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The olfactory sense

Smell, called olfaction, is the ability of an organism to sense and identify a substance by detecting tiny amounts of the substance that evaporate and produce an odor. Smell is the most primitive sense. Many species use their sense of smell to locate prey, navigate, recognize, communicate and mark territory. Our ancestors were more dependent on smell than on sight. It is the body's initial and most definitive tester. Body odors remain chemical messengers for infant identity, sexual stimulation, memory arousal and disease detection. There is nothing like an odor to stir memories. It is the basis for food discrimination, fluid acceptance and gas recognition.

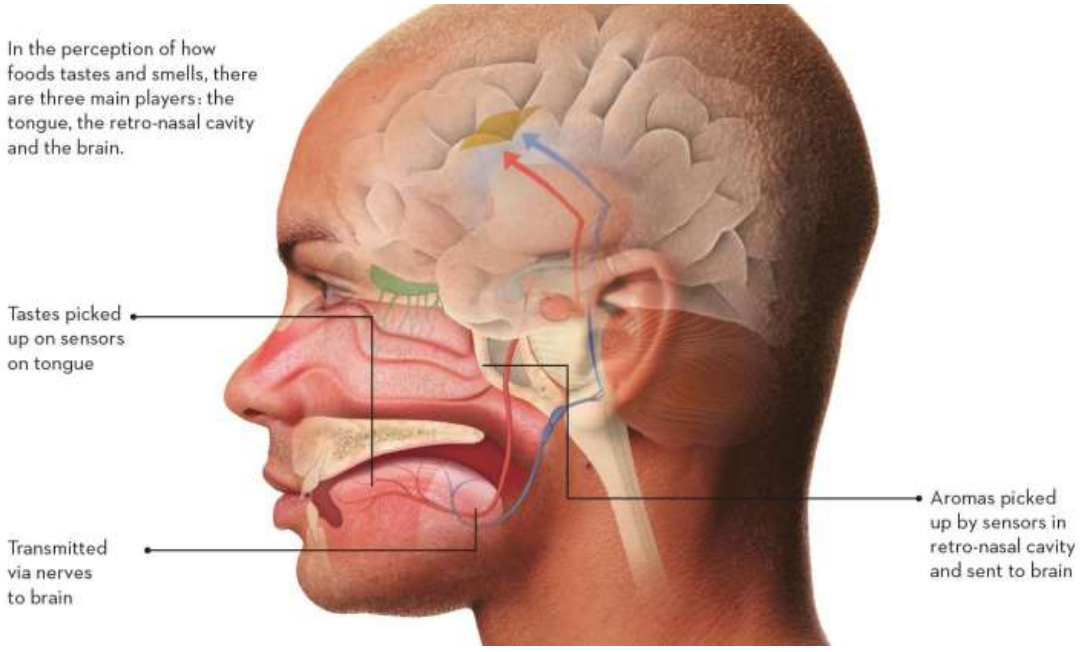
Although, it is generally agreed that man's olfactory powers have degenerated, modern man is becoming increasingly conscious of his sense of smell. Odor and taste are now matters for concern at all levels of awareness from the individual nose of the consumer right up to the corporate nose of the industrial company.

How do we smell?

The sensation of odor is caused by airbone molecules of a volatile substance entering the nose.

Humans possess around 12 million olfactory receptor cells that can detect approximately 10,000 odors. Dogs, on the other hand, have anything from 100 to 200 million plus receptor cells, depending on the breed. The bloodhound is thought to have more receptor cells than any other dog (as many as 300 million) and can detect 40,000 different odors!

The sense of smell long remained the most enigmatic of our senses and has been investigated by a number of academics worldwide for many years. We now know from the work carried out by Zozulya et al. that there are 347 human odorant receptor genes. The exact mechanism of olfaction is uncertain, with opinion shifting between Turin's spectroscopic theory, where odor is derived from molecular vibrations via inelastic electron tunneling and Amoore's stereochemical theory, which proposes a lock and key mechanism based on molecular shape. The basic principles for recognizing and remembering about 10,000 different odors are still to be found.



