Chapter 5: Abnormalities of smell

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Awareness of both the internal and external environment is obtained by special receptor cells and organs. Much of this internal awareness is related to the maintenance of homeostasis in the body and does not necessarily reach consciousness. Yet, no one will deny the general feelings of ill health which a breakdown in this balance will produce. The external sensors providing information about the external environment are, on the contrary, principally related to conscious perception, but there is little doubt that they also provide an awareness of the environment that is not wholly conscious. This aspect is particularly important in the chemical senses and, although still not clearly defined in the human, ought to be kept in mind when considering the chemical senses.

The chemical senses

It is not possible to separate olfaction from the gustatory sense and the chemical response mediated by the trigeminal nerve. First of all, the nature of the stimuli is similar as the stimuli represent the chemical rather than the physical properties found in hearing and sight. Secondly, they act in combination - for instance, perception of flavours relies on all three, although the more subtle elements depend on the sense of smell.

Olfaction

The olfactory mucosa is limited to a region which includes the upper part of the superior turbinate, a corresponding region of the nasal septum and the roof of the nose which is between these.

The olfactory epithelium consists of receptor cells, supporting cells and basal cells. The receptor cell is a bipolar neuron whose distal process carries cilia which project into the nasal cavity - these cilia are assumed to carry on their surface membrane receptors sensitive to odoriferous molecules. The proximal process, which is long and thin, is invested by the basal cells until it perforates the basement membrane and comes into association with the cytoplasm of the Schwann cells. These slender axons come together in the submucosa to form fasciculi which travel in parallel towards the openings in the cribriform plate of the ethmoid. They end in the olfactory bulb which lies on the intracranial side of this structure.

As well as the epithelium, the olfactory mucosa contains Bowman's glands. Neither the nature of their secretion nor their function is properly understood.

In many vertebrates, including humans, the olfactory mucosa has a yellowish colour. This is due to pigment granules found in the supporting cells as well as in those of Bowman's glands. They consist mainly of complex lipofuchsins, but also of carotenoids, and it is the presence of these carotenoids that suggests a similarity to visual pigment, leading to the use of vitamin A in the treatment of olfactory abnormalities. However, there is little evidence of empirical success with this treatment and the theoretical basis is likely to be erroneous.
The place of olfaction in mammals is worth considering because, although its role in man is limited by comparison with other species such as dogs, some functions may have persisted to a degree which has been overlooked. Other functions can also be trained to a wider use in individuals who have lost another sense such as vision.

Many animals live in an olfactory rather than a visual world and olfaction allows them direction both above and below ground. The sense of smell is closely related to food and is necessary for finding it as well as for correct identification and assessment of its edibility. Sensing other animals, whether as prey or as predators is largely olfactory. Sociobiological functions may also be present in man at a muted and unrecognized level. Mammals use olfaction as a means of territorial marking and of appreciating their mates’ sexual condition. Ranking in animal groups is often related to smells as is bonding between parent and offspring. These functions are in fact a form of communication between animals of the same species and probably have a place in humans at conscious or subconscious levels and may explain the wide use of artificial odorants. The nature of the odorants involved is the subject of important work at present and it seems that in many species a chemical emitted by one animal results in dramatic physiological changes in another. The mode of action, as a type of external hormone, has led to their being given the name ‘pheromone’. Although no evidence has been obtained in humans and the higher primates of a direct effect of olfactory stimuli on the neuroendocrine system, it is possible that a subthalamic olfactory projection may provide access to the part of the brain associated with emotional behaviour. The relation between olfactory symptoms and disturbed psychological and psychiatric patterns has long been known, but the specific mechanism has not been elucidated.

In lower animals pheromone effects are striking. The smell of male urine results in a lengthening of the oestrus cycle in the female of the same species; oestrus can quickly be induced by an odorant in male urine. This is known to be a small androgen-dependent molecule. It is species specific and not only can it synchronize ovulation in a group of females, but it also blocks an early pregnancy from a different male. No pheromonal effects have, however, been shown in man.

