Why can’t you tickle yourself?

Olfaction
- Sensation of molecules in the air around you
- Every animal (and some plants) have something like olfaction
- Olfaction is less important for humans than for other animals
  - Often disparaged by philosophers as an ignoble sense
  - Compared to vision and hearing
- Indeed, olfaction has been largely misunderstood throughout history
  - Garlic to ward off vampires
  - Don’t breath in a dying person’s last breath
  - Judged in the 1800s used antimephitic (anti-poison) smells to ward off typhus when visiting a prison
- Needed chemistry and medicine to reveal how smell is related to molecules in the air

Not every molecule produces a smell
- The molecule must be able to exist in the air
  - For example, the molecules of a piece of glass do not evaporate in to the air, so it produces no smell
- If it cannot get in to the air, it cannot enter our nose
  - Inside the nose is an organ that is involved in olfaction

The top of your nasal cavity is defined by bone
- There are tiny holes in this bone in an area called the cribriform plate
- Olfactory receptors stick through these holes to get information about molecules

Here is another view
- All the receptors are stuck in a bunch of mucus
- The molecules must get through the mucus to be detected
A close up looks like this:
- Olfactory mucosa
  - The region with the olfactory receptors
- You take a whiff in order to bring molecules in the air up to these receptors
- You hold your nose to prevent molecules from reaching these receptors.

Here is another view:
- The olfactory bulb of the brain sits right above the receptors
- Different from almost every other sensory system (thalamus)

How does it work?
- Molecules are combinations of basic elements (periodic table)
- Molecules have characteristic molecular shapes
- There is no simple correspondence to shape and smell

<table>
<thead>
<tr>
<th>Smell</th>
<th>Molecule Name</th>
<th>Chemical Formula</th>
<th>Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toot</td>
<td>n-hexane</td>
<td>C6H14</td>
<td></td>
</tr>
<tr>
<td>Mary</td>
<td>2-butanone</td>
<td>C6H12O</td>
<td></td>
</tr>
<tr>
<td>Mary</td>
<td>2-butanone</td>
<td>C6H12O</td>
<td></td>
</tr>
<tr>
<td>Jamie</td>
<td>ethylamine</td>
<td>C6H11NO</td>
<td></td>
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</table>

Olfactory receptors
- There are roughly 1000 olfactory receptors (Nobel prize winning work)
- They are regenerated every few weeks
  - Why might this be necessary?

Olfactory receptors
- We can distinguish at least 10,000 different odors
  - Experts may be able to distinguish 100,000 odors
- A single odorant might be bound to several different receptors
- So a stimulus generates a pattern of responses across the receptors
- Similar to color perception, the three cone types can lead to many different patterns
- Think also of IT cells and distributed codes

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Odor discrimination

- People are not particularly good at identifying odors if just given the odor alone.
- There are sex differences.
  - Women tend to be better than men.
  - High end of white bars.
- Men are better at some odors.
  - High end of dark bars.

Testing odors

- It is rather difficult to produce a good odor stimulus.
- You have to go to great lengths to clear the air of various molecules.
- The physiology also adapts to smells.
  - Receptors.
  - Neural responses.

Perception

- It is unclear exactly how to describe odor perception.
  - Much seems to be tied to the sources.
- In English:
  - Aromatic: strong scented.
  - Fragrant: pleasant smelling.
  - Pungent: sharp, biting.
  - Redolent: spreading sweet scent.
  - Stinky: bad.
- We do use other words:
  - Floral, fruity: reference to the sources of the smell, not the smell itself.
  - Sweet: reference to a taste that accompanies the smell.
  - Green: reference to a visual association with a smell.

Perception

- It's fairly easy to demonstrate the lack of words for describing odors.
- Try to identify the difference in odor between these two sources.

Odor discrimination

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- There are sex differences.
  - Women tend to be better than men.
  - High end of white bars.
- Men are better at some odors.
  - High end of dark bars.
- Many of the problems seem to be less involved in perception and more to do with memory of the labels for odors.
  - Training helps a lot.
Smell and language

- Language and smell seem to generally be disconnected
  - Different hemispheres of the brain
  - Smells can influence behavior without conscious awareness

Primary smells

- Researchers have tried to identify primary smells
  - In the style of primary colors
  - But there is not a lot of agreement
  - Nor do they seem to easily match up with receptors
  - There is currently no theory that predicts what a molecule will smell like
    - But there is a lot of interest!

Primary smells diagram

Anosmia

- Some people lose their sense of smell
  - Usually due to brain injury
  - The textbook makes it out to be quite serious
    - That has not been consistent with my own observations of my wife, who has anosmia

Anosmia diagram

Olfaction

- There are more questions than answers
- There are no overall theories of how the brain represents smells
- Candidates include:
  - Vibration of molecules (largely discounted)
  - Chaotic attractors (possible, but difficult to test)
  - Perfumes and such are involved in over $25 billion sales every year
    - A good theory will be worth a lot of money!

Olfaction diagram

Conclusions

- Molecules
- Olfactory receptors
- Olfaction and language
- Lack of theory

Next time

- Other chemical sense
- Taste
- Flavor