

*At the
Taste Science Laboratory
in the Division of Nutritional
Sciences at Cornell University*

*we explore how
taste sensitivity
influences food choice,
personality,
and outlook on life.*

The American Heritage Dictionary tells us that taste is: "1.a. the sense that distinguishes the sweet, sour, salty, and bitter qualities of dissolved substances in contact with the taste buds on the tongue. b. This sense in combination with the senses of smell and touch, which together receive a sensation of a substance in the mouth."

What is taste?

In its first definition, the American Heritage Dictionary limits the tastes perceived by the taste buds to four; in fact there are at least six – in addition to the classic four, there are the taste of fat, and a taste called *umami*. "Umami" means delicious in Japanese, and is the word for the savory taste of meat. In fact, our taste buds are designed to tell us about the nutritional qualities of the food we eat: sweet for ripe fruits and carbohydrates, sour for unripe fruit and vitamin C, salty for salt and other minerals, bitter for poisonous plants, umami for protein, and fat for...fat!

*E. B. Titchener (1867-1927)
popularized the notion of four
basic tastes in his best-selling
textbook, "An Outline of
Psychology," first published in
1896. He stated: "Taste has
four qualities and no more.
Smell seems to have a very
large number of qualities."*



Read
as you taste
fruit or savor
wine, or enjoy
friendship, love or
life.

George Herbert

The second definition is the one most people have in mind when they talk about the taste of a food – taste, in this sense, means flavor. Better than any of the other components of flavor, smell allows us to determine the specific food we are eating, for example to distinguish a lemon from a lime. In fact most people can distinguish among 1000 odors, and perfumers among as many as 10 000!

The sense of touch provides us with information about the texture or "mouthfeel" of a food. This sense of touch is joined by the ability to feel temperature. Amazingly, menthol activates the tongue's nerve endings in the same way that cold temperatures do, which is why we can talk about the coolness of a mint; and jalapeños activate these nerve endings in the same way as do heat and pain, so talking about the "burn" of chili peppers is right on the mark!

You can find us at www.tastescience.com



Red circle surrounds two pink fungiform papillae on this blue-stained tongue.

From Tongue and Nose to Brain

Taste cells throughout the mouth and throat cluster together to form taste buds. Isolated taste buds are scattered on the surface of the palate and throat, but on the tongue they are grouped in specialized structures called papillae: mushroom-shaped fungiform papillae in the front of the tongue, leaf-shaped foliate papillae protruding from the sides, and circumvallate papillae arrayed in a chevron at the back of the tongue. The tips of the taste cells reach toward a tiny opening on the tongue—the gustatory pore—through which food chemicals can fall. Nerve endings for the taste system, carried primarily by the facial nerve, and for the touch/temperature/pain system, carried by the trigeminal nerve, surround the base of the taste bud cells.

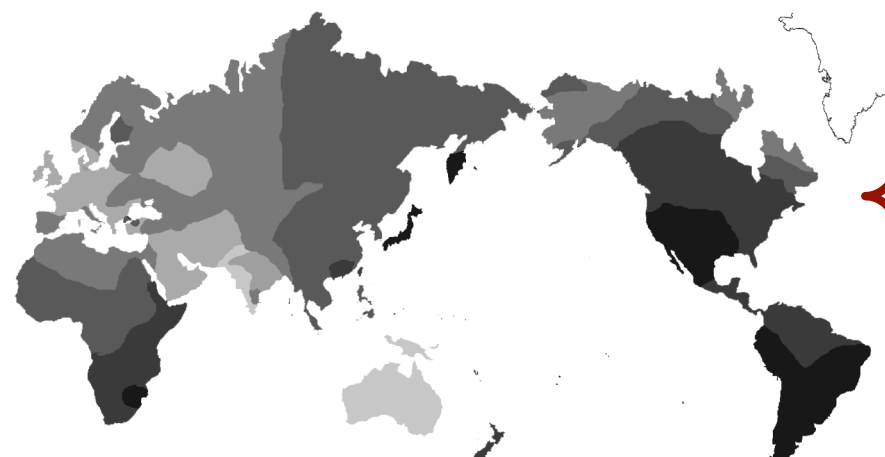
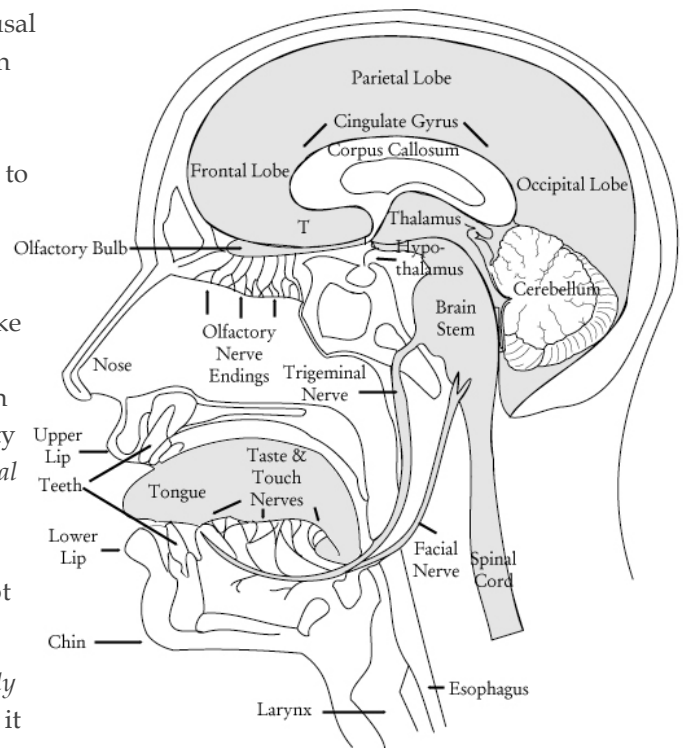
These nerves bring messages to the brainstem, which assists in arousal (for example from sleep), and is — according to Antonio Damasio in *The Feeling of What Happens* — the locus of our sense of self.

