

# From “Supertaster” to the Taste-blind

BY CRISTIAN BOBOILA

**Taste is critical to our ability to identify chemical objects. Sweetness, for example, identifies sugars, sourness acids, and bitterness poisons. Yale’s renowned taste researcher Linda Bartoshuk emphasizes that studies on taste perception can offer immediate solutions to a variety of nutritional and health problems.**

The new scientific revolution of the twentieth century shaped modern research on taste. Taste influences food preferences, which in turn can affect dietary behavior and, consequently, disease risk. Validly assessing taste variations now permits the measurement of their impact on health.

Bartoshuk, professor of otolaryngology and psychology, is one of the leading scientists researching genetic variation in the ability to taste. About 25 percent of the American population is born as “supertasters,” a group with an unusually high number of taste buds. The increased number of taste buds has an interesting effect on the way food tastes. Because food preferences are influenced by taste, the extra taste buds also affect diet. Since diets can contain major risk factors for many chronic diseases, it has become important to study genetic differences in taste. While scientists once believed that all variation in food preference was learned, we now know that some of the variation is biological, giving us a new spectrum of cures for dietary diseases.

## Path to Modern Taste Research

The first case of taste blindness was accidentally discovered in 1931 by chemist A.F. Fox. At the time, Fox was working with PTC (phenylthiocarbamide) when it exploded into the air. While the person next to him found it bitter-tasting, Fox did not taste anything. This discovery spurred on early work, which suggested that nontasters like Fox lacked a receptor for the N-C=S group.

Upon further testing, it was found that about 25 percent of the population is unable to taste PTC while 75 percent finds it bitter. In the family studies that followed, taste-blindness was found to be a recessive trait. Because animal studies showed that higher apes are similar to humans in the genetic distribution of differential taste perceptions but different from humans in that all of them are “tasters,” human nontasters are thought to have somehow appeared later in evolution.

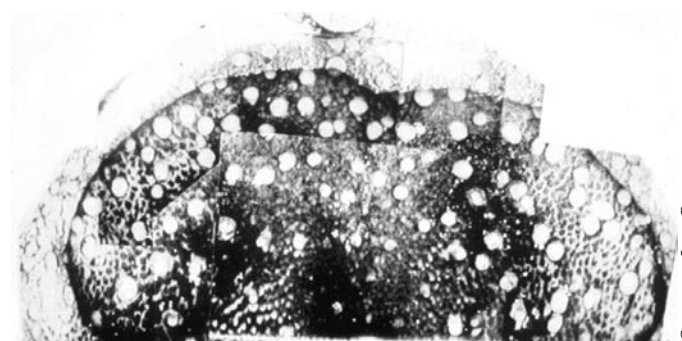
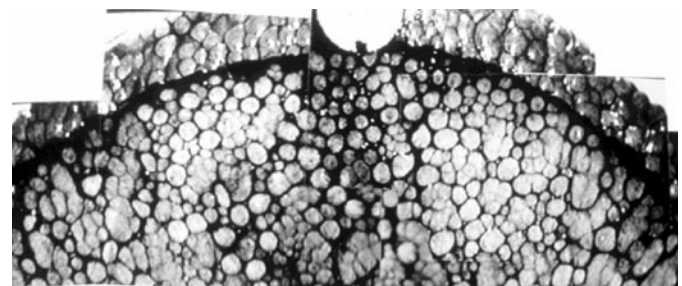
## Supertasters vs. Nontasters

By the 1990s enough data was accumulated to show that one group of tasters is much more sensitive than the others. Thus, the sensitive group members were named the “supertasters.” “They live in a ‘neon world’ of taste, while nontasters are in a ‘pastel

world,” explained Bartoshuk.

So what are some of the differences between nontasters and supertasters? The tongue’s anatomy is such that there are clusters of pain fibers associated with each taste bud. With a higher-than-average number of taste buds, supertasters are also super-perceivers of oral pain, such as the burning sensation of capsaicin and ethanol. A similar anatomical association affects the perception of fat. Taste buds are buried in tongue tissue within fungiform papillae — mushroom-like structures equipped with touch fibers. Fatty food enters the mouth, pushes touch fibers, and triggers touch responses. Because supertasters can sense more “touch” than the rest of the population, fat produces more sensation in supertasters.

