SENSORY ANALYSIS 101
PART I: TASTE AND SMELL

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What is Sensory Evaluation?

"A scientific discipline used to evoke, measure, analyze and interpret those responses to products that are perceived by the senses of sight, smell, touch, taste and hearing."

Stone, H and Sidel, JL. 1993. Sensory Evaluation Practices. 2nd ed. Academic Press: San Diego.





How is Sensory Evaluation Used?

- In a food company, sensory scientists work closely with product developer's to understand:
  - What consumers like and why.
  - If consumers can tell a difference when they change a product.
- In academia, sensory scientists:
  - Try to understand how our senses work and how our senses respond to stimuli (both from food and chemicals).
  - Improve testing methodology.

Why Is Sensory Evaluation Used?

- It reduces uncertainty and risks in decision making.
- It ensures a cost-efficient delivery of new products with high consumer acceptability.
- Human observers are good measuring instruments.
  - People can sometimes detect odorants at levels lower than what can be detected by an instrument.
  - Instruments can not measure liking.

How do our senses work?

- There are five senses:
  - Taste
  - Smell
  - Touch
  - Sight
  - Sound
- All senses are important when eating.





How does taste work?

- There are five basic tastes:
  - Sweet
  - Sour
  - Salty
  - Bitter
  - Umami
    - The Japanese word “umami" translates as "pleasant to the taste, agreeable, good, mild, savory, delicious."
    - Sources of the taste include monosodium glutamate (MSG), broth, and shiitake mushrooms.

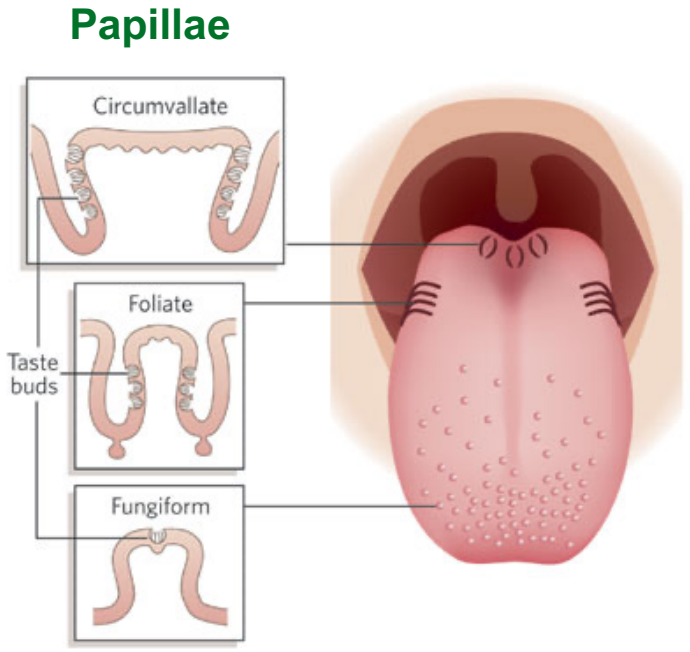
How do we taste?

- Taste Map
  - All qualities of taste can be elicited from all the regions of the tongue that contain taste buds.
  - Taste researchers have known for many years that the taste map is wrong.

http://library.thinkquest.org/05aug/00386/taste/fun/sweetandsour/sweetandsour.htm

How do we taste?

