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Overview of Anatomy and Physiology of Gustatory and Olfactory System

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A B S T R A C T

The olfactory system is involved in detecting potential threats in the environment, generating sensations of enjoyment, facilitating proper nourishment, impacting sexual behavior, and regulating mood. Concurrently, the human taste system identifies hydrophilic molecules dissolved in saliva. The purpose of this review was to offer a thorough depiction of the human gustatory and olfactory systems. The various regions of the brain and the taste pathways transmit and receive information through distinct mechanisms. The taste circuits and various regions of the brain interconnect bidirectionally. The peripheral subdivision of the olfactory system consists of the olfactory epithelium and nerve fascicles. On the other hand, the central subdivision includes the olfactory bulb and its links to the central nervous system. Olfactory dysfunction (smell) and gustatory dysfunction (taste) can manifest independently or together. The robust correlation between olfaction and gustation engenders a gustatory feeling. Disruption of a feeling can alter the sense of flavor. Human olfactory and taste senses become less sensitive as they age.

1. Introduction

In addition to influencing the flavor of foods and beverages, the gustatory and olfactory system conveys information regarding toxins and nutrients. Ultimately, this system is capable of detecting and reacting with hydrophilic molecules that are dissolved in saliva. There are taste receptor cells in the taste buds and all over the mouth. These cells stimulate nerve afferents that go to the medulla. The data is then put together with data from other senses and homeostatic, visceral, and emotional processes in the thalamus, subcortex, and cortex.[1,2] Different parts of the brain and the taste pathways send and receive information in very different ways. These different parts of the brain and the taste pathways are connected to each other in a way that works both ways. These extensive interactions between numerous systems are vital to the way in which sustenance is perceived. A few bodily functions that the tasting experience can directly affect and influence include memory, appetite, satiety, and visceral changes.[3,4]

The human olfactory system is subdivided into both peripheral and central regions. The olfactory epithelium and nerve fascicles constitute the peripheral subdivision, while the olfactory bulb and its central connections comprise the central subdivision. Human bodies do not have the accessory olfactory system that many other mammals do. Instead, they only have the vomeronasal organ, which is not working. Major components of the human olfactory system are diminished in comparison to the majority of mammals. For instance, humans have a comparatively smaller number of turbinates, and their olfactory epithelia are restricted to the surfaces of one or two of these structures.[5] This review was aimed at providing a comprehensive description of the human gustatory and olfactory systems.

Olfactory and gustatory system

Olfactory dysfunction (smell) and gustatory dysfunction (taste) can manifest independently or together. The robust correlation between olfaction and gustation engenders a gustatory perception. Disruption of a feeling can alter the sense of flavor.[5,6]

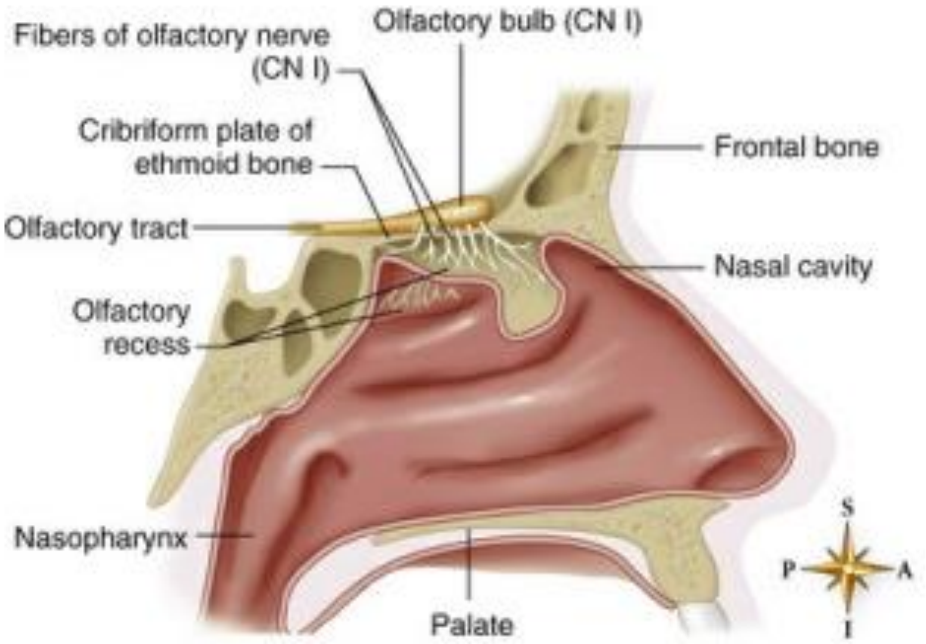

Figure 1. Olfactory system. The midsagittal section of the nasal region shows the location of the main olfactory sensory structures.

