Chapter 14: Taste

Taste isn't the same without smell
The Perception of Flavor

Taste + Smell = Flavor

- Combination of smell, taste, and other sensations (such as burning of hot peppers)
- Odor stimuli from food in the mouth reaches the olfactory mucosa through the retronasal route
- The taste of most compounds is influenced by olfaction, but a few, such as MSG are not

Flavor is affected by blocking the nose.
Structure of the Taste System

- Four kinds of papillae (bumps):
  - Filiform - shaped like cones and located over entire surface
  - Fungiform - shaped like mushrooms and found on sides and tip
  - Foliate - series of folds on back and sides
  - Circumvallate - shaped like flat mounds in a trench located at back
In extreme cases, normal individuals may have as few as 5 fungiform papillae in a 6mm area, or as many as 60.
Structure of the Taste System

- Taste buds are located in papillae except for filiform
  - Tongue contains approximately 10,000 taste buds
  - Each taste bud has taste cells with tips that extend into the taste pore
  - Transduction occurs when chemicals contact the receptor sites on the tips

Basic Taste Qualities

- Five basic taste qualities:
  - Salty
  - Sour
  - Sweet
  - Bitter
  - Umami - described as meaty, brothy or savory and associated with MSG

Contrary to popular belief, sensations of different qualities are not localized to specific parts of the tongue.
quinine

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\text{quinine}
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\[
\text{sucrose}
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\[
\text{sucrose}
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Tastes can (usually) be described as a combination of the basic taste qualities.

Structure of the Taste System

- Signals from taste cells travel along a set of pathways:
  - Chorda tympani nerve from front and sides of tongue
  - Glossopharyngeal nerve from back of tongue
  - Vagus nerve from mouth and throat
  - Superficial petronasal nerve from soft palate
Neural Coding for Taste

- Distributed coding
  - Experiment by Erickson
  - Different taste stimuli were presented to rats and recordings were made from the chorda tympani
  - Across-fiber patterns showed that two substances (ammonium chloride and potassium chloride) are similar to each other.
Neural Coding for Taste

- Experiment by Sato et al.
  - Recordings were made from 66 fibers in the monkey's chorda tympani
  - Results showed that there were fibers that responded best to one of the basic tastes (sweet, salty, sour, and bitter) but poorly to the others
  - Thus, there are fibers that respond specifically to particular chemicals

The tastes that human subjects perceive for each of four stimuli: sucrose, NaCl, HCl, and quinine. Also shown are the tastes that a monkey would perceive if the monkey's sweet-best fibers coded sweetness, NaCl-best fibers coded saltiness, HCl-best fibers coded sourness, and quinine-best fibers coded bitterness.
(Monkey data from Sato, Ogawa, and Yamashita, 1975.)
Structure of the Taste System

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- These pathways make connections in the nucleus of solitary tract in the spinal cord
- Then they travel to the thalamus
- Followed by areas in the frontal lobe:
  - Insula
  - Frontal operculum cortex
  - Orbital frontal cortex
The Physiology of Flavor Perception

- Responses from taste and smell are first combined in the orbital frontal cortex (OFC)
- OFC also receives input from the primary somatosensory cortex and the inferotemporal cortex in the visual *what* pathway

A combination of genetics and culture determine our food preferences
PTC /PROP – Taster vs. non-taster

In 2003 the gene that expresses PTC/PROP receptors was found. A member of the bitter family. Individuals with two recessive alleles are nontasters; those with either one or both dominant alleles are tasters.

Nontasters: high thresholds, Tasters : low thresholds. 

Distribution varies by sex and race: 
Women have lower thresholds than men  
Asians have lower thresholds than Caucasians.

Tasters were more finicky eaters: tend to dislike foods high in bitter compounds, such as many vegetables,.

Alcoholics and smokers were found to contain a lower proportion of tasters than would be expected by chance, presumably because unpleasant sensations (e.g., bitterness) produced by alcoholic beverages and tobacco acted as deterrents.

The effect of genetic variation in taste was even related to cancer risk, as will be described shortly.

Are you a ‘supertaster’?

To test your taste buds, you need some blue food coloring, a piece of paper with a 7mm-wide hole punched through it, and a magnifying glass.

Swab some of the food coloring onto the tip of your tongue. The tongue will take up the dye, but the papillae, tiny structures that house the taste buds, will stay pink.

Put the piece of paper on the front part of the tongue and, using the magnifying glass, count how many pink dots are inside the hole.

Fewer than 15 papillae - insensitive "non-taster", between 15 and 35 indicates an average "taster" and over 35 papillae then you are a "super-taster".
Supertasters.

Those with more fungiform papillae not only experience the most intense taste sensations in general, but also experience the most intense sensations of oral burn (e.g., chilis) and oral touch (fats, thickeners in foods) because fungiform papillae are innervated by nerve fibers that convey burn and touch sensations, as well as those that convey taste sensations.

In addition, because of central connections between taste and retronasal olfaction, those who experience the most intense taste sensations also perceive more intense retronasal olfaction and thus more intense flavor.

<table>
<thead>
<tr>
<th></th>
<th>Many fungiform papillae</th>
<th>Fewer fungiform papillae</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROP sensitive</td>
<td>PROP supertaster</td>
<td>PROP taster</td>
</tr>
<tr>
<td>PROP insensitive</td>
<td>supertaster</td>
<td>non-taster</td>
</tr>
</tbody>
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Genes affect behavior

• Elderly men tasting PROP as more bitter had the most colon polyps, a precursor to colon cancer (Basson et al., 2005).

• Fats can produce unpleasantly intense sensations to supertasters, leading them to eat fewer high-fat foods and thereby lowering their risk of cardiovascular disease (Duffy, Lucchina, and Bartoshuk, 2004).

• Nontasters are more likely to smoke and consume alcohol
As does environment

<table>
<thead>
<tr>
<th>Big Mac</th>
<th>Apple</th>
</tr>
</thead>
<tbody>
<tr>
<td>$3.57</td>
<td>$8</td>
</tr>
<tr>
<td>Heavily advertised</td>
<td>is an apple</td>
</tr>
<tr>
<td>Tastier</td>
<td>is an apple</td>
</tr>
<tr>
<td>Smellier</td>
<td>is an apple</td>
</tr>
<tr>
<td>Not so healthy</td>
<td>is an apple</td>
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Especially when our environment is “enhanced”

Rats on diets containing the artificial sweetener saccharin gained more weight than rats given sugary food.

Obesity epidemic since the rise of “low-fat” foods – “biggest public health disaster of the 20th century” (Michael Pollan)

http://www.michaelpollan.com
The French paradox

The traditional French diet:

- Fewer sugars
- Enough fat to satisfy
- Non-processed foods
- No artificial sweeteners
- Slowly with company
- Don’t snack