There are two ways we detect odors:

- In the air we breathe through the front of the nose (orthonasal olfaction)
- Through the back of our nose from our mouth (retronasal olfaction). It is activated only when breathing out through the nose between mastications or swallowings. This is the route used to sense aromas of food.

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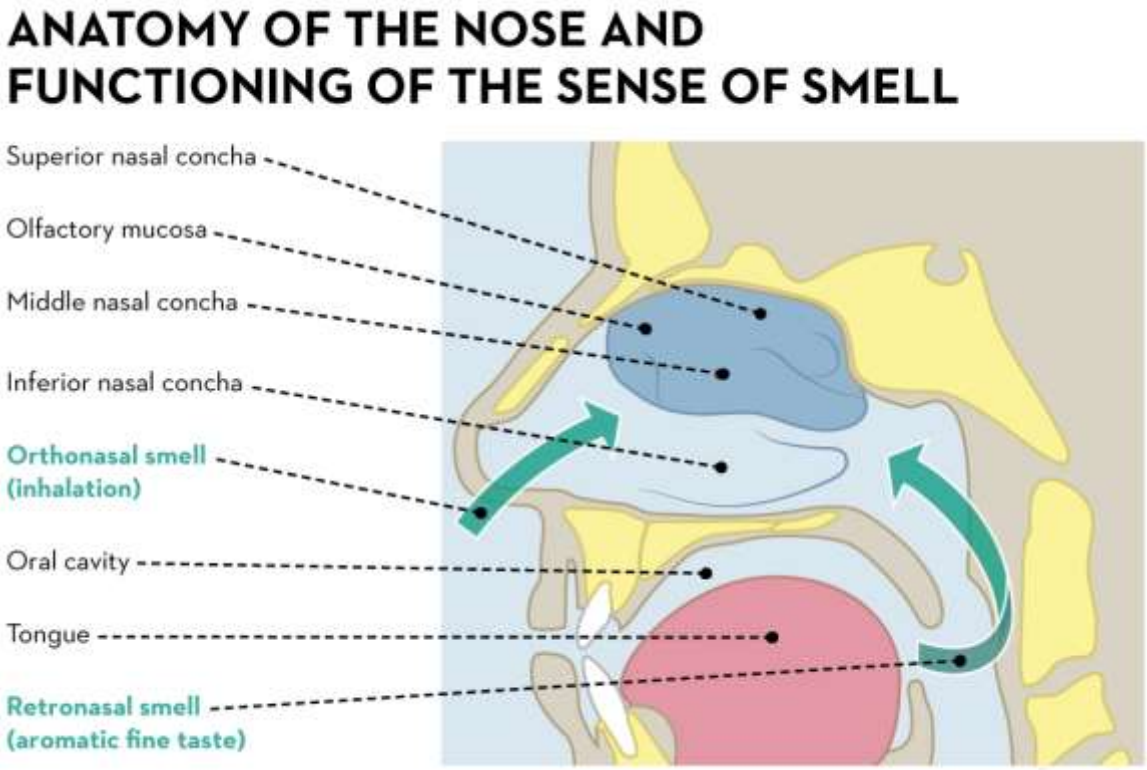
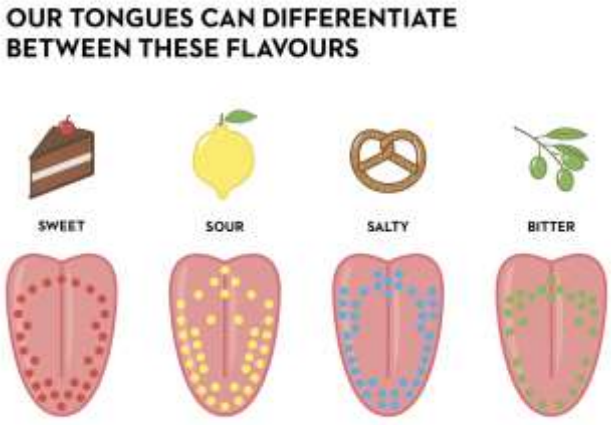