The olfactory nerve (cranial nerve I) mediates the sense of smell and is further influenced by the trigeminal nerve (part of cranial nerve V). The olfactory epithelium contains the olfactory receptor cells. There are seven primary categories of substances that stimulate the sense of smell: (1) camphoraceous, (2) musky, (3) flowery, (4) peppermint, (5) ethereal, (6) pungent, and (7) nasty. The sense of smell plays a crucial role in identifying potential threats in the surroundings, eliciting pleasurable sensations, facilitating proper nourishment, impacting sexual behavior, and regulating emotional state.[3-5]

Olfactory dysfunction includes hyposmia, anosmia, hallucinations, and parosmia. Hyposmia refers to a condition where there is a reduced ability to detect smells, whereas anosmia refers to a complete inability to detect any smells. Both illnesses are linked to the process of aging and neurological diseases, as well as nasal or sinus ailments and head trauma. Bilateral hyposmia or anosmia typically arises from rhinitis (nasal mucosa inflammation), sinusitis, nasal polyps, or excessive smoking. Hyposmia or anosmia on one side can mean that the olfactory bulb or nerve tract is being pressed on, which could be caused by a tumor or a blow to the head. Olfactory hallucinations occur due to increased neural activity in the cortex, resulting in the perception of odors that do not exist. Although temporal lobe seizures commonly link to olfactory hallucinations, their association with schizophrenia is infrequent. Parosmia, an atypical or distorted olfactory perception, can manifest in individuals with significant depression, Parkinson's disease, and Alzheimer's disease.[6,7]

Many nerves located in the tongue, soft palate, uvula, pharynx, and upper esophagus determine the sense of taste. These nerves include cranial nerves VII (facial nerve) and IX (glossopharyngeal nerve). Specific regions of the tongue house taste receptors (fungiform, foliate, and circumvallate papillae) that continuously regenerate and respond to each of the primary taste sensations. The primary gustatory perceptions encompass sourness, saltiness, sweetness, bitterness, and umami (savoriness). The circumvallate, fungiform, and foliate papillae in specific regions of the tongue house taste receptors that respond to each of the primary sensations. Taste receptors are present in the smooth muscles of the respiratory system (for bitter taste) and the gastrointestinal tract (for bitter and sweet tastes). Its purpose is not for gustatory perception. In the lungs, they induce bronchodilation, while in the digestive system, they contribute to the regulation of metabolism and digestion. Taste alterations can arise from factors such as trauma, pharmaceuticals, oral infections, or the natural process of aging. Disruptions in the sense of smell that are linked to damage in the vicinity of the hippocampus can also cause altered taste sensations.[8]

Hypogeusia refers to a reduction in the ability to taste, while ageusia is a complete lack of taste perception. A complete loss of taste sensation in the entire tongue may occur as a result of a head injury. Hypogeusia and ageusia are common symptoms observed in cases of respiratory and oral viral infections. Autoimmune illnesses, such as systemic lupus erythematosus and cancer chemotherapy, have an impact on taste sensitivity. Damage to the glossopharyngeal nerve (cranial nerve IX), responsible for providing sensation to the back part of the tongue, leads to the inability to perceive bitterness. The reason for this loss is due to the positioning of bitter taste receptors at the posterior part of the tongue. Facial nerve damage (cranial nerve VII) results in the inability to perceive sour, sweet, and salty tastes as it innervates the anterior two-thirds of the tongue. Only a discernible bitter flavor was perceptible. The loss of taste happens due to the positioning of the sour, sweet, and salty receptors on the front section of the tongue.[9]

Aging related gustatory and olfactory system

Olfactory sensitivity diminishes progressively with advancing age. An investigation into olfactory identification revealed a pattern of increasing ability from childhood to adolescence, followed by a decline after reaching the age of 60. Olfactory sensory neurons and cells in the olfactory bulb start to deteriorate, leading to a decline in the sense of smell. The cause of the loss is currently unidentified. An impairment of the sense of smell and ability to identify odors might diminish hunger and meal choices, perhaps resulting in malnutrition. Compromising safety might also result from the failure to detect the odor of decaying food or toxic gases.[10,11]

Parageusia is a condition characterized by a distortion of taste perception, causing a substance to have an unpleasant flavor. Parageusia, a condition characterized by a distorted sense of taste, can occur spontaneously in older individuals, resulting in a loss of appetite and inadequate nutrition. The decrease in gustatory perception is characterized by a slower progression compared to olfactory perception and is linked to the loss of olfaction. Greater concentrations of flavors are necessary, and elderly individuals struggle to discern combinations of flavors. Aging reduces the quantity of fungiform papillae present on the tongue and modifies the functionality of taste receptors, which is linked to the alteration in taste perception. Decreased salivary gland secretion might potentially impact taste perception. The presence of amylase in saliva enhances the detection of sweet flavors.[12-15]

2. Conclusion

Humans divide the olfactory system into peripheral and core areas. The olfactory epithelium and nerve fascicles make up the peripheral subdivision, while the olfactory bulb and its central connections form the central subdivision. Many nerves located in the tongue, soft palate, uvula, pharynx, and upper esophagus, such as the facial and glossopharyngeal nerves, determine the sense of taste.

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