



Life Lines

The Science Podcast from The American Physiological Society

Questions and Answers From Episode 27

When the Sense of Smell Fails

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Question and Answer Sheet

- 1) What are the major components of the olfactory system and what are their functions?

Answer: The olfactory consists of sensory receptors that are located in the nasal mucosa that are bathed in nasal mucus. The mucus protects the receptors and also contains growth factors that help to maintain the function of the receptors. In order for an odorant to be smelled, the receptor must be stimulated so that it can send a message to an area of the brain (cortex) that integrates information from a number of olfactory receptors and results in a particular sensation of smell.

(Teacher's Note: Olfactory receptors are sensory neurons that are known as bipolar cells. These cells have projections that have sites where odorant molecules bind to the cell, causing a change in the cells membrane potential. When the cell depolarizes to a sufficient extent, the depolarization results in an action potential that travels along the cell's axon and sends a message to the brain about the presence of the stimulus. The message is coded by the pattern and frequency of action potential, travels to a region of the olfactory lobe which is a part of the cerebral cortex. The olfactory lobe integrates the messages that are transmitted by numerous olfactory receptors and determines the olfactory sensation. Odorant molecules (or substances that are smelled) must be dissolved in the fluid that bathes the olfactory receptors in order to come in contact with the receptor and bind to it to cause a response. There for the substance must have some lipid and or water solubility. Olfactory receptors have different types of olfactory binding proteins that recognize various classes of odorant molecules. An interesting question is whether there is a specific receptor or olfactory binding protein for everything that we can smell. Although the number of types of olfactory binding proteins is limited, have the ability to smell thousands of smells. Therefore, the olfactory sensation is determined by the integrated response pattern of a number of olfactory receptors. This pattern is determined by the olfactory lobe.)

- 2) Why do smells evoke memories?

Answer: Information from the olfactory receptors is sent to the brain and shared by other areas of the cortex where the smell is interpreted in conjunction with other types of stimuli such as taste. This information is interpreted together to provide more complex information related to the smell and may be stored as a memory which includes the information about the context of the smell.

(Teacher's Note: The olfactory information from the olfactory cells travels directly to the olfactory bulb where the axons of many olfactory receptors connect in their pathway to the olfactory lobe. In addition, information from the olfactory receptors is also sent to other regions of the brain via a structure known as the thalamus that acts like a switchboard in channeling information. For example, sensations for smell are sent to an area of the cortex called the limbic system

that is very important for determining emotion and moods. Other types of sensations such as taste may be sent together with those for smell to help determine the total sensation. Smells evoke many sensations that are interpreted in conjunction with a variety of other sensations that are interpreted by many areas of the cortex in stored in multiple areas of the cortex as memories.)

- 3) How are the senses of smell and appetite linked and if you lose the sense of smell, why would this decrease the ability to taste?

Answer: Input from olfactory (smell) receptors and taste receptors are sent to the brain and processed individually in sensory receiving areas and in association with each other in cortical areas where more complex sensory integration that links stimuli occurs.

(Teacher's Note: The sense of smell with regard to certain odors may be increased when one is hungry. This occurs as a result of sensory processing in the cortex that can increase the input or gain of sensory information from olfactory receptors. It has been found that the sense of smell can be manipulated to control appetite.)

- 4) Name several factors that could cause the sense of smell to fail.

Answer: Injury to the olfactory mucosa, loss of olfactory receptors, and injury to the brain (head injury) can cause loss of the sense of smell. Certain chemicals may also cause changes in the components of the nasal mucus that helps to maintain the function of the olfactory receptors and can cause injury. The nasal mucus protects the receptors and contains growth factors. Loss of these growth factors leads to loss of smell. Loss of cyclic nucleotide factors is one example and zinc deficiency is another example. There are zinc containing families of carbonic anhydrase and Zinc helps to increase the level of a carbonic anhydrase enzyme that is important for the function of certain taste receptors. In addition phantom odors and distortions of smell may occur from injuries to the brain that alter synaptic connections and circuits that are involved in the processing of information from olfactory receptors. In other words, pathways get distorted. Neurotransmitter levels may also become depleted.

(Teacher's Note: The nasal mucosa also contains stem cells that differentiate into new olfactory receptors. Normally there is a turnover of receptors and receptors are replaced.)

- 1) What are the major components of the olfactory system and what are their functions?
- 2) Why do smells evoke memories?
- 3) How are the senses of smell and appetite linked? If you lose the sense of smell, why would this decrease the ability to taste?
- 4) Name several factors that could cause the sense of smell to fail.