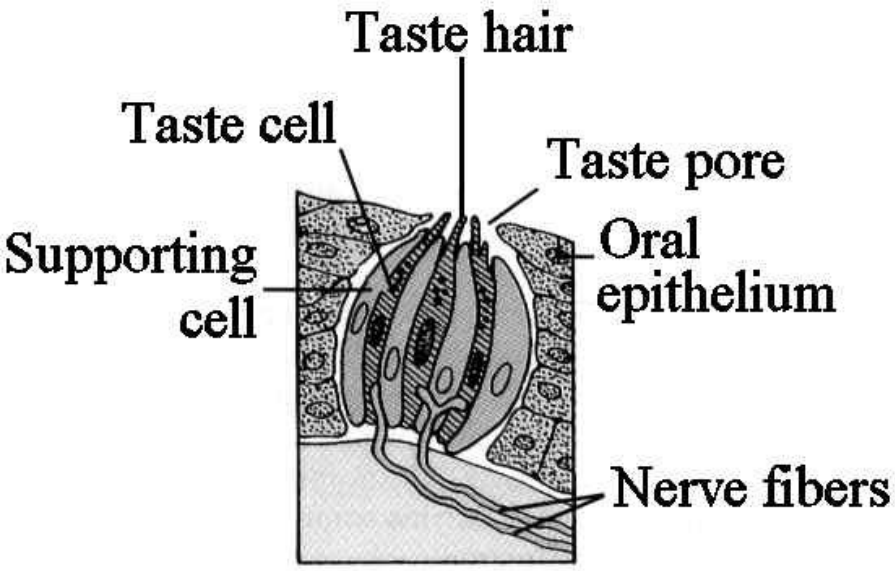
- The tongue has four types of papillae (pa-pill-ah):
  - Filliform (no taste buds)
  - Circumvallate
  - Foliate
  - Fungiform



Chandrashekar J, Hoon MA, Ryba NJ, Zuker CS. 2006. The Receptors and Cells for Mammalian Taste. Nature. 444: 288-294.

How do we taste?

- The fungiform, foliate, and circumvallate papillae contain many taste buds.
  - Each taste bud contains 30-50 taste receptor cells (TRCs).
  - TRCs project microvillae to the surface of the taste bud, where they form the taste pore; the taste pore is in contact with the fluid portion of food within the mouth.
  - Taste molecules from food are believed to bind to hair-like cilia that project from the top of the taste cells.



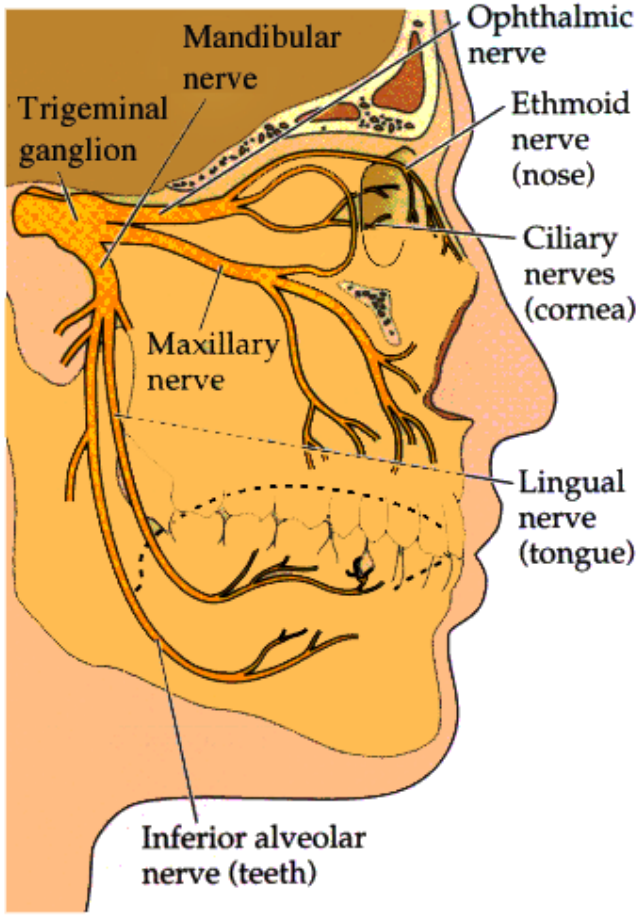
Seeley, Rod R.; T.D. Stephens, and P. Tate. (1996). Essentials of Anatomy & Physiology, 2nd ed.. Mosby, NY. pg.240.

How do we taste

- After the tastants bind to the cell, the next step, taste transduction is somewhat different for each of the basic tastes.
- The chemicals that produce salty and sour tastes act directly through ion channels, whereas those responsible for sweet, umami, and bitter tastes bind to surface receptors that trigger a series of signals to the cells' interiors that ultimately results in the opening and closing of ion channels .
- The opening of the ion channels increases the concentration of positive ions inside taste cells - this depolarization causes the taste cells to release tiny packets of chemical signals called neurotransmitters, which prompt neurons connected to the taste cells to relay electrical messages to the brain.

