THE MYTH OF THE TONGUE MAP
and other ways to explore our individual tastes

Tongue maps - that four distinct tastes (sweet, sour, bitter, salty) are detected by discrete and generally non-overlapping areas of the tongue) have resulted from a mistranslation of a German paper by D.P. Hanig. His original tongue map (1901, see attached) showed that no taste areas of the tongue were sensitive to less than 4 distinct tastes. Mistranslation and misinterpretation led to the nearly -impossible -to -eradicate -from -textbooks erroneous concept of taste maps.

We can still, however, map our tongues to discover the truth of tongue maps, and what, if any, conclusions we can make about tongues and taste.

Materials
- vinegar, red wine vinegar, or lemon juice
- sugar water, 20% (w/v); 20 grams sugar into 100 ml water
- tonic water containing quinine
- salt water, 20% (w/v); 20 grams salt into 100 ml water
- small cups • cotton swabs
- paper tongue • 4 colors markers or colored pencils (optional)
- blindfolds (optional)

Place the liquids into small cups and distribute one of each, plus the other materials, to each pair or group.

To Do and Notice
The "subject" should keep their eyes closed or wear a blindfold during the experiment.

Decide how you will mark the paper tongue data sheet to distinguish the different tastes. You might use 4 different colors of markers, or different symbols on the data sheet. (ex. sour is red X's, sweet is green O's, bitter is blue X's, salty is black O's.)

Choose one of the four solutions. DO NOT tell the subject which solution you have chosen. Dip a cotton swab in the solution, then press it against the side of the solution container so that the swab is wet but not dripping.

The subject opens their mouth. Gently touch different areas of their tongue with the cotton swab. You may need to rewet it in the solution after a few touches. Ask the subject to tell you when, and what taste, they are experiencing. DO NOT tell them if they are experiencing the "correct" taste. Record the answer on the paper tongue data sheet by putting a mark (as described above) on the area of the tongue you've just touched. Try the tip, sides, center, back (careful of the gag reflex) and other spots.

Record any unusual responses -- for example, if you are testing bitter, but the subject thinks it is sweet.

Repeat for the other 3 solutions. Trade roles and repeat.

Exploratorium Teacher Institute

What's Going On?

Compare your "tongue map" with other students in the class -- or display them all as a "gallery" of tongues. Do they all look the same? Are there discrete areas where only one taste is detected?

All areas of the tongue that can sense taste can detect all four tastes -- sweet, sour, bitter, salty. There are different sensitivities in these areas, and they will vary somewhat from person to person. You may have found that it's difficult to determine what taste it is that you're being tested with. "Flavor" is a combination of taste (gustation), smell, and "mouthfeel" or texture. When you don't know what to expect and are relying only on taste, it can be a challenge to decide what you are experiencing.

