportion of older adults are impacting global population trends. In Europe some 17% are over 65 now and 28% are projected to be over 65 in 2050. In Japan, more than 40% of the population is expected to be over 65 in 2050 [1]. Understanding the changing needs of older adults and how those needs interface with those of consumers across the lifespan is a critical first step to designing consumer products that meet the growing demand for appropriate food choices for older adults in the changing population.

A clearer picture of the chemosensory world of adults over 65 will emerge as we focus not only on peripheral changes in chemosensory perception, but central changes in how the older brain responds to stimuli and initiates and directs food choice and consumption. A neuroscience approach to understanding the older adult's sensory, perception and cognitive responses and his consumer behavior can reveal complementary information not available from conscious awareness and self report.

Segmenting the older adult consumer marker

For the purposes of this review, older adults are defined as 65 and older with many studies reporting a mean age in the early seventies and a range from 65 to 85. Information about chemosensory aging and food intake has largely targeted older adults as a group. The gerontology literature refers to segments of the older adult populations as the young-old (65–74), the old-old (75–84) and the oldest-old (85+). A few studies have begun to consider chemosensory and consumer behavior in the old-old and oldest-old groups. There have been some surprises. Centenarians, for example, performed much better than expected in a study of odor threshold [2]. Rather than making assumptions about how individuals in these upper age groups sense, perceive, and act on information about foods and beverages, it is critical to study the old-old and oldest-old in detail. As the population ages, their numbers are rapidly increasing.

Women live longer than men and are represented in greater number in these older age groups. This suggests that aging occurs differently in older men and women and that gender will be an important variable as we study the old-old, and the oldest-old to better understand their behavior as consumers of foods and beverages. In older segments of the population larger percentages of males than females were more likely to smoke, though that is changing in younger cohorts. These differences also suggest that gender differences in consumption will be amplified in these older age groups.

Claire Sulmont-Rosse, Sylvie Issanchou and others have investigated factors other than age that may be important in addressing the differences among the young-old, the old-old and the oldest-old. They found that the degree of dependency (defined as living at home independently, living at home with assistance and living in a nursing home) was associated with chemosensory function [3•]. Indeed, the direction of the relationship between health and chemosensory function in the oldest-old is an empirical question since longitudinal data on this issue are largely lacking. As we consider how to investigate chemosensory function and consumer behavior in these older

old, these investigations will be most powerful if they consider age, dependency and consumer behavior: Older adults living independently make more consumer decisions than older adults living dependently in settings where others shop for and prepare meals or, certainly, institutionalized older adults. The frontier of studying the old-old and oldest-old demands new methods, such as neuroimaging, for studying and interpreting chemosensory function and consumer behavior.

Sensitivity to low concentrations of odor and flavor in older adults

Studies have reported for decades that the older adult is less sensitivity to low concentrations of odorants than the younger adult [4,5•]. One important observation is that there is much greater variability in thresholds in older than in younger adults [6,7]. Epidemiological and multicenter larger studies are revealing, for example, that significant numbers of older adults perform as well as young adults do. This segment of the population is attracting research attention as the effects of aging are distinguished from the effects of poor health [5•], drugs [8], and dependency (i.e. living at home vs. living in a nursing home) [3•]. Research is needed to understand the factors that drive better sensory function in older adults. A clearer understanding of these factors will be helpful in predicting future trends in sensory function and consumer choice. In the Beaver Dam epidemiological study [5•,9], a number of factors appear to be contributing to better olfactory function over time in the population. For example, the use of statins to lower cholesterol may be producing better olfactory function as people age [10]. We might also speculate that the use of nasal steroids and antibiotics to treat nasal sinus disease may minimize smell loss from nasal disease in future cohorts [10]. Emerging cohorts may well be more sensitive to subtle odors and flavors than older generations.

Odor identification by older adults: variability

Sensitivity is necessary for the ability to identify odors, though many factors impact odor identification ability. Enjoying an appetizing dinner of complex flavors typically involves identifying the components of the appetizer, main dish, dessert, etc. Flavor, of course, includes not only tastes (sweet, salty, sour, bitter, umami, fat) but also the volatiles that stimulate the olfactory system, enhance pleasantness and intake, and contribute to food recognition. Odor identification is the most studied and one of the most robust indicators of olfactory impairment in older adults [6,11,12,13•,14•]. The effect has been replicated in the US [5•], Europe [14•], Sweden [15,16], Japan [17]. Recent attention has been focused on understanding the underlying mechanisms for this loss. Odor identification studies indicate wide variability in how adults over 60 are able to identify common odors. It is likely that many epidemiological studies include older participants with a wide range of cognitive function. Many studies do not have the resources to diagnose Alzheimer's disease (AD) or Parkinson's disease (PD), though some have included a diagnosis of dementia. Both AD and PD begin decades before clinical manifestation. Olfactory dysfunction is an early characteristic of both of these diseases and has even been suggested as a biomarker of pre-clinical neurodegenerative disease [18•]. Thus, it seems likely that some of the variability in odor identification in these large population based studies may be due to participants in varying stages of pre-clinical decline. More research is needed to better understand this phenomenon. Determining the odor identification ability of a typically aging older adult compared to a normal young adult, without the influence of disease, particularly diseases related to olfactory impairment due to central nervous system degeneration, is important if we wish to understand the sensory world of a normally aging, independently-living consumer.

Taste function in aging: how best to capture factors that drive food choice

Taste threshold shows less impairment with age than olfactory threshold, though it is taste quality specific: bitter > sour > salty > sweet [19,20]. There is a considerable body of literature on psychophysics and sensory evaluation that provides useful information about the ratings and magnitude estimations of intensity and pleasantness given by older adults and how these ratings and estimates agree or do not with those of younger adults. A number of studies have indicated that older adults prefer higher concentrations of sugar and salt than younger subjects do [21], though this finding is not without exception [22]. This is in line with nutrition surveys that show increased consumption of sugar and salt by older adults [23].

One of the most dramatic advancements in the field has been the adaptation of neuroimaging methods that reveal brain activity during processing of a stimulus to better understand the chemosensory world of the older consumer [24,25•,26,27•]. Since psychophysical ratings provide information about subject's ratings and brain imaging provides information about activity in different brain areas that process different types of information (e.g. intensity, pleasantness, reward value, cognitive effort, etc.) neuroimaging data nicely complement information that can be gained from psychophysics.

In healthy, young adult subjects psychophysical data are often correlated with brain activation [28,29]. Older adults show brain activation that is different from activation in young people in some areas and this is modulated by body weight [30,31]. They show less activation to sweet, overall, in primary taste, reward and memory areas [27•]. Importantly, areas such as the caudate, the orbitral frontal cortex and the nucleus accumbens that process information about reward have shown less activation,