Taste

A distinction should be drawn between taste and smell. Both are included in the chemical senses. The sense of smell in the nose deals typically with volatile chemicals diffused in air. It may be contrasted with the sense of taste (on the tongue and palate) which typically handles soluble chemicals dissolved in water. The flavor of a food, sometimes simply called the taste, really includes not only oral sensations of taste (sweet, salt, sour and bitter) but also nasal sensations of smell, resulting from vapours entering the notrils as the food is put into the mouth and later to vapors rising up the back of the throat when the food is swallowed.



Odor Description

The odors of single chemical compounds are extremely difficult to describe unequivocally. The odors of complex mixtures are often impossible to describe, unless one of the components is so characteristic that it largely determines the odor or flavor of the composition. Although an objective classification is not possible, an odor can be described by adjectives such as flowery, fruity, woody, hay-like, etc.

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Threshold Concentration

Due to the specificity of olfactory receptors, some compounds can be perceived in extremely low concentrations and significant differences in threshold concentrations are observed. The threshold concentration is defined as the lowest concentration at which a chemical compound can be distinguished with certainty from a blank under standard conditions.

Olfactory adaptation

The olfactory sense is easily fatigued with rapid adaptation to one odor without impairing the sensitivity to another. The human olfactory system adjusts over time and has trouble detecting both bad and good odors provided they are not too strong. This is called olfactory adaptation and it usually takes an hour to become adapted to an odor or scent. For example, people working in a scented environment often adapt to the scent and lose their ability to detect it even if people entering the space can readily perceive it.

Are you 'odor blind'?

It is well known that human color vision is based on a system of three primary colors: red, green and blue. Corresponding defects in components of the human visual system result in three main types of color blindness: red-blindness, which afflicts about 2% of men; green-blindness, also affecting 2% of men; and a rare blue-blindness (1 in 50,000).

However, it is very little known fact that a similar situation applies to odor. Some persons, while having an apparently normal sense of smell, find that they are unable to detect one particular odor. About 10% of people cannot smell the poisonous hydrogen cyanide, 2% cannot smell the sweaty odor of isovaleric acid, 1‰ cannot smell the mercaptan odor of the skunk. This phenomenon has been called 'odor blindness' and it is known scientifically as 'specific anosmia'.

Factors affecting normal odor sensitivity

In a large series of tests, using 18 different odorants and 97 observers, no significant difference was found in sensitivity between men and women or between smokers and non-smokers (Table 1). However, actually smoking immediately prior to the test or chewing gum during the test, caused a two-step decrease in sensitivity (reduction to ¼). A head cold or nasal allergy also reduced sensitivity about two steps (as long as breathing through the nose was still possible). It is yet unsettled as to whether there are systematic changes in sensitivity in relation to time of day or condition of hunger.

Factors affecting normal odor sensitivity		
Factor		*Ratio*
Men vs women	(no significant difference)	1/1
Smokers vs nonsmokers		1/1
Smoking	(during test)	1/4
Chewing		1/4
Heal cold	(nose not blocked)	1/4
Nasal allergy		1/4

Table 1

It makes rather depressing reading to find that all our special senses deteriorate in acuity over the years, though at somewhat different rates (Table 2). The 50% loss of taste sensitivity occurs in 29 years, which may be compared with the 22 years for 50% loss of smell sensitivity. This general decline in the senses of smell and taste with age could be relevant to personal preferences with regard to the intensities of food flavors and especially to the common complaint that 'nowadays foods (chicken, apples, etc.) don't seem to taste like they used to in the good old days'.

Loss of sensory acuity with age	
Sense	*50% loss (years)*
Sight (night vision)	13
Sound (125-500 cps)	15
Smell (18 odorants)	22
Taste (sugar & salt)	29
Touch (cornea)	60

Table 2

Sensory tests

Consumer understanding is ultimately the only way to sell. The variability of human opinion, especially as regards taste and smell, is proverbial. The democratic solution to this problem is to use a large committee, or 'panel of judges' and calculate the mean result of their responses.

