

Psych 215 Instructors



SMELL & TASTE

Psychology 215
Spring 2002
Jody Culham



Final Exam

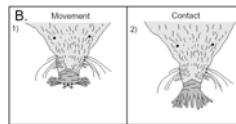
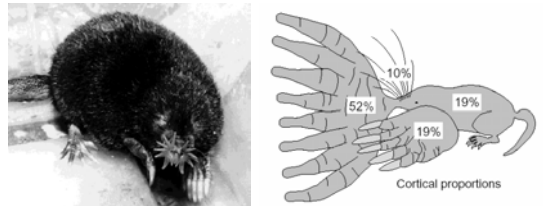
Psychology 215B-002

- Wednesday April 17
- 7:00 p.m.
- SSC2028

Format

- same as previous two tests
- 50 multiple choice = 50 points
- 3 short answers (each instructor writes two questions, you must answer one from each of the 3 instructors): 3 x 10 points = 50 points
- non-cumulative

Star-nosed Mole Homunculus



Nose ~ "Somatosensory fovea"

Why study smell and taste?



Evolutionary significance
Safety and survival

Hedonism
(Enjoyment)

Emotion & Memory
(Marcel Proust's
madeleines)

Anosmia

"I always thought I would sacrifice smell to taste if I had to choose between the two, but I suddenly realized how much I had misseed. We take it for granted and are unaware that everything smells: people the air, my house, my skin"

—anosmic patient (Birnberg, 1988, in Ackerman, 1990)

= "without smell"

- complete inability to smell
- "odor blindness"
- damage by chemicals or drugs or brain damage or illness
- often temporary (e.g., during a cold)
- can cause a loss of appetite and libido

Smell and Taste

Chemical senses

- Smell = olfaction
- Taste = gustation

(and by the way Touch = somatosensation = tactile sensation)

- chemosensation
- rely on chemoreceptors
- Interdependence between smell and taste

Olfaction



- volatile: substances must give off vapors
 - Weber's experiment
- fat-soluble

Humans vs. Other Species



Bloodhounds can pick up a 24hr old trail. Dogs have 1,000,000,000,000 receptors and we have about 10,000,000 (i.e., They have 10,000X more receptors than humans).

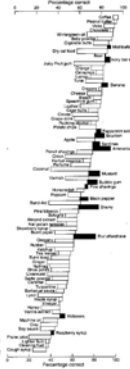


Sniffer rats have been used to detect explosives. Rats are 8-50X more sensitive than humans.



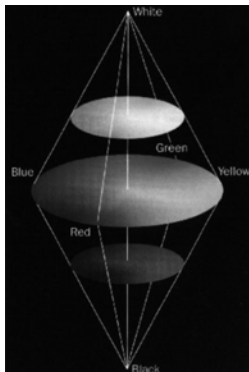
Humans' receptors are as sensitive. We just have fewer of them. Human olfactory receptors can be excited by the action of just one molecule of odorant

Identification vs. Discrimination



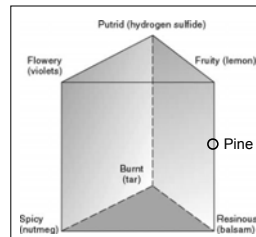
- Odor Identification: Most people can identify fewer than half the odors presented to them in a laboratory experiment.
- "tip of the nose phenomenon": inability to name a familiar odor
- Odor discrimination: Although identification is poor, people can tell the difference between approximately 10,000 odors
- With training and additional clues, people can reach 98% correct odor identification
- Varies from person to person
 - Females are typically better than males
 - Declines with age
 - Worse for smokers than non-smokers

Classifying Smells



- In vision we can classify colors into color space (e.g., hue, saturation, brightness)
- Is there a "smell space"?

Smell Space



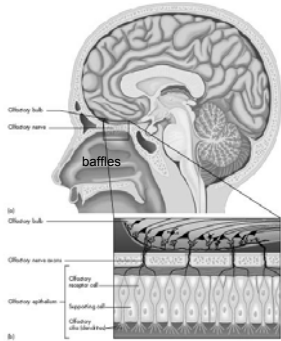
Hennig's smell prism

- subjects rated similarities of 400 different odors
- a particular odor falls on one part of the surface of the prism
- odors near each other on the surface are perceived as similar
- newer statistical techniques (multidimensional scaling) can map out odor space with fewer assumptions

Are odors additive (like color, e.g., red + green = yellow) or superimposable (like piano keys → chords)?

