# 4 Odour and sense of smell

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Many of the complaints presented by indoor workers are due to odour. With this in mind, this chapter provides background information as an aid in interpreting complaints about odours correctly and identifying the options available for remedial action.

## 4.1 The nose's olfactory sensory system

The olfactory sense is a sensory system that allows odorant substances to be perceived/sensed for the purpose of assessing the environment around us, food and potential mates [1].

Odour perception [2] begins in the olfactory mucosa – an area measuring approximately two by five centimetres and home to the olfactory receptor cells, which number between 10 and 30 million. Unlike all other nerve cells, these cells are reproduced approximately every four weeks and are in direct contact with the outside world. Each cell only has one type of odorant receptor. Human beings have around 350 different odorant receptors, capable of molecular recognition. As such, they react not only to the form of odorant molecules (size and shape) but also to their chemical properties (chain length, number and arrangement of functional groups, etc.). They are particularly sensitive to certain molecular characteristics but also have a high tolerance for other chemical properties. As a result, a receptor responds to several odorant substances and a single odorant substance is registered by several receptors.

Once an odorant molecule reaches the receptor, it triggers an electrical signal in the cell, which is then relayed to the olfactory bulb in the brain. This contains spherical control centres, known as the glomeruli. The information from around 1,000 olfactory cells of the same type is bundled in one such glomerulus. The advantage of this huge concentration is that the olfactory system can continue to perceive odours even if large parts of the olfactory mucosa are damaged, e.g. as in the case of an infection. In total, there are some 350 different types of glomerulus though each type has a large number of redundant glomeruli.

The olfactory system appears to use a combination of receptors of differing levels of activity, much like the combination of notes and sounds used in music. In this way, it is able to identify and distinguish between the multitude of different odours (the "sounds"), around 10,000 in number, using just the "few" 350 different types of receptor ("notes") at its disposal.

Odours in turn are each comprised of various chemical substances, making it virtually impossible to determine precisely how many substances are capable of being smelled. The scent of a rose alone consists of around 500 individual components. However, it is usually possible to recognise an odour based on just a few key substances that determine it. The scent of a rose, for example, is determined by geraniol. When we smell geraniol, we are immediately reminded of roses but we also notice there is something lacking that would make the smell that of a real rose.

The neuronal activity pattern produced in the olfactory bulb is relayed to the "smell brain", where the neural impulses are processed, bundled and forwarded. One of the routes the information takes leads directly from the smell brain to the centre of our emotions, the limbic system. The odour information that arrives there immediately generates an emotion. Depending on the odour, that emotion can range from happiness to fear or even disgust. If the smell is strong enough, the smell brain sends neural impulses to the olfactory cortex via the thalamus. This is where the conscious olfactory impression is created and the scent is recognised as being (in our example) that of a rose.

The human nose is extremely sensitive to certain substances. For instance, it detects isobutyl-methoxypyrazine, an odour compound found in the bell pepper, at concentrations as low as 0.002 µg/m³ [3]. Difficulties arise if an odorant substance is present in a concentration so low that measuring devices cannot register it but the human nose can. It is therefore often impossible to register and assess odours using conventional chemical and physical measurement methods as would normally be used to measure air pollution (see Section 12.2).

## 4.2 Odour detection thresholds in the literature

Evaluating odour detection thresholds (ODTs) cited in the literature can be problematic. In particular, where a substance has been the subject of extensive research and one would expect a certain level of consistency in the values in the literature, the opposite is often the case. In fact, the more ODTs one finds in the literature for one specific substance, the more they differ from each other – often by several orders of magnitude. For instance, the literature cites ODTs for aniline ranging from 0.2 to 350,000 µg/m³. Though partly the result of different measurement strategies, this divergence is also due to the differences in humans' sensitivity to smell. Inevitably, this large variation in the published values means that any assertions concerning the concentration required for a substance to be perceptible to the olfactory system will be extremely unreliable. By the same token, if the literature only states one single ODT for a given substance, there is no certainty that this value is correct.

## 4.3 Perception of smell

Like or dislike of a particular odour is not something we are born with – it depends on our experience of the odour. Dried fish provides a good illustration. The way we perceive the smell of dried fish differs according to our cultural background: whilst Japanese noses find it pleasant, the average German nose does not.

Our sense of smell can also not be depended on to distinguish "good" from "bad". It perceives many aromatic hydrocarbon compounds as having a pleasant odour although they are often toxic even at low concentrations. Conversely, it sometimes protests strongly when faced with the completely harmless odour of some pungent types of cheese.

When we smell something, we take in a variety of aromatic substances (e.g. vanilla), add them to information supplied by our other senses ("The oven is still warm", "Grandma wanted to do some baking today", etc.) and then perceive and store the information as "cake smell". Yet the same olfactory impression, if mixed with different information or perceived by a different person, might be stored as "overly sweet perfume" and "unpleasant".

In this way, smells are linked to memories and can make us feel good or bad without us realising at that particular moment that we are associating them with past events.

Whether an odour is perceived as unpleasant and undesirable depends on various factors. As well as the substance's concentration, type of odour and the individual's experiences and memories, these factors include the duration and frequency of perception (habituation effect) and the individual's sensitivity to smell.

## 4.4 The nocebo effect

The nocebo effect is the opposite of the placebo effect, which is best known as a medical concept [4].

Medical drugs always transmit two "messages". Firstly, the active ingredients convey chemical information, reacting with particular parts of the organism and triggering events that lead to desired or undesired effects. Secondly, drugs send a signal to the patient to tell them that something is happening to them. As a result, the mere expectation of a positive effect can lead the patient's symptoms to improve even if there is no chemical information. This is referred to as the placebo phenomenon (Latin for "I shall please").

A nocebo is the negative counterpart of a placebo. It means "I shall cause harm" and is essentially the manifestation of what a person fears. He or she displays physical symptoms and endeavours to identify factors in their environment that they consider to be likely causes. As with a placebo, this phenomenon can occur irrespective of whether the substance has any chemical effect. For instance, it has been reported that people who hear that the ozone levels have increased and that certain courses of action are recommended feel that this must affect them and can begin to worry that they are at risk. These people cite symptoms that the media have described as being typical of ozone exposure, e.g. irritated eyes, difficulty swallowing, difficulty breathing, pain when inhaling deeply, headaches, flaccidity and circulatory problems. Strikingly, these health complaints are cited where the ozone concentration is actually probably not high enough to cause such symptoms.

**Conclusion**

It is not possible to draw any health-related conclusions about an odour merely by perceiving it. Even if a human perceives a smell as being very strong it can still be lower than the analytical detection limit for that specific substance. Conversely, it is not always possible to detect all potentially hazardous substances by their smell. It is therefore important to take seriously any reports of unusual odours. They may be an indication that the air quality or other ambient conditions at the workplace are not as they should be.

The pertinent legal requirement can be found in Section 3.6, "Ventilation", of the Annex to the Arbeitsstättenverordnung (Ordinance on Workplaces) [5]. It states that the amount of healthy, breathable air in enclosed workrooms must be sufficient for the work processes, the level of physical strain and the number of employees and other persons present. Odour annoyance must therefore be avoided as far as the nature of the organisation's operations permits. As a rule, this means there must not be any unwanted odour emissions from products (e.g. construction chemicals), equipment (e.g. laser printers/copiers) or systems (e.g. ventilation and air conditioning systems).

## 4.5 References


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