There are many types of sensory tests:

Difference tests

Like all objective tests, difference tests are usually carried out by trained panels. The most important and useful difference tests are triangle tests, where the panel attempts to detect which of three samples is different from the other two, and duo-trio tests, where the panel must select which of a pair of samples is different from a standard, both of which are commonly used to determine the accuracy of matching work.

Paired comparison tests are used to determine which of a pair of samples has more of a specific characteristic, such as sweetness or freshness.

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Threshold tests

The threshold concentration of a chemical in a specific food product is the level at which its odor/taste can be recognized. Key issues are the fact that the same chemical will have very different threshold levels in different media and also the fact that different chemicals will have very different concentrations/ intensity profiles.

Intensity tests

Intensity tests are, like threshold tests, essentially objective tests, but they also contain a subjective element. Trained panels are generally used. Scales vary considerably; for example, the low anchor point can be described variously as 'low', 'very low' or 'just detectable'. Despite these inconsistencies, the results can be very helpful in a number of areas, especially when the results are plotted against time:

- Bitterness suppression
- Sweetener profiling
- Chewing gum flavor release
- Breath freshness effects

Affective tests

Affective tests deal with subjective, rather than objective, information and are often carried out by consumer panels. Paired comparison tests are widely used, generally to establish consumer preferences. Hedonic ratings, usually on a 1 (extreme disliking) to 9 (extreme liking) scale, do give quantitative information and can be much more helpful when assessing a range of samples.

Quantitative descriptive analysis

Descriptive analyses are often carried out by expert panels and describe the perceived characteristics of the food. They are commonly used to describe odor characteristics, but can also serve to quantify any perceived parameter, including the emotions attached to the experience of consuming the food. The results of these analyses can be extremely complex, especially if they are used in conjunction with hedonic ratings from different groups of consumers.

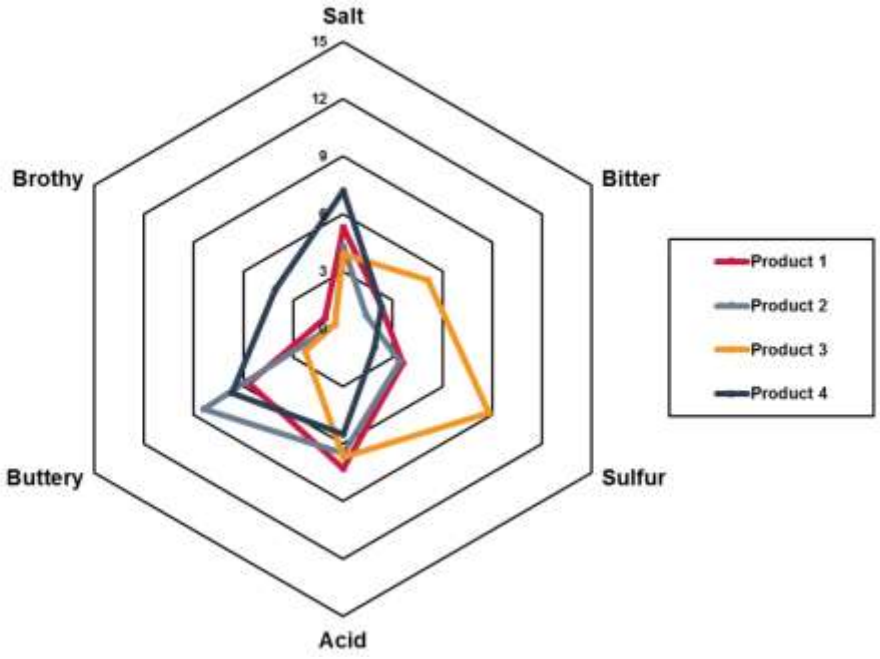

Figure 1. Flavor descriptor comparison across four products evaluated.

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