Some Cool Things About Taste: The Trigeminal Sens-

- The nose and mouth are vastly innervated by the trigeminal nerve, including fungiform papillae!
- Many food components stimulate these nerve endings and have irritative aspects:
  - *Sting* from horseradish and mustards
  - *Burn* of chili peppers
  - *Tingle* from carbon dioxide
  - *Numbing* from menthol
- These compounds have long-lasting time properties.
- They can cause defensive physical reactions (e.g., salivation, tearing).
- They have *desensitizing* properties – meaning they reduce the sensitivity to stimuli and result in a delayed ability to recover full sensitivity.



St Joseph's Gamma Knife Center:
http://www.stjosephsatlanta.org/gamma_knife_center/trigeminal.html

Some Other Cool Things About Taste: Adaptation

- Adaptation is a decrease in response under conditions of constant stimulation.
- Taste adaptation is seen with a stable stimulus.
  - Example: When drinking a beverage the first sip will be perceived as sweeter than the last because you adapt to the sweetness.
- While similar to desensitization from trigeminal irritants, recovery from adaptation is much faster.

Some Cool Things About Taste Context Effects

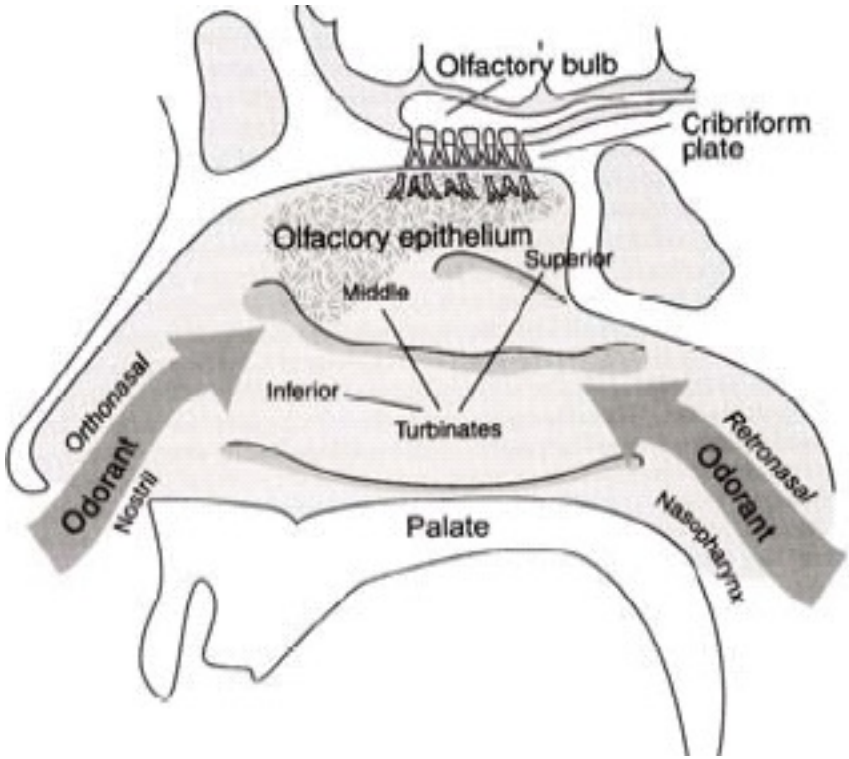
- Human observers act like measuring instruments that constantly re-calibrate themselves to the expected frame of reference.
  - Example: How warm (cool) is 40°F in January? What about in August? In January it will feel pretty warm within the context of the cold days vs. in August it will feel cool within the context of the hot days.
  - The same phenomena occurs with taste.

How do we smell?

- Most of what we "taste" is actually being sensed by our olfactory cells within the nasal canal.
  - Remember: taste is only sweet, sour, bitter, umami, and salty.
  - In contrast to taste, humans can smell hundreds of compounds (for a list visit http://www.flavornet.org/flavornet.html).
- Flavor is used to describe the perception of taste and smell together.

How do we smell?

- Odorants can reach the olfactory epithelium by two routes:
  - **Orthonasal olfaction:** The detection of an odor through the nostrils by sniffing or inhalation.
  - **Retronasal olfaction:** The detection of an odorant when it is released from food in your mouth during chewing, exhalation, or swallowing. During this process, the odorant passes through the posterior nares of the nasopharynx.



