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COMMENTARY

# Birth of a New Breed of Supertaster

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People differ in the intensity of their reported experience of taste but the origins of these differences, whether they generalize to some or all chemosensory stimuli, and the most accurate way to measure them are controversial. In this issue of *Chemical Senses*, Lim et al. address the question of the general nature of perceived intensity and report that a subject's response to the bitter chemical 6-*n*-propylthiouracil (PROP) is less predictive of overall taste intensity ratings than ratings of sucrose, sodium chloride, and citric acid.

## A quick test of the tongue

Although there are tests developed to assess human hearing, vision, and smell, there is no brief but comprehensive test for tasting ability. This deficit has been recognized, and working under the auspices of the National Institutes of Health Toolbox, researchers are trying to fill this gap by the development of a fast, valid, and reliable method to assess taste function (Anonymous). In the past, the most often used brief test of taste function has been to ask people to rate PROP or its chemical relative phenylthiocarbamide (PTC). Some people, because of their genotype (Kim et al. 2003), are insensitive to these bitter chemicals whereas other people find them intensely bitter, so this is a particularly satisfying test because in any given group of people, there is a wide range of response. However, this taste "blindness" (sometimes called a specific aguesia) was originally discovered because people with otherwise normal taste perception were selectively insensitive (Fox 1932), so it is reasonable to ask—as Lim et al. have done here—whether this is the most useful compound upon which to base tests of general taste function.

## Historical context

So how did a compound initially studied because it was associated with a specific aguesia become a candidate marker for general taste function? Early work focused on structural analogs of PTC using threshold methods (Barnicot et al. 1951) although it was noted by early geneticists that people who were more sensitive to PTC tended to be more sensitive to other unrelated taste stimuli (Blakeslee and Salmon 1935). This tendency has also been noted in olfaction. People with specific smell blindness (specific anosmia) tend to be slightly less sensitive to all olfactory stimuli than those without specific anosmias (Amoore et al. 1975). For the taste blindness to PTC, the focus of research gradually shifted from thresholds to intensity, which was measured first using magnitude matching (Marks et al. 1988) and later by a scale anchored with adjectives (Green et al. 1996). The early version of this scale was known as the Labeled Magnitude Scale (LMS) labeled at the top by the phrase "strongest imaginable". This phrase was revised to "strongest imaginable sensation of any kind" and the scale name changed to the general Labeled Magnitude Scale (gLMS) (Bartoshuk et al. 2004). With the results of these studies using these scales came observations linking the perception of PROP intensity to the intensity of other taste qualities, as well as the perception of fat, alcohol, and capsaicin. These 2 lines of investigation, intensity ratings and the inclusion of other stimuli, led to a new hypothesis, which was that some people are supertasters (Bartoshuk 1991), defined as people who rate PROP as extremely bitter and who also experience other chemosensory stimuli to be more intense compared with medium and nontasters. Originally supertasters were thought to arise because the intensity effects of the responsible gene and its allele were additive (Bartoshuk et al. 1994), but this hypothesis was later proved to be inadequate to explain the high-intensity ratings for PROP made by some people (Bufe et al. 2005).

## Flipping it around

One hallmark of the supertaster is that they experience other tastes (not just PROP and its structural relatives) as more intense than do other people, and this observation is confirmed by Lim et al. Supertasters were specifically defined

by these investigators as people who rated a 0.32 mM solution of PROP as above "moderate" on the gLMS scale. Supertasters reported that fixed concentrations of sucrose, sodium chloride, citric acid, and quinine are more intense compared with medium tasters (who rate PROP above "weak" but below "moderate"). However, Lim et al. flipped the question around and asked whether the intensity of PROP perception is the best index of intensity ratings for other taste compounds. For this question, the answer was no. The correlations among ratings of sucrose (sweet), sodium chloride (salty), and citric acid (sour) were higher than the correlations between PROP intensity and these compounds. Therefore, although people who rate PROP as more intense do report higher perceived intensity of other taste qualities compared with those who rate it as less intense, using other taste stimuli besides PROP is a more accurate method to find people who are supertasters of all taste stimuli. This observation may lead researchers to a revised definition of supertasters, to mean those people with heightened taste sensations for all tastes, not only the bitterness of one class of chemical compounds. The authors use new nomenclature to introduce this distinction, referring to supertasters defined by the PROP rating as pST (PROP supertasters). A logical extension of this nomenclature would be to call people who are supertasters as defined by their general enhanced taste intensity as gST (general supertasters). These new terms may help allay the confusion over what is meant when the label "supertaster" is used.

## Bitterness and creaminess

Among the stimuli that supertasters report as more intense than do other groups is the fat content of foods or drinks (Tepper and Nurse 1997), which was a surprise because fat perception was thought to be due to textural rather than chemical cues. In the current study, Lim et al. asked whether the perceived intensity of the bitterness of PROP or another exemplar taste stimuli would be related to the subjects' reports about the creaminess of milk. They found that PROP intensity ratings are less strongly associated with creaminess than are the intensity ratings of at least one other quality (salty), confirming that PROP intensity ratings are not the best predictors of fat perception.

## Mechanism

The reframing of the concept of supertasters to refer to individuals who experience all taste stimuli with heightened intensity creates new questions about the biological mechanisms involved. The usual explanation offered is that some people have a higher density of fungiform papillae than others and that the increased number of taste receptors presumed to be imbedded in these papillae translates to enhanced intensity perception (Miller and Reedy 1990). Parenthetically, there are three types of taste papillae but the fungiform is the most easily counted because they are easily visible at the tip of the tongue, but the density of other papillae (circumvallate or foliate) may also contribute to enhanced perception. However, this classic explanation is not the one these authors favor. Instead, they postulate that there is a central gain among supertasters, meaning the brain amplifies the taste signal more in some people than others. Empirical support for this possibility comes from the study of olfactory acuity in genetically engineered mice. Deletion of a potassium channel gene leads to a refinement of peripheral to central connectivity, which results in supersmeller mice (Fadool et al. 2004). Thus, it is possible that differences among individuals, perhaps due to genotype, might lead to supersmellers or supertasters, but the exact genes in humans that might amplify the communication between central and peripheral processes are not known. However, the idea of a general taste genetic locus, which turns up the gain in the taste system, has been previously suggested (Olson et al. 1989).

## A new breed of supertasters

There has been confusion in the popular media and in the scientific literature over the nature of supertasters because it is hard to reconcile how an allele in one of the 25 bitter receptors might be involved in general taste sensitivity. However, this mystery is now at least partially solved. With the discovery by Lim et al., that PROP is not the most predictive compound to use to detect elevations in general taste intensity, it is possible to move away from defining supertasters by their response to PROP, which is confounded by genotype, and study people who perceive many or all taste qualities as extremely intense. The detection of this new breed of gST opens a path to fresh hypotheses. The genetics of PTC thresholds, which has been of interest for years, may now take a backstage to other individual differences in taste perception that may be more predictive of human food preferences (Hayes et al. 2008).

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