- lemon + balsam ≠ pine
- more like superimposition

Olfactory system

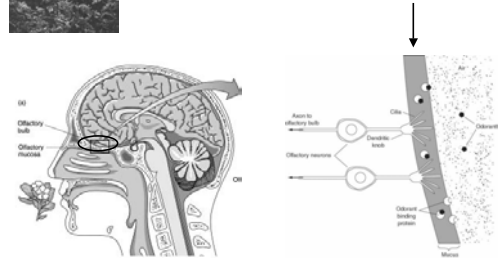


- nose
 - baffles
- olfactory epithelium
 - olfactory mucosa
 - olfactory sensory neurons
 - olfactory receptors
- olfactory nerve
- olfactory bulb
- olfactory cortex
 - limbic system
 - orbitofrontal cortex

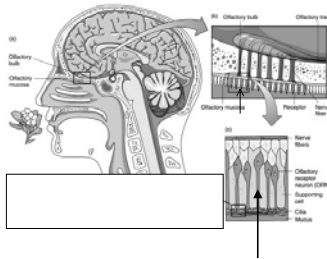
Olfactory Mucosa



- dime-sized region in nasal cavity
- contains cilia of olfactory receptors



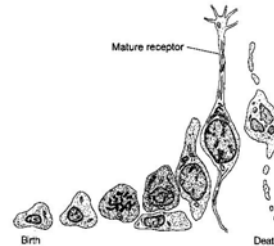
Olfactory Sensory Neurons



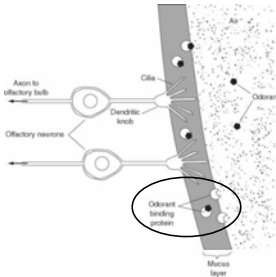
- unlike other senses, receptors are in direct contact with the outside world
- transduce odor molecules into neural signal
- cilia
 - protrude into mucosa
- dendrites
- axons
 - long connections
 - form olfactory nerve

Neuronal growth and death

- Smell and taste receptors only last 5-7 weeks
- How do new receptors get wired up appropriately to replace dead receptors?

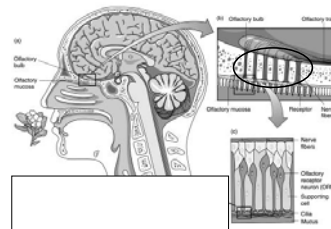


Odorant binding proteins



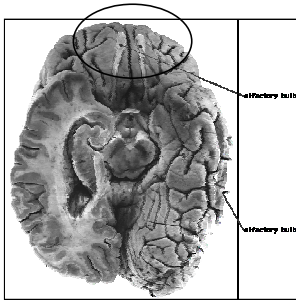
- Odorant binding proteins traps odor molecules and transports them to the mucosa
- Over 100 varieties of olfactory binding proteins
- "lock and key": some molecules can bind to a particular binding protein, some can't

Olfactory Nerve



- axons of sensory neurons transmit electrical signals to olfactory bulb

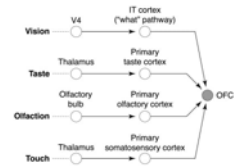
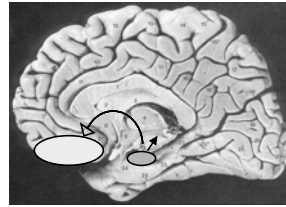
Olfactory bulb



View of bottom of brain

- receives input from olfactory nerve
- no clear "odorotopy"

Olfactory cortex



olfactory bulb

→ olfactory (piriform) cortex

→ orbitofrontal cortex

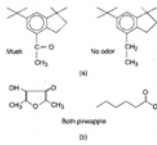
• multisensory integration (smell, taste, vision, touch)

→ limbic system (not shown) including amygdala and hippocampus

• emotion and memory

How do we code odors then?

- There's no clear "odor space"
- There's no "odorotopy"
- There's no clear pattern of which molecules activate which receptors

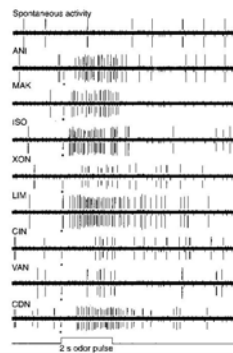


• Molecules with similar structure can smell different

• Molecules with different structures can smell the same

How can we encode different smells?!!!

