Neural Pathways of Smell, Taste, and Touch

Sensory information from the nose, tongue and the skin undergoes transmission from one part of a neural pathway to the other, until it reaches the part of the brain that serves as the processor of the input for the sake of perception and interpretation.

Smell

In the nasal passage lies the olfactory epithelium (mucous membrane) lined by olfactory receptors. These olfactory receptors contain Golf protein, which are stimulated by odor molecules. Upon stimulation, the Golf protein stimulates the release of a cyclic AMP catalysing enzyme. When catalysed, this cyclic AMP serves as a transmitter that signals the opening of sodium ion channels, leading to depolarization of the receptor cells.

Olfactory sensory input travels from the axons through the cribiform plate holes and mitral cell synapses. These mitral cells, found in the olfactory bulbs, comprise the olfactory tract. The information travels through the olfactory tract towards the primary olfactory cortex in the limbic system. This cortex transfers the information to three areas: the hypothalamus, the thalamus and the orbitofrontal cortex. The reception of olfactory input in the orbitofrontal cortex explains why we may perceive smell and taste at the same time.

Taste

The tongue contains small bumps called papillae, within or near which taste buds are situated. In the tongue's taste buds, the taste receptors receive sensory input via two important mechanisms – depolarization and neurotransmitter release. Intake of salty foods leads more sodium ions to enter the receptor, causing the said mechanisms. The same is true with intake of sour foods (hydrogen ions) and sweet foods (sugar molecules), both of which result to the closing of K+ channels upon their entry.

From the axons of the taste receptors, the sensory information is transferred to the three taste pathways via the branches of cranial nerves VII, IX and X. The chorda tympani of CN VII (facial nerve) carries the taste sensory input from the tongue's anterior two-thirds. Then, the rest of the taste sensations from the throat, palate and posterior tongue are transmitted by the branches of CN IX (glossopharyngeal nerve) and CN X (vagus nerve). From these cranial nerves, taste sensory input travels through the nerve fiber synapses to the solitary tract, the ventral posteromedial thalamic nuclei , and the thalamus. In these three locations, there are clustered neurons which respond to the same taste (sweet, sour, salty or bitter).The thalamus relays the information to the primary gustatory cortex located in the somatosensory cortex. The primary gustatory cortext is where the perception of a particular taste is processed.

Touch

There are different types of skin receptors that respond to and transmit stimuli. Pacinian corpuscles and free nerve endings are found in both hairless and hairy skin. The Pacinian corpuscles are skin receptors that receive stimuli associated with high frequency vibrations, while free nerve endings receive pain stimuli. Meanwhile, the Meissner's corpuscles are exclusive in hair skin and respond to low frequency vibrations and pressure stimuli. Other touch receptors include Merkel's disks (pressure) and Ruffini's corpuscles (low frequency vibrations).

The sensory information from the receptors is transmitted through either one of the three systems: (1) dorsal-column-medial lemniscal system (touch and proprioception), (2) anterolateral system (pain and temperature), or (3) spinocerebellar system (proprioception) towards the dorsal columns. From there, the input is transferred to the thalamus, which then relays the information to the primary somatosensory cortex [1] for processing.

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