Molecules for smell move through the back of the throat and reach olfactory nerve endings in the roof of the nose. The molecules bind to these nerve endings, which signals the olfactory bulb to send smell messages to two critical parts of the brain:

- ❖ the section of the temporal lobe (T) involved with memory, particularly memories of place — this is why smells can evoke powerful images of your experiences;
- ❖ the part involved with speech, also in the temporal lobe — in fact smelling some perfumes can actually inhibit your ability to speak or even to think in words, so you are left with *visual* thinking.

Of course, we have to know *what* we are eating, so taste, smell, and trigeminal messages meet in a part of the brain called the insula (not shown in the image at right) which identifies “*what*” the flavor is.

But knowing “*what*” is not enough. We also need to react *emotionally* to what we are eating — do we like it? is it poison? should we enjoy it or spit it out? Flavor messages go to the emotional centers in the temporal lobe and the cingulate gyrus. Messages from all of these areas then reach the the frontal lobe of the brain, right above the eyes. This part of the brain evaluates experience and choose among alternatives.



Where do your ancestors come from?

This map shows the percentage of mildly sensitive tasters: the lighter the area, the higher the percentage. The percentage of mildly sensitive tasters varies from 15% in the areas that are the darkest gray in this map to more than 80% in the areas that are lightest. Note that the data for the Americas and Australia/New Zealand were obtained from the *native non-European* populations.

Map based on our data and corresponding data from *The History and Geography of Human Genes* by L.L. Cavalli-Sforza and his colleagues.

People differ...

...in their taste papillae:

It is easy to see fungiform papillae if you stain your tongue with blue food coloring, as we have done in the pictures at right. The fungiform papillae do not stain, so they stand out as pink against the blue background.

...in taste sensitivity:

We test for taste sensitivity with a chemical called 6-n-propyl-thiouracil, or PROP for short. Some people can taste PROP and find it bitter, while other people cannot taste PROP at all. For the people who *can* taste PROP, the more papillae they have the more intensely bitter PROP is.

...in smell sensitivity:

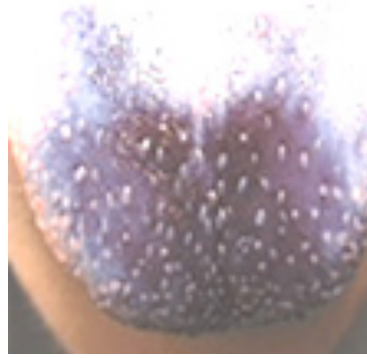
People vary considerably in how intensely they perceive odors. People who are highly sensitive to PROP tend to be highly sensitive to certain flower odors, such as jasmine, rose, and heliotrope, and certain food odors, such as chocolate, banana, citrus, and anise.

...in trigeminal sensitivity:

We test for trigeminal sensitivity using LifeSaver™ peppermints – the stronger the “cooling rush” a person experiences when crunching down on the peppermint, the greater the person’s trigeminal sensitivity.