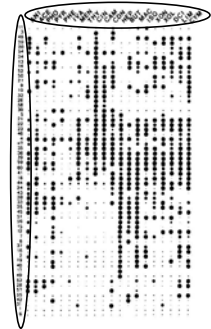
Olfactory Coding



• Different olfactory receptor neurons respond differently to different compounds

• This neuron responds well to all compounds except vanilla

How do we code odors then?



The sizes of the spots are proportional to the strengths of the neural responses

- The pattern of responses across all the different receptor types is unique for each odor
- Brain circuits learn to recognize the different patterns

Taste, flavor and heat

Taste

- only four (debatable five) aspects
 - sweet
 - salty
 - bitter
 - sour
 - umami (e.g., monosodium glutamate; tastes 'meaty' or 'savory')

Flavor

- the complex sensation associated with food, based on the food's taste, temperature, texture and smell
- flavor = taste + olfaction



"Heat"

- pain receptors on tongue register capsaicin, the substance in hot peppers

Taste without Smell



- Black bars = correct identification with smell
- White bars = correct identification without smell

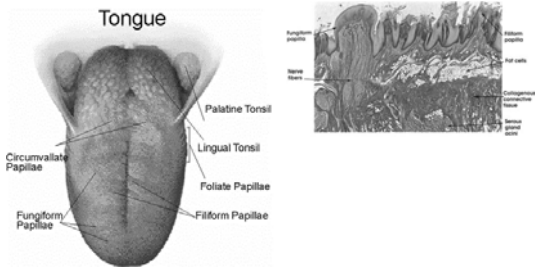
Taste

- substance must be soluble
 - you don't taste your fork
- need saliva
 - 25 ounces (1 L) per day!
- mixtures interact in complex ways
 - whole can be more than sum of parts

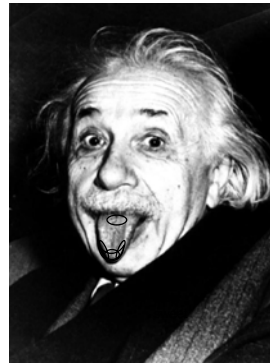
Tongue Papillae

Tongue

- muscle with mucous membrane
- covered in papillae ("pimples")

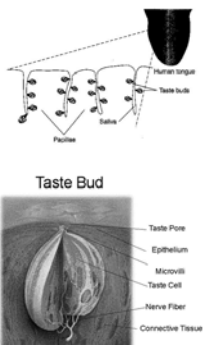


Tongue Map



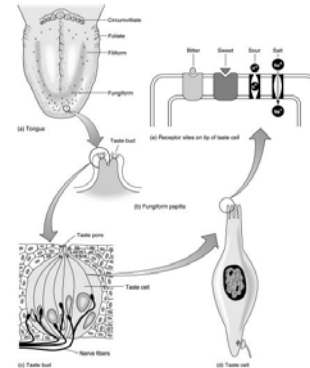
- Textbooks used to say that you could only taste certain things in different regions of the tongue
- Those maps only apply to weak solutions
- With stronger solutions, you can taste any of the aspects anywhere you have taste buds

Taste buds



- receptor cells for taste
- in papillae
- none in the centre of your tongue
 - a gustatory "blind spot"
- also in throat, roof of mouth and inside of cheeks
- life expectancy ~10 days
- each bud has ~50 taste receptor cells
- a taste bud looks like a head of garlic and the receptors look like the cloves

Taste receptors



- Villi at the tip of the taste cell contains receptor sites for bitter, sour, salty and sweet substances
- Stimulation of the receptors causes and electrical signal in the receptor

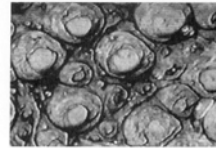
Individual differences

- Different people have different sensitivity to certain substances
- Ability to taste certain substances (PTC, PROP) is genetically determined
 - nontasters
 - report little taste
 - 25% of people
 - tasters
 - report bitter taste
 - 50% of people
 - supertasters
 - report extremely bitter taste
 - 25% of people
- Other substances may taste different to nontasters, tasters and supertasters (e.g., bitterness of coffee)

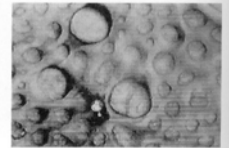
Nontasters, Tasters and Supertasters



- Dye tongue blue
- Count number of papillae in reinforcement circle at tip
 - <20: nontaster
 - >40: supertaster



supertaster



nontaster

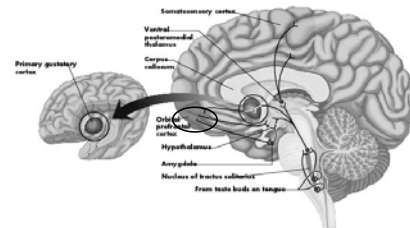
Taste variability

"I do not like broccoli. And I haven't liked it since I was a little kid and my mother made me eat it. And I'm President of the United States and I'm not going to eat any more broccoli."