Classification of symptoms

Patients may simply complain that they have lost the ability to smell. Alternatively complex and bizarre descriptions may be presented which can obscure the real pattern of the abnormality. It is important for a classification to be retained in the mind, and for the patient to be questioned accordingly to avoid the vagueness which often impedes a proper understanding when perceptive problems are considered.

The following arrangement may be found to be useful:

(1) quantitative changes
   (a) decreased sensitivity to smells
      (i) anosmia
      (ii) hyposmia
   (b) increased sensitivity to smells
      (i) hyperosmia
(2) qualitative changes
   (a) peripheral type
      (i) local causes
      (ii) anosmic zones
      (iii) single non-discriminating response
      (iv) essential parosmia
   (b) central type
      (i) illusions
      (ii) hallucinations
      (iii) abnormal sense memory.

Patients will generally present with the symptom of being unable to smell and often they will add that they cannot taste. It is only under close questioning that they may agree that they can smell a little or occasionally. This distinction between anosmia, or a complete loss of smell, and hyposmia, some decrease in the sense of smell, is crucial to the prognosis and management.

It is also important to decide whether the abnormality is bilateral or unilateral, as unilateral changes may occur in intracranial lesions. It has been demonstrated that loss of smell need not be to the same degree for every odorant. For instance, testing olfaction with different odorants in patients suffering from allergic rhinitis will show relatively normal responses to some and none at all to others. These areas have been called 'anosmic zones' (Douek, 1967). There are also a relatively large number of individuals who have specific anosmias to a particular odour which appears to be genetically determined.

Another hyposmic response in fact represents a type of anosmia. This is a single non-discriminating response to odours and means that the patient may experience a fleeting olfactory sensation of slight degree, but that it is the same smell whatever the stimulus. There is no doubt that this symptom suggests an invariably bad prognosis. It occurs commonly in those patients where the olfactory neurons have been damaged during a viral upper respiratory infection.

The causes of decrease in olfactory sensitivity can be divided into two broad groups as shown below.

**Abnormalities of structures not directly related to the olfactory organ**

Structural abnormalities, such as a deviated nasal septum, practically never cause anosmia or hyposmia in isolation, so that septoplasty invariably fails if offered as a treatment.

Allergic or vasomotor rhinitis, on the contrary, commonly causes abnormalities of smell with related problems of taste. Rarely, total anosmia is present, but the typical features of these conditions are a fluctuation in the degree of hyposmia and the presence of residual perception of smell. On testing, differences to different smells can be found creating the anosmic zones which are often present in allergic rhinitis.

Loss of smell in chronic sinusitus and sinusitus of infective origin is not dissimilar to that of nasal allergy and fluctuation is obvious in response to treatment. Atrophic rhinitis is
not a specific cause of loss of smell, but the infected crusts may set up changes producing a diminution in smell. Specific rhinitis as from, for example, syphilis, sarcoidosis, leprosy, scleroma, and tuberculosis, does not cause loss of smell except in so far as obstruction of the airway is produced. The same applies to tumours involving the nose and paranasal sinuses, but in those conditions other nasal symptoms are more apparent and olfaction hardly dominates the picture.

Nasal polyps should be mentioned specifically as they produce quite severe loss of smell. The cause is simple obstruction which can be corrected by removal, but also the specific effects of allergic rhinitis which cannot be corrected.

Misuse of intranasal medication can affect the sense of smell as it produces a rhinitis, but the effects are by no means permanent if properly treated.

Abnormalities of the olfactory organ and its central connections

Damage to the olfactory organ itself occurs rarely. When this happens it is associated with an influenza-like illness and recovery never takes place. On questioning, the patient frequently recognizes the fleeting non-discriminating olfactory response, but the prognosis is inevitably poor.