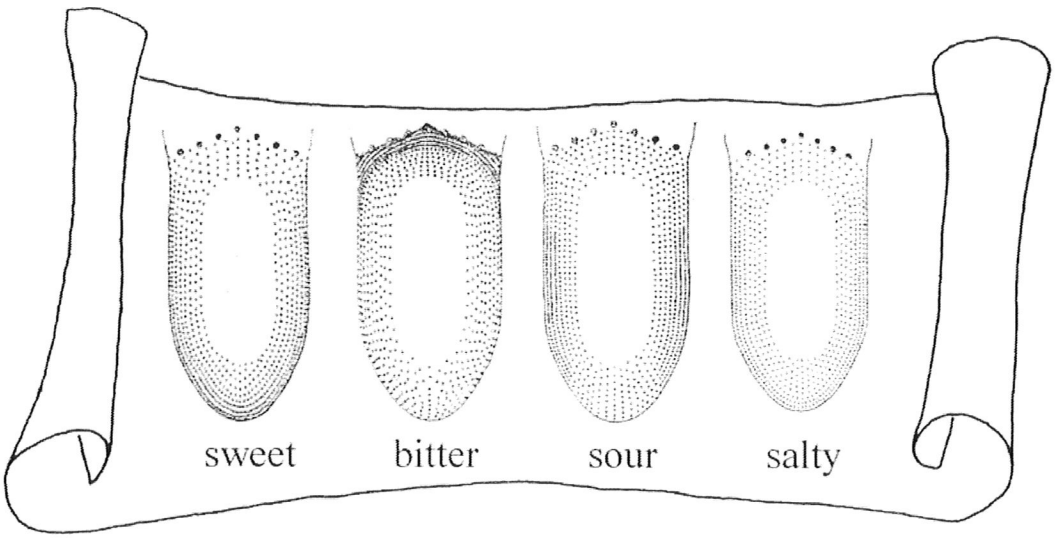
Going Further

Scientists now recognize a fifth distinct taste, *umami* Umami is a Japanese term that means "savory" and is associated with the flavors in meats, seaweeds, and ripened cheeses. Since only the Japanese had a word for it, it was long debated whether or not umami was a distinct taste. Scientists have found that taste cells do respond to the amino acid glutamate (think MSG or monosodium glutamate) so we know that it is a distinct taste.

Make a solution of MSG in water (Accent brand seasoning is MSG). Repeat the above test -- can you "map" MSG? Do subjects recognize it as a distinct taste? If not, how do they describe it?

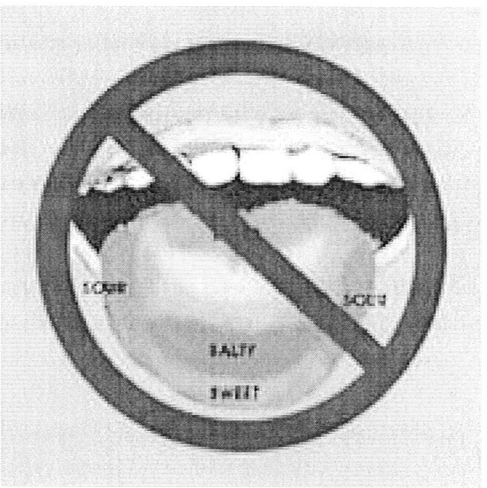
Original "Taste Map" Image

Hanig, D.P. 1901. Zur Psychophysik des Geschnmakssines. Philosophische Studien, 17: 576 – 623.