Halpern, BP. 2004. Retronasal and Orthonasal Smelling. ChemoSense. 6(3). 1-7.

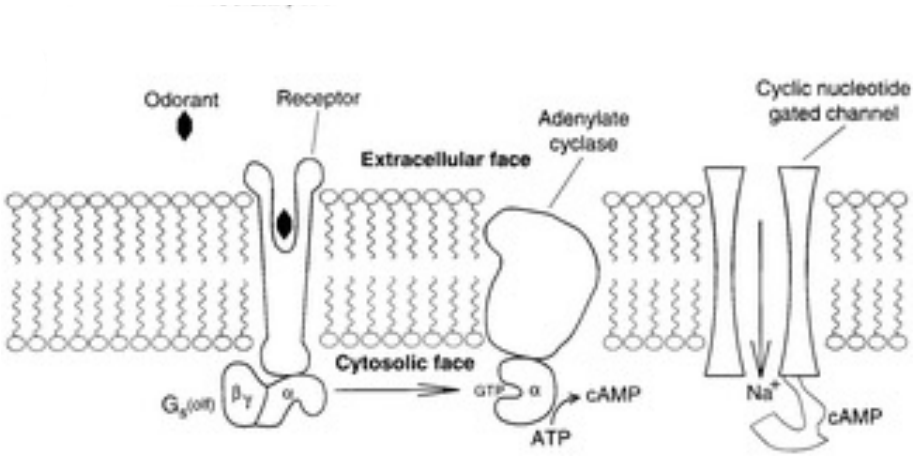
How do we smell?

- Odor molecules bond to olfactory receptors (ORs) which are expressed in olfactory sensory neurons (OSNs) in the nose.
- Each odorant bonds to a unique combination of ORs.
  - Each OSN expresses only one OR type but multiple odorants can bond to a single OR type, while a particular odorant can bond to multiple OR types.
  - There are about 400 functional OR types
  - Different people express different OR types.

Buck L and Axel R. 1991. A Novel Multigene Family May encode Odorant Receptors: A Molecular Basis for Odor Recognition. Cell. 65:175-187

How do we smell?

- When stimulated by odorant binding, the olfactory receptors (ORs) activate an olfactory-specific G protein which is displayed on the surface of the modified cilia that extend from each cell.
- The G protein in turn activates adenylyl cyclase. The resulting increase in cyclic AMP opens *cyclic-AMP-gated cation channels*, thereby allowing an influx of Na+, which depolarizes the olfactory receptor neuron and initiates a nerve impulse that travels along its axon.



Buck L and Axel R. 1991. A Novel Multigene Family May encode Odorant Receptors: A Molecular Basis for Odor Recognition. Cell. 65:175-187

How do we smell?

- Axon extensions from the olfactory sensory neurons (OSNs) converge onto matching glomeruli in the brain's olfactory bulb.
- This means that the response of each glomerulus is an amplified version of the responses of the subset of individual receptor cells.
- Odor information is then relayed to many regions throughout the brain.