Tumours of neuro-olfactory origin are very rare but are reported from time to time. Gross appearance is similar to nasal polyps and the diagnosis is histological although they tend to be more vivid in colour than benign polyps.

The effects of ageing on smell have recently received more attention. Interest arose when a study (Chalke and Dewhurst, 1957, 1958) showed that more than 70% of domestic fatal accidents occurred in persons aged more than 75 years, but that an increasing number of accidents were due to gas. It was suggested that one cause was inability to smell gas. Hinchcliffe (1962) reviewed perception in old age and suggested that all sensory modalities including olfaction show an exponential decrease with age, calling this a fundamental 'presbypsychic' law. The most important study (Van Toller, Dodd and Billing, 1985) showed that by using pure, single odorants which could give repeatable results, there was indeed and decrease in sensitivity with age for 10 odorants. There is also a qualitative loss centred on the primary notes of odorants with decrease in discriminating ability. Interestingly, however, anosmia does not appear to be a feature of old age and no differences between male and female and between smokers and non-smokers were detected.

Abnormalities of smell will occur when interference with the central connections of the olfactory organ takes place. This is common in intracranial lesions and also in association with psychological disturbance. These will be considered separately.

Intracranial lesions

These may be related to trauma or to tumours and can be found in epilepsy.
Trauma

Anosmia not infrequently follows a head injury and, although severe injuries are more likely to cause anosmia, even minor ones can produce this deficiency. Frontal injuries are more common, but occipital blows are more likely to produce anosmia.

Recovery, if it takes place, does so during the first few weeks after the injury. After that the prognosis is invariably poor. Only a minority of cases are unilateral, but this is always uncertain as complaints are less likely. Decrease in smell without complete loss is uncommon and usually if the patient still complains of loss of smell after about three months, this indicates a total and irrecoverable anosmia. A small number of cases develop parosmia, where smells are severely altered and sometimes are experienced spontaneously. These smells are generally unpleasant and the prognosis is poor often contributing to depression.

The causes of post-traumatic anosmia are still a matter for speculation, but tearing of the fine olfactory fibres as they pass through the canals of the cribriform plate is likely especially in fractures of that region and where there is a cerebrospinal fluid leak. In contrecoup injuries a shearing tear of the olfactory nerves is possible. Compression of the tracts and bulbs from oedema or blood clot must also occur.

Tumours

Direct pressure on the olfactory nerves or tract raises the olfactory threshold but does not appear to prolong olfactory fatigue, whereas supratentorial, intracerebral lesions will do so on the side of the tumour, both effects may be present simultaneously.

Osteomata growing from the inner table of the skull or the paranasal sinuses grow slowly but unilateral loss of smell may appear as the first symptom.

Meningiomata, particularly of the olfactory groove, may also present in this way.

Frontal lobe tumours usually present other symptoms including intellectual deterioration together with visual disturbance and headaches. Occasionally focal convulsions occur. Anosmia can also be a feature. Tumours around the optic chiasma can cause disturbance of smell as well as visual defects. Temporal lobe tumours do not cause anosmia but there may be some impairments and fits with olfactory aura can occur.

Epilepsy

Abnormalities of smell are found in temporal lobe epilepsy. Olfactory aura are rare but when they occur the hallucinations tend to be unpleasant. They have been described as organic in nature, such as a smell of putrefaction or faeces, or chemical such as petrol or ether. Sometimes there is a smell of burning and only occasionally is it pleasant and perfumed. Usually this smell comes from outside the patient and only rarely may the symptom represent the whole seizure. Generally, however, there are other features such as emotional effects - rage and anger or anxiety and fear. Memory changes such as déja vu may be associated with the olfactory aura as well as motor and sensory phenomena though the most common are gustatory.
Although some patients have described more prolonged olfactory changes after seizures, these do not seem to be permanent.