Thus, supertasters tend to experience more intense sensations from fat, irritants, and other foods. How does this affect their



**Supertasters (top) have a much higher number of taste buds than nontasters (bottom). Each of the circular light structure is a fungiform papilla.**



**Professor Linda Bartoshuk of the Otolaryngology and Psychology Departments is renowned for her research on supertasters.**

dietary preferences? Bartoshuk asserts that supertasters tend to find the taste world too strong. Consequently, they dislike a number of foods, making themselves more susceptible to health risks in the long run. For example, they eat less fruits and vegetables that contain bitter-tasting flavonoids. Since flavonoids are thought to play a role in preventing colon cancer, supertasters are more at risk for colon cancer.

At the same time, supertasters dislike and avoid fatty and sweet foods. They thus tend to be thinner and have a lower risk for cardiovascular disease. Additionally, medium and supertasters have a lower occurrence of alcohol- and smoking-addiction due to unpleasant oral sensations from these unhealthy habits.

### **Supertasters – Burning Mouth?**

Supertasters have increased perception of pain and are prone to develop a pain disorder called burning mouth syndrome. In this disorder, taste and pain are not just anatomically associated in the periphery but also closely associated in the brain. Normally, taste inhibits oral pain, a mechanism to ensure that animals obtain proper nutrition. For example, if an animal develops a tongue lesion due to malnutrition but does not eat, it could die, but as soon as the animal starts to eat, the pain vanishes. Conversely, if taste is damaged and the related pain inhibition disappears, the brain turns on the pain centers for the mouth. Thus, a supertaster with severe damage to taste can have spontaneous pain on the tongue without an apparent reason.

Considered a psychogenic disorder for years, burning mouth syndrome was only recently linked to taste damage. Even more recently, a new cure that reduces oral pain by simulating taste inhibition in the brain was found. This led Bartoshuk to suspect that many other disorders are likewise influenced by taste.

Taste can inhibit many processes incompatible with eating, such as the gag reflex. Cancer chemotherapy damages taste, and cancer patients undergoing treatment often have problems with gagging. Now they can be treated with drugs that produce the same inhibitions that taste perception normally produces in the brain. “Such treatments appear to be very promising,” Bartoshuk stated.

### **Quantifying Taste and Pain**

Bartoshuk’s second research focus is experimental psychology,

more specifically psychophysics, where measurement techniques are used to study taste and pain in different population groups. When scientific interest shifted towards the genetic and pathological variation in taste, a standard method of quantifying sensory intensity as it relates to concentration was acutely needed. Since we cannot share one another’s sensations, this presents a major challenge.

One problem is to find a common scale for measuring pain since pain is taken very seriously in modern clinical settings. Labeled scales in use today “have an intuitive appeal and can be used for within-subject comparisons,” Bartoshuk explained. “Nevertheless, such scales may not be appropriate when used for across-subject comparisons.” For instance, the “strongest pain experienced” denotes a more intense pain to a woman who has experienced a particularly painful childbirth than to someone whose most intense pain to date is a stubbed toe.

Pain retards recovery and destroys quality of life, and pain treatment is considered to be a very important part of medical practice. Bartoshuk is working on the question of whether men or women experience more intense pain sensations. The sex effect is significant, especially for women who have given birth to children. These women have higher “maximum pain” standards than women without children. As the result, some people are given pain medication for less intense pain sensations than others. To correct the unequal nature of this treatment, Bartoshuk is researching better methods to quantify pain intensity and to challenge the pain intensity scales currently used by physicians.

After successfully using sound intensity as a proxy for measuring taste perception, Bartoshuk decided to employ brightness of the sun to relate pain across individuals. This method is useful because everyone sees the sun and perception of brightness is not lost with time.

The validity of Bartoshuk’s standard was confirmed by a Boston study of the most intense pain experienced by women during childbirth. In the study, the subjects rated their pain 20 percent higher than the highest sunlight intensity. On average, male subjects in the test reported that their worst pain was about the same as the brightness of the sun. Therefore, the sex difference in pain perception was quantified at around 20 percent.

Such research in the Bartoshuk lab offers a great example of how basic research findings can have immediate applications in clinical settings and patient treatment.

#### **ABOUT THE AUTHOR**

CRISTIAN BOBOILA is a senior in Yale College majoring in Molecular Cellular and Developmental Biology and Economics. As a graduating senior, this is his last article in *Yale Scientific Magazine* (as an undergraduate student at least).

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#### **FURTHER READING**

- Prutkin, J., *et al.* Genetic variation and inferences about perceived taste intensity in mice and men. *Physiology and Behavior* **69**: 161-173