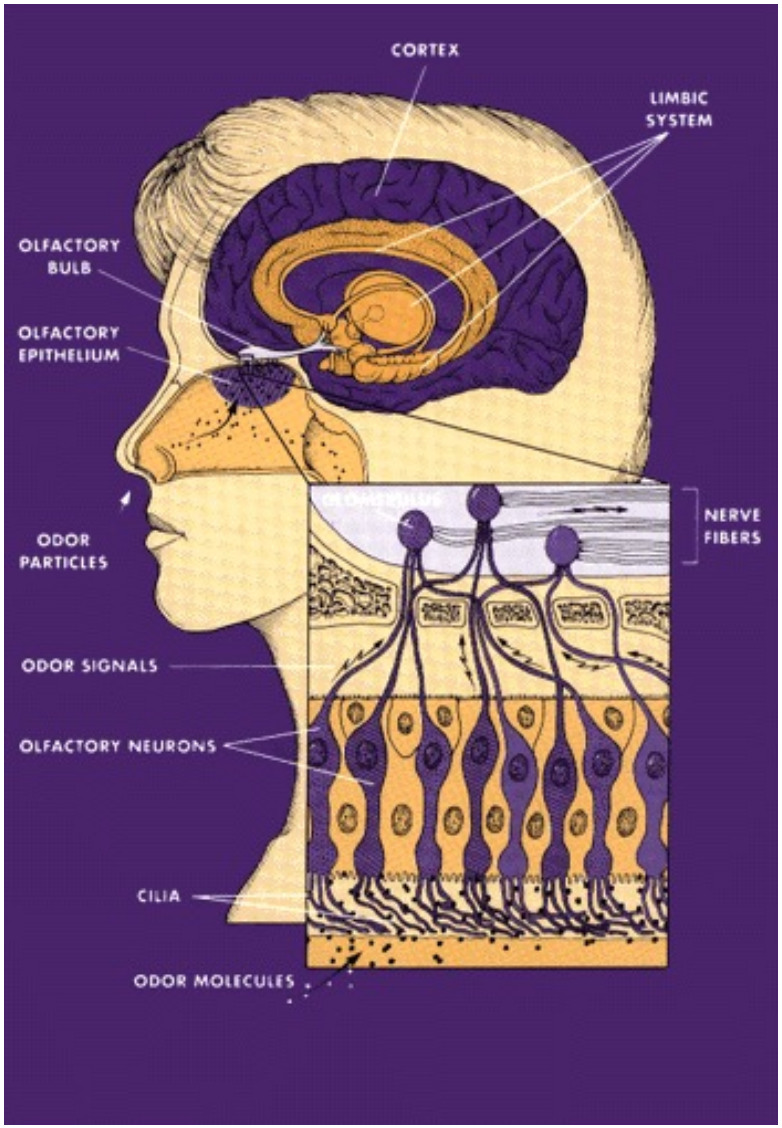


Illustration by Lydia Kibiuk, Copyright © 1995 Lydia Kibiuk.
http://www.sfn.org/index.cfm?pagename=brainBriefings_smellAndTheOlfactorySystem

Thank you for your patience.
Now it is time to taste!!!

Some Interesting Things About Smell: Individual Differences

- Some people lack or lose the ability to smell. This is called **anosmia.** This condition may be temporary or permanent. Causes can range from a cold to a brain injury.
- Some people can't smell certain compounds. This is called a **specific anosmia.** Individual differences in the expression of the several hundred olfactory receptor proteins has been used to explain the variation.

Compound, Odor Quality, and Frequency of Specific Anosmia

Compound	Odor Quality	Anosmia Frequency
Androstenone	Urinous	50%
4-chloroaniline	Mixed	41%
Isobutyraldehyde	Malty	36%
1,8-cineole	Camphoraceous	33%
pentadecalactone	Musky	31%
Trimethyl amine	Fishy	6%
L-carvone	Minty	3%

Wysocki, C. and Labows, J. 1984. Individual differences in odor perception. *Perfumer and Flavorist, 9,* 21-26.

Some Interesting Things About Smell: Individual Differences

- Did anyone ever tell you that you had a "good nose"?
- Differences also exist in how sensitive people are to different odorants. Some people are more sensitive to some odorants than others.
- Individual differences in the expression of the several hundred olfactory receptor proteins probably also explain the variation.

Some Cool Things About Smell Adaptation

- Adaptation or a decrease in response under conditions of constant stimulation occurs with smell as well as taste.
  - Example: Ever go into a smelly room and realize later you don't smell it anymore? Or ever wonder why you can't smell perfume on yourself?
  - That's because you have adapted to the smell. This process prevents your brain from going into sensory overload!

Careers in Sensory Evaluation

- Job Titles:
  - Sensory Scientist
  - Sensory Analyst
  - Sensory Technician
  - Corporate Executive Chef/Research Chef
- Employers:
  - Food processors
  - Cosmetic and fragrance manufacturers
  - Ingredient manufacturers/suppliers
  - Academia (Higher Education)
  - Consumer and marketing research firms
  - Self-employed/Consultant

- Job Responsibilities:
  - Experimental design
  - Sample Preparation
  - Perform, analyze, and report experimental results
  - Troubleshooting

Sensory Scientist at Work!

Questions?
Feedback?