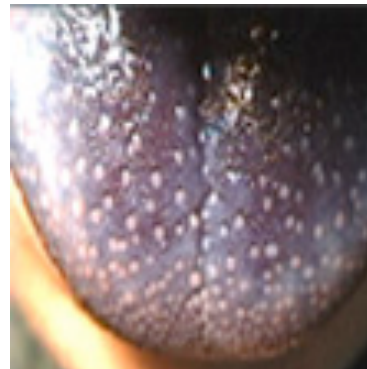
...and in their enjoyment of food:

Brillat-Savarin observed in *“La Physiologie du Goût”* that people who had fewer “bumps” (fungiform papillae) on their tongues did not enjoy food as much as did people whose bumps were plentiful.



Tongue of a mildly sensitive taster

The fungiform papillae are the small pinkish dots on this tongue. Note that they are small and seed-shaped.



Tongue of a moderately sensitive taster

The fungiform papillae on this tongue are larger and more rounded than those on the tongue above.



Tongue of a highly sensitive taster

This tongue is covered with fungiform papillae. Note that this tongue does not have any blue areas like those in the tongues shown above.

Mildly
sensitive tasters
“eat to live”

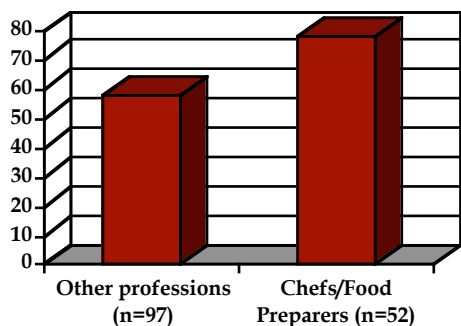
Moderately
sensitive tasters
“live to eat”

Highly
sensitive tasters
love what they
like,
hate what they
don't like

A Tasteful Perspective ~

The National Restaurant Association Show provided us an opportunity to explore taste sensitivity among people involved in the food business. We found that chefs and food preparers had, on the average, significantly higher responses to the “coolness” of mint than did restaurant managers and most everyone else.

This graph shows the average intensity values for the “coolness” of mint (out of a possible 100) for chefs/food preparers and others.



Chefs and food preparers also had higher scores for absorption into visual experiences, described below.

Tasters of PROP, and people who sense coolness when they taste LifeSaver™ mints, say :

- ❖ The crackle of flames of a wood fire stimulate my imagination.
- ❖ My thoughts often don't occur as words but as visual images.
- ❖ I like to watch cloud shapes change in the sky.
- ❖ I can be deeply moved by a sunset.

In other words they become *absorbed in* and *take pleasure from VISUAL experience*. And coupled with this visual absorption and pleasure is a tendency to experience vivid memories.

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Overall, we have found that people of different taste sensitivity tend to approach decision-making in differing ways, even problems concerning issues that have nothing to do with flavor or food!

- mildly sensitive tasters tend to rely more on logical reasoning to arrive at decisions than do other tasters;
- moderately sensitive tasters are more likely to “play things by ear” and improvise;
- and highly sensitive tasters tend to spend time mulling things over, often “sleeping” on a problem if it is complex.

The reason for these differences may come from the fact that taste, smell, and trigeminal sensations all reach the same area on the right side of the brain, called the orbitofrontal cortex. This cortex weighs values and appreciates contingencies – the specifics of a situation, rather than its general characteristics. No such input arrives in the part of the brain involved in logical sequential reasoning, called the dorsolateral prefrontal cortex. Our guess that you may become more involved in considering contingencies if you have strong sensations arriving in your orbitofrontal cortex, but logic will dominate if your orbitofrontal cortex is less active.

...and shortly thereafter, mechanically, loaded down by the dreary day and the prospect of a sad tomorrow, I brought to my lips a spoonful of tea into which I had let a piece of madeleine soften. But at the very instant that the mouthful mixed with cake crumbs touched my palate, I shuddered, attentive to the extraordinary thing that was happening in me. A delicious pleasure had invaded me, isolated – no notion of its cause. It immediately rendered all the vicissitudes of life unimportant, life's disasters harmless, its brevity illusory...
...And suddenly the memory appeared to me...But, when nothing remains of a remote past, after the death of beings, after the destruction of things, only smell and flavor, more frail but more lively, more immaterial, more persistent, more faithful, only they last for long, like ghosts, to be recalled, waiting, hoping (on the ruins of all the rest) to carry without bowing, on their almost impalpable droplet, the immense edifice of memory.

M. Proust ~ Translation VU