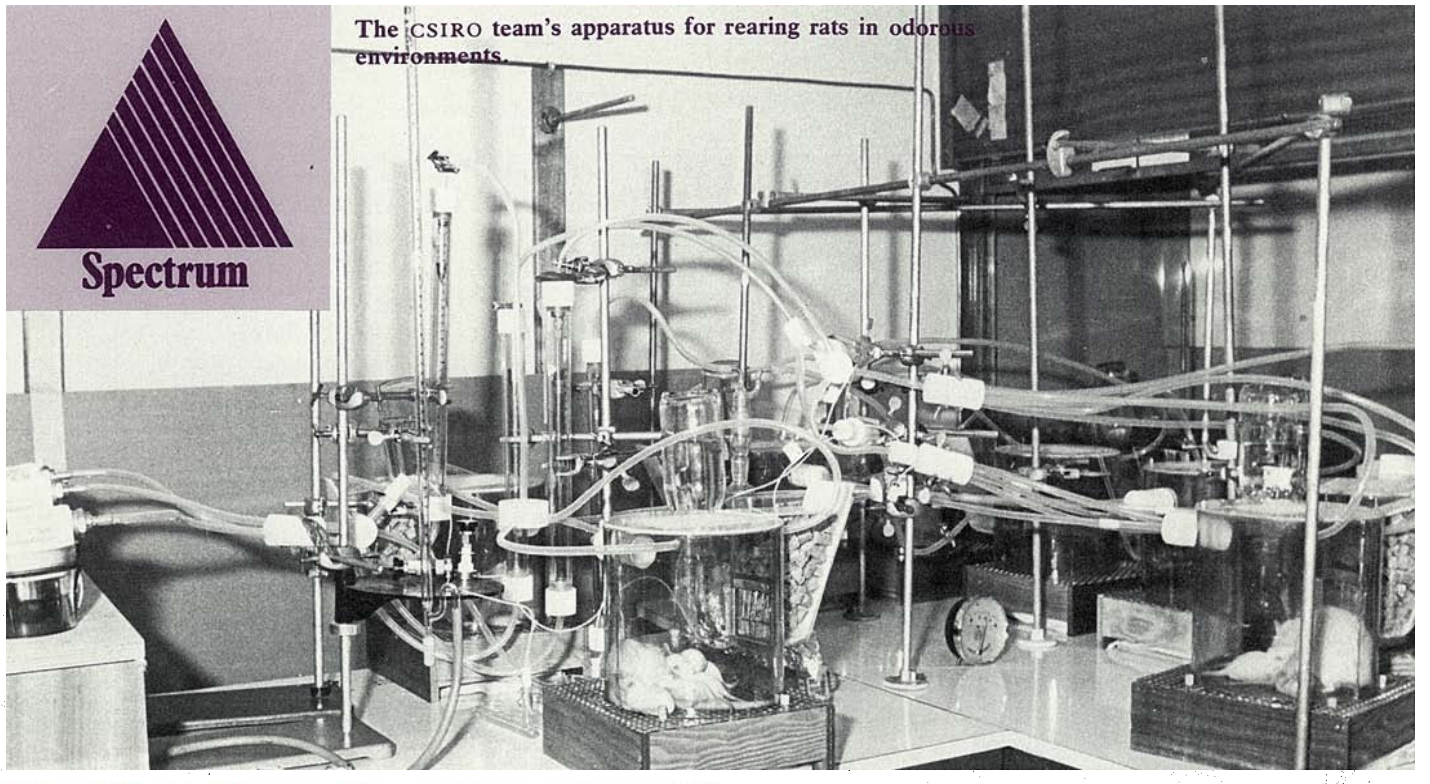
Spectrum



The CSIRO team's apparatus for rearing rats in odorous environments.

Tracking down the sense of smell

Unlike the senses of vision and hearing, the sense of smell is a bit of a mystery. We know that colour is related to the wavelength of light, and the pitch of a sound to its frequency. But any code that may exist relating the nature of a substance to its smell remains to be detected.

The CSIRO Division of Food Research wants to find out more about the sense of smell because of its importance in determining how people react to foods. As food manufacturers know well, flavour and texture influence people's eating habits at least as strongly as nutritional factors. And flavour is perceived as much by the sense of smell as by the sense of taste.

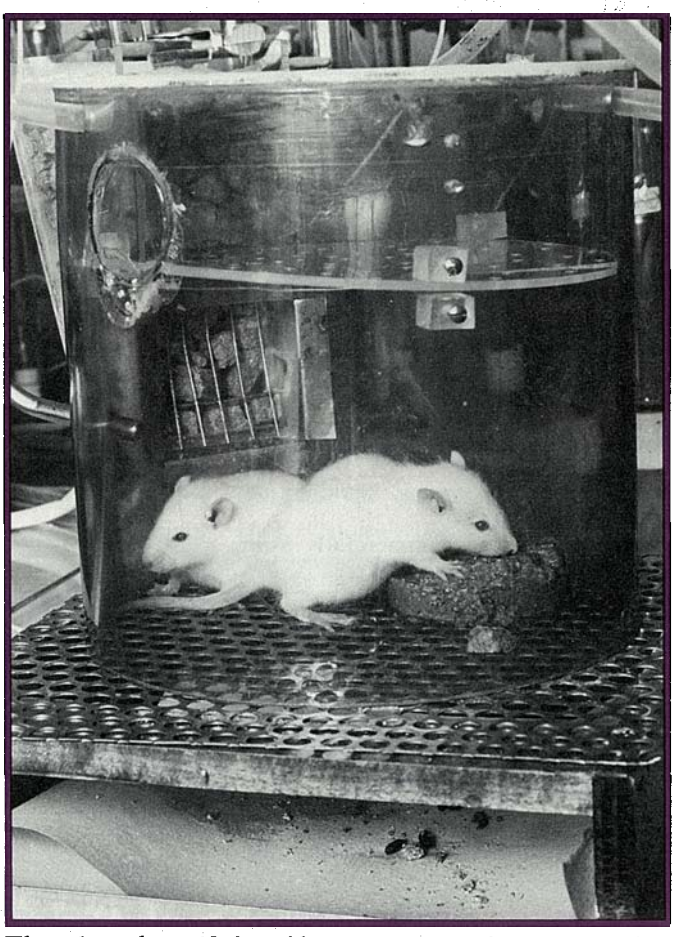
Using powerful analytical instruments, scientists at the Division have isolated and identified hundreds of food constituents, often present in extremely low concentrations, that contribute to flavour.

They have gathered a great deal of information on matters such as odour-detection thresholds and ability to distinguish and remember odours, by having panels of people sniff precisely measured quantities of odorous substances in a specially constructed 'olfactometer'.

The scientists have found that, when two or more odours interact, the most intense will predominate. However, the resulting odour may be considerably more or less intense than any of its components. Why? Nobody knows.

The food technologist trