Smell and Taste

Perception and Attention Course

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Smell

- Smell is usually considered a minor sense in humans, but it is emotionally powerful.
- The experience of a smell can evoke strong memories, rich in emotional tones.
- The emotional impact of smell is the basis for the perfumery industry eg. Body perfumes, household products to remove ‘bad’ smells.
- A major component of taste eg. coffee, butter, fruits.
Humans can distinguish gender on the basis of hand or breath odour
Olfactory receptors

- Olfactory receptors are found in the roof of the nasal cavity (50 million in humans).
- Receptor sites are on hairs projecting from receptor cells.
- The mechanism of transduction is still disputed but there are thought to be 500-1000 different types of receptor in humans.
- Each type of receptor projects to specific ‘mitral’ cells in the olfactory bulb.
- There are about 10,000 mitral cells, whose axons project into the brain. They are distributed over the surface of the mucous membrane (olfactory epithelium).
Olfactory pathways

- The 2000 axons of mitral cells travel to the rest of the brain via the olfactory bulb.
- They connect to a small area of cortex, and also to the limbic system (associated with emotional responses).
- Uniquely among the senses, projections from the olfactory bulb do not pass through the thalamus on the way to the cortex.
Humans can recognise up to 10,000 different smells.

In this experiment, men were able to identify only 15 of 80 odours better than women (Cain, 1982, *Chemical Senses* 7, 129-142).
Theories of odour coding

- How can we recognise 10,000 different smells with only 5,000-1,000 different receptors?
- Recall that each mitral cell receives inputs from only one type of receptor.
- A particular odour will generate a response in more than one receptor.
- Different odours therefore produce different patterns of activity in the array of mitral cells.
Odour adaptation

- The perceived intensity of a smell drops by 30% or more after continuous exposure.
- This explains why people cannot smell their own house or body odour.
- Adaptation is selective – exposure to lemon does not affect the smell of peanut butter, but does affect the smell of limes.
Anosmia

- Odour blindness (anosmia) can have various origins.
- There are several dozen partial anosmias, probably due to a genetically transmitted deficiency in a specific type of olfactory receptor.
- 1/10 people cannot smell cyanide.
- 1/1000 people cannot smell butyl mercaptan.
Taste

• Most vertebrates have taste systems that respond to four taste qualities – sweetness, saltiness, sourness, and bitterness (though the cat family apparently cannot detect sweetness).
• Sweetness relates to food that is safe to eat eg. Fruit.
• Detection of saltiness is important to maintain levels of sodium in the body (depleted by sweating or bleeding).
• Sourness relates to the acidity produced by bacteria as food decomposes.
• Plants produce poisonous, bitter-tasting substances to avoid being eaten.
Taste receptors

- Receptors are found on the tongue, and in the mouth and throat.
- Receptors are grouped into about 10,000 taste buds.
- Each taste bud (yellow) contains 50-150 receptor cells that connect to a single sensory neuron. Taste bud cells last only about 10 days.
- The exact mechanism of transduction is still not known.
Neural coding of taste

Sensory neurons fall into four categories depending on their response to four different kinds of substance: sugars, salts, acids, and plant alkaloids.

Data show responses recorded from four rat sensory nerve fibres (A-D) during the first 5 sec of application of each of the four substances.

Each fibre responds most strongly to one of the four taste qualities, but also responds to the other qualities.
Taste pathways

- Sensory neurons terminate in the brain stem (medulla).
- Projections from the medulla travel to the thalamus, hypothalamus, and amygdala.
- The thalamic pathway continues to the cortex.
The four basic dimensions of taste (sweet, salt, sour, bitter) were identified in the early 1900’s, long before the physiology was known.

Henning produced a taste tetrahedron to summarise the primary dimensions and their combinations.
Taste dimensions - umami

- In addition to the four basic taste qualities (sweet, sour, salty, bitter), a fifth quality has also been proposed – ‘umami’.
- Umami is a Japanese word meaning “good taste” or “yummy”, and is used by researchers to refer to the taste evoked by glutamic acid.
- It is present, for example, in parmesan, tomatoes, mushrooms, peas, and monosodium glutamate (MSG).
- Snack manufacturers add MSG to their products.
- There is very recent evidence for taste receptors specialised to detect glutamic acid.
Taste adaptation

- Prior exposure to one taste can affect perception of a later taste, either by diminishing the taste or by enhancing it.
- For instance, adaptation to a sour, acidic taste (e.g., lemon) diminishes later sour tastes (e.g., lime) but enhances the sweet taste of sugar.
- Orange juice tasted immediately after brushing the teeth tastes particularly sour because of the effect of the detergent in the toothpaste.
- Such cross-adaptation has implications for theories of taste perception.
Theories of taste coding

• The ‘cross-fibre’ theory proposes that taste is coded by the pattern of activity across the different types of taste fibre eg. Sugar tastes sweet because it activates ‘sweet’ fibres more than any other fibres.

• The ‘taste-primaries’ theory proposes that each fibre is a labelled line that codes the intensity of a single quality independently of other fibres and qualities.

• Both theories are consistent with the response properties of sensory fibres.

• Cross-adaptation favours the cross-fibre theory.
Conditioned taste aversion

- When an individual experiences a particular taste in extremely unpleasant conditions, a powerful aversion to that taste is created.
- Rats given a sweet solution laced with a sickness-inducing chemical later reject or avoid the solution.
- This effect is powerful in humans too (eg. the taste of beer after sickness induced by drinking too much).
- More seriously, CTA is a problem for individuals undergoing chemotherapy treatment for cancer, who can lose appetite entirely. It is advisable to avoid eating before and after therapy. Experimental treatment has involved adding MSG to stimulate the appetite.