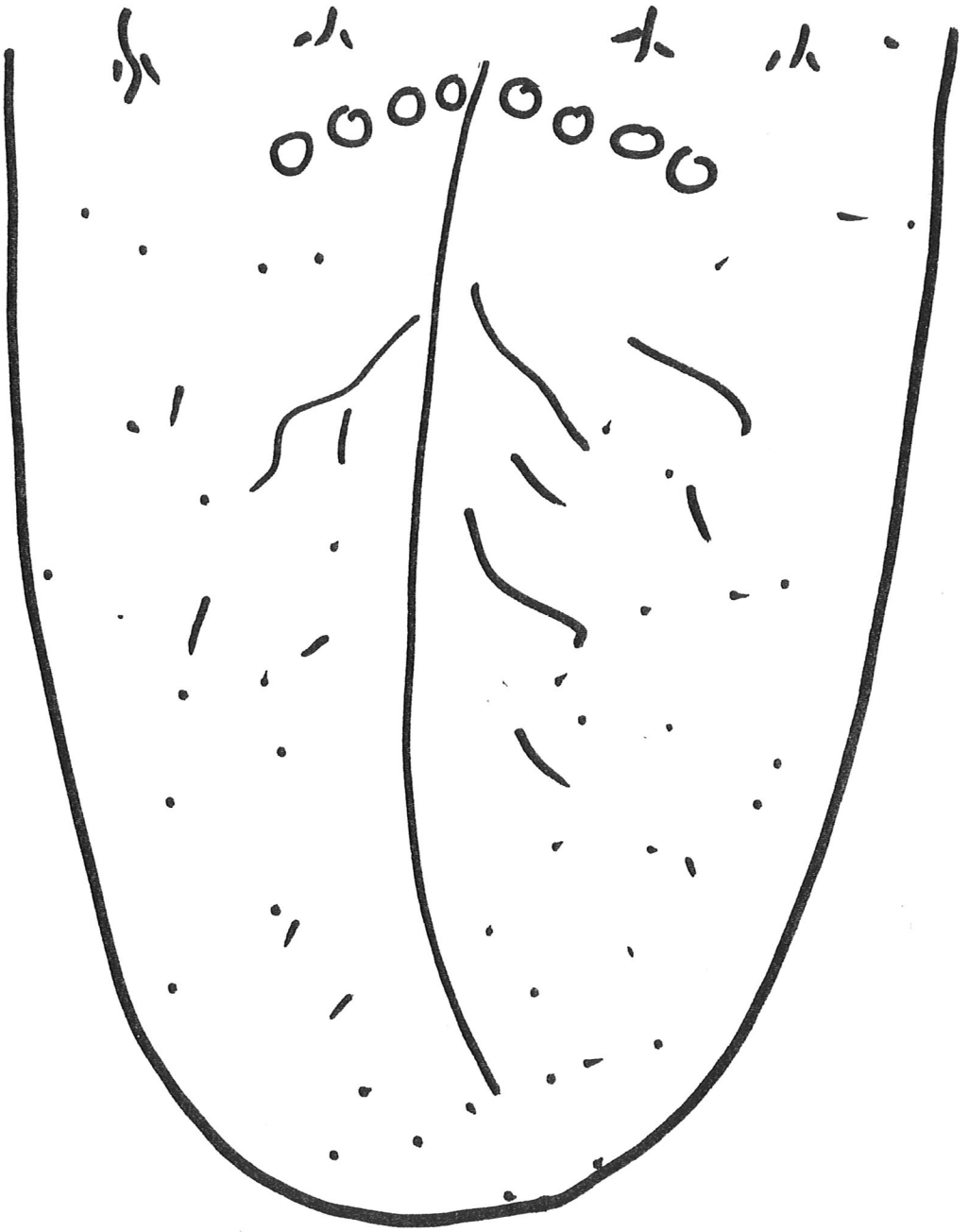
Chemotopic representation of the human tongue according to Hänig (1901), the first source on tongue maps, showing that no taste area is sensitive to less than 4 taste qualities. Taste sensitivity (inverse detection threshold) is represented by the density of symbols. For each of the 4 qualities shown, sensitivity extends across anterior, lateral and posterior (vallate) parts of the tongue. It is highest for sucrose-sweet at the tip, for HCl-sour at the sides and for quinine-bitter at the back, but the differences in sensitivity within each quality are moderate they are also controversial). In addition, taste sensitivity was reported for the palate (not included here).

From these diagrams, now 105 years old (now being 2006), the popular textbook versions, often conveying the impression of more or less specialized areas, probably arose by "graphical evolution", a curious process.



TASTE MAPS ARE WRONG!!!

MY PERSONAL TONGUE "MAP"