**Psychogenic disorders**

There is no doubt that the abnormalities of smell are present in psychiatric illness and are also related to powerful emotional changes which verge on disorder.

Abnormal sense memory has proved an interesting phenomenon in many ways. The sense of *déjà vu* which can occur in epileptic aura sometimes involves a smell. Occasionally a sense of *jamais vu* is described when visual, auditory and olfactory experiences appear, surprisingly, never to have been experienced before.

There are many literary allusions to abnormal sense memory, but the most striking is that of Marcel Proust at the beginning of his great work. It starts with the dipping of a small cake, a *madeleine*, into a cup of coffee and the smell experienced by bringing it up to his mouth evokes memories of childhood. These are so detailed that they lead to the 13 volumes of *A la Recherche du Temp Perdu*. Obviously, the author is using this as a literary device, but it represents a well known phenomenon. Although the recall which smell produces cannot be called a disorder, it can sometimes trigger emotions of fear and anxiety which lead to a real disorder.

More common abnormalities are those which can be called illusions or hallucinations. The distinction between the two is not always clear. Illusion may involve alteration of smell, almost invariably for the worse and sometimes carrying a powerful emotional content. Hallucination is the experience of a smell when none is present.

There is no specific abnormality for a specific disorder, but abnormality has been described in schizophrenia as well as in alcoholism, senile dementia and depression. Hallucinations of smell become built into the delusional system of schizophrenia together with auditory hallucinations.

Olfactory hallucinations also occur in depressive illness sometimes associated with delusions of guilt and shame.

There is a group of people who develop a belief that they have a bad smell. This may emanate from the mouth or represent body odour. Although this is a delusion, these patients do not show any obvious sign of psychiatric illness otherwise. They fall nevertheless into a particular group, as the majority are under 30 years of age and they present as shy, embarrassed and withdrawn persons. They are not infrequently referred for an otolaryngological opinion and the diagnosis has to be differentiated from true halitosis. In the latter condition the complaint comes from other people such as the patient's relatives and the individuals themselves state that they are not aware of an abnormal smell at all. This distinction is not always simple as olfactory hallucinations usually give rise to delusions regarding the environment, and the patients will describe the behaviour of other people as responding to their own bad smell. Referral for psychiatric treatment is often resisted and, when accepted, not usually successful.
An interesting historical reference is that of Louis XI of France who is described as always being conscious of a bad smell about him. This may have been associated with paranoid features as his personality was deeply suspicious and cunning, leading to dangerous and fatal repercussions on those around him.

There is a similar, but lesser, disturbance which relates more to taste than smell and which could be confused with it. It seems to affect mainly women between the ages of 40 and 55. It presents principally as a bad taste in the mouth and sometimes gives rise to anxiety as to whether others are aware of it in the form of halitosis. Reassurance here is necessary after exclusion of a dental or gingival problem as the symptoms are usually self-limiting.

Both hysteria and malingering occurs from time to time after nasal operations, and very much less frequently after head injuries and fractures.

Testing the sense of smell

Compared with the advances made in testing auditory and visual acuity, quantifying the sense of smell still poses a difficult problem. There are two major difficulties which make quantification difficult. The first is that, as opposed to our knowledge of the nature of sound and of light, the stimulus which produces smell is only partially understood. The second is that it has not been possible, as yet, to devise satisfactory techniques of recording objective responses.

The nature of the olfactory stimulus

There is now no doubt that the stimulus producing a sensation of smell and flavour, whether olfactory, trigeminal or gustatory, is chemical in nature and that the olfactory sense depends on odorant molecules.

An odorant may be pure, representing a single molecular type, or it may be a mixture. Naturally occurring odours are usually mixtures and rose oil, for instance, contains more than 400 different types of molecules. The relative number of these molecules decides the particular quality of the oil. The difference between pure chemicals and mixtures makes a considerable difference when testing the sense of smell.