— George Bush (Sr., "the elected")

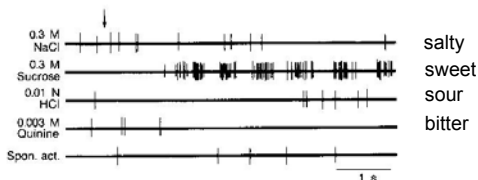
- Individual differences in taste ability may account for people's taste preferences
- Does cilantro taste like soap to you?
- (People also differ in their ability to smell certain substances too... "asparagus pee")
- Conditioned taste aversion: can easily develop an aversion to tastes (Garcia effect)
- Sensory-specific satiety: changes in enjoyability with fullness

Taste system



taste buds → 3 nerves → nucleus (NST) → thalamus
 → insula (primary gustatory cortex) → orbital prefrontal cortex

Taste coding

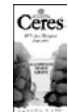


- Single neurons in taste-related nerves fire to different taste properties (e.g., neuron above is active for sweet tastes)

Applied Chemosensation: Wine Tasting



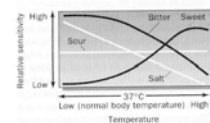
1. Chill the wine
 - Whites ~10°C
 - Reds ~15°C



Don't drink wine? Try good quality grape juice.

Why?

- Wine odors are more abundant around room temperature
- Substances taste very different depending on temperature
 - cold → less sweet, more acidic
 - serve fruity wines cold, dry & acidic ones just below room temperature



Wine Tasting



2. Check the label
3. Remove the cork

Why?

- People do much better at identifying flavors if they know what to expect
- Different cultures prefer different tastes (for Coca-Cola, Germans like spicy, Mexicans like citric, Italians like a little bitterness)
- People's expectations are higher in wine with corks (even though plastic stoppers yield better wine, it doesn't sell)

Photos from Oz Clarke's *The Essential Wine Book*

Wine Tasting

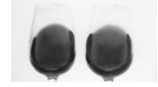


4. Look at the wine (brownier = older)



young

old



young

old

Why?

- Other properties affect the enjoyment of flavor
 - all the senses come together in orbitofrontal cortex
 - St. Patrick's day: green food tastes weird
 - achromatopsics (patients with lesions to the "color area" of the brain who see the world in shades of gray) lose their appetites

Wine Tasting



5. For rich-tasting wines, use a glass that's narrowed at the top. Don't fill the glass too full (~1/3). Swirl the wine in the glass.

Why?

- Flavor is largely related to smell.
- The swirling releases the volatile aromas.
- The narrowed top captures the aromas.

Wine Tasting



6. Give it a gentle swirl and take a good steady sniff. Characterize the scent. What does it remind you of (honey, chocolate, apples, black current)?

Why?

- Smelling is an active process – you must sniff
- Sniffing activates olfactory (piriform) cortex
- More isn't always better
 - odor constancy: perceived strength of an odor remains constant despite variations in the flow rate
- People's odor identification abilities are so poor (~50% for simple smells), your friends won't be able to tell you you're wrong (even if they're wine snobs)

Wine Tasting



7. Take a mouthful.
8. Draw in a little air through your mouth and suck it through the wine. "Chew" the wine.

Why?

- back door flavor: some argue that odors arriving in the nostrils from the mouth are processed differently than those arriving through the nose
- this may explain why some foods smell bad but taste good or vice versa
- slurping and chewing help cover the whole tongue and make the wine more volatile



Wine Tasting



9. Assess the wine's taste
 - acidity
 - tannin (bitter, astringent)
 - fruit
 - alcohol (burning)

Evaluate the wine with common terms (good, bad, fruity, grapy, spicy, sweet) or more pretentious terms (buttery, earthy, green, honeyed, oaky, petrolly, plummy, steely)

Why?

- While taste is actually quite limited (5 aspects), the flavor and texture add a lot ("full-bodied" = high in alcohol and/or tannin)
- Wine is complex – remember flavors don't add in a straightforward manner, they're a "complex tapestry"
- Have fun! It's all subjective anyway.