Fill in the "taste" in the blank

A = = RED X _____

B = GREEN X _____

C = BLUE X _____

D = BLACK X _____

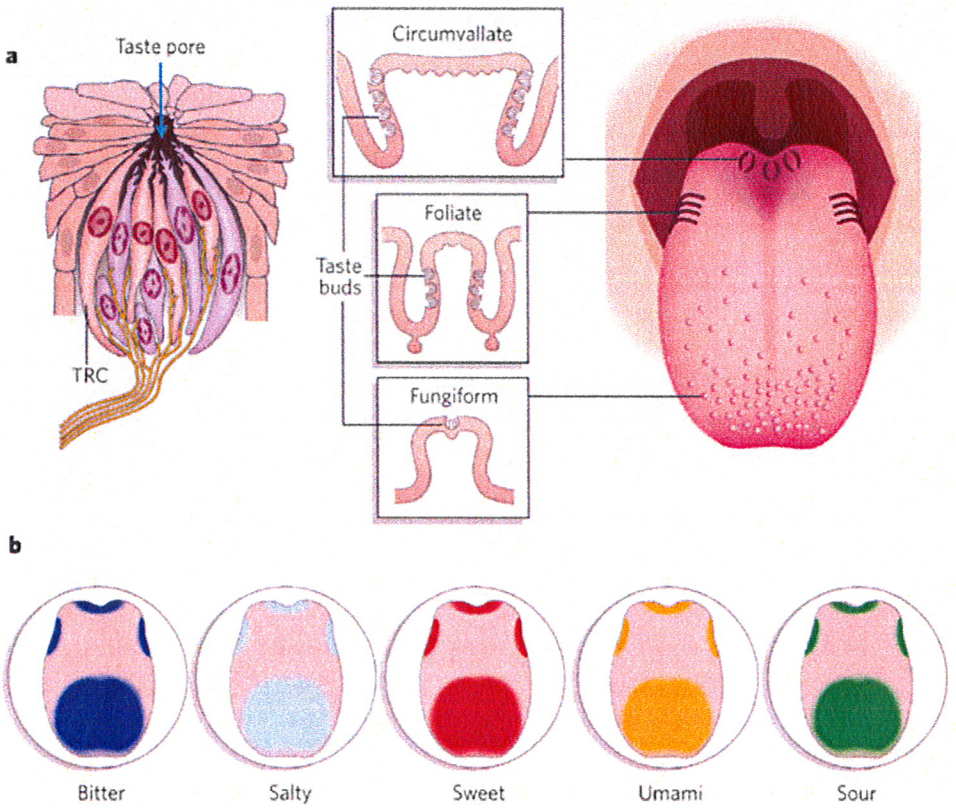
Your Sense of Taste (Gustation)

We can detect 5 "tastes" vs. 10,000 "smells"

Taste Sensation	What triggers the receptor	Example
Salty	Sodium ions, Na^+	Table Salt
Sour	Hydrogen Ions, H^+	Acids, e.g. vinegar, lemon juice, etc.
Sweet	Sugars	Sugars, e.g. sucrose
Bitter*	Compounds with large carbon rings	Quinine, caffeine,
Umami (translation = "savory")	Salts of glutamic acid	MSG (monosodium glutamate)

**there are 25 different known receptors for bitter molecules*

Gustatory Receptors and their Location on the Human Tongue



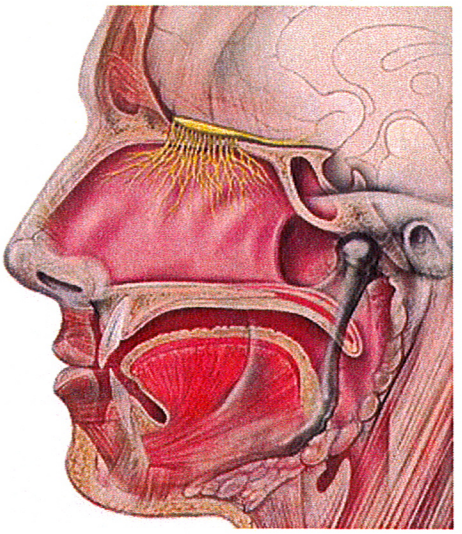
Your Sense of Smell (Olfaction)

- Humans have a total of about 40 million olfactory receptors.

- These receptors are located at the top of the nasal passages (the yellow fibers in the diagram at the right).

- There are about 350 different types of olfactory receptors that respond to one or more types of odorants.

- Humans can distinguish about 10,000 different scents



Our perception of different scents results from stimulation of different combinations of odorant (olfactory) receptors, for example:

Odorant receptors	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Description
Odorants															
A					●										rancid, sour, goat-like
B		●				●									sweet, herbal, woody
C	●			●	●		●			●	●				rancid, sour, sweaty
D		●			●	●									violet, sweet, woody
E	●			●	●		●	●		●	●	●			rancid, sour, repulsive
F				●	●		●			●					sweet, orange, rose
G	●			●	●		●	●		●		●		●	waxy, cheese, nut-like
H				●	●		●			●		●			fresh, rose, oily floral

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