There are some common features of odorant molecules: the molecular weight usually lies between 20 and 300 and the molecules are relatively apolar. Consequently they are relatively less soluble in water and more soluble in both the lipid phase of membranes and in the hydrophobic binding sites on proteins. There is usually a single polar group which gives the molecule a certain orientation.

There is also a definite correlation between the shape and size of the odorant molecules and the quality of their smell. The most important demonstration of this was that of Amoore (1962).
Tests of smell

These are continuously being proposed with an increasing degree of refinement but they fall within certain types.

Threshold tests

These can be performed by dilution in air, in an inert powder or on paper, but nowadays the most commonly used tests are by dilution in liquid. The nature of odorants has developed from complex mixtures to single chemicals. A useful technique is that recently proposed by Van Toller, Dodd and Billing (1985). They have used the following 10 pure odorants:

1) trimethylamine - fishy
2) 1-valeric acid - sweaty, cheesy
3) phenylethanol - rose water
4) 2-acetyl pyrazine - roasted popcorn
5) methone - minty
6) 2-isobutyl-3-methoxy-pyrazine - green pepper
7) 5-alpha-androst-16-en-3-one - urinous
8) acetic acid - vinegar (trigeminal)
9) dodecylmercaptane - petrol-like
10) musk ketone - musky.

All of these were in smelling bottles and musk was on a perfumer's smelling strip.

The kit is portable in 20-mL vials packed in boxes of 10 rows of five bottles each. They were in aqueous solution except for the dodecylmercaptan which was dissolved in diethylphthalate.

The technique used for measuring threshold was that employed by Amoore (1970). This requires that subjects sniff five bottles in each concentration row of the odorant to determine which two contain the odorant. The other three only contain the solvent. It can be called the 'two-out-of-five-forced-choice' method. Subjects first tried sample series and then the test proper is carried out with the record marked on a score sheet.

Odour quality

In Van Toller, Dodd and Billing's test the subjects, using standard concentration, had to place them on a scale of descriptor terms. Two scales were used - one bipolar and one monopolar.

Olfactory spectrogram

This technique attempted to combine a qualitative and quantitative element in a rapid test (Douek, 1967).
The odorants used were based on Amoore's description of the smells of the seven most common (primary) odours: ethereal, camphoraceous, musky, floral, minty, pungent, putrid. The dissolved substances were placed in bottles and the air above the solutions was blasted into the nose by a syringe.

The volumetric quantity required to produce a sensation of smell was recorded on a block graph for each substance. Although the mixtures were complex rather than pure, and the blasting technique introduced many variables, the approach proved valuable in a clinical situation as it compared one nostril with another, one patient with another, and could record the progress of one case. It allowed the recognition of 'anosmic zones' which could recover with treatment in conditions such as allergic rhinitis.

In cases where hysteria or malingering is suspected, it is necessary to test the patient with trigeminal stimuli, such as dilute ammonia, acetic acid or menthol, as often they will deny any sensation.

It is also important to test the sense of taste as they will frequently deny that sensation also.

Management of abnormalities of smell

There are few useful forms of treatment and diagnosis should be based on the description below.

Exclusion of the intracranial lesions

This includes the history and examination of the cranial nerves as well as the nose. If there is any question of such a lesion computerized axial tomography is required.

Recognition of sinus disease

This requires sinus X-rays as well as nasal examination.

Recognition of peripheral causes

Commonly this is related to nasal abnormalities such as nasal polyps, chronic sinusitis and allergic rhinitis. Diagnosis is from examination and sinus X-rays.

A particularly important feature in these cases is the presence of residual experiences of smell even though these may be transient.

If the cause of the abnormality is an intracranial lesion there is no useful treatment. If the lesion appears to be peripheral there is a much better prognosis and the treatment should be intensive. Sometimes surgical intervention, such as the excision of polyps or sinus drainage, is necessary as a first step and this often should be followed up by treatment for an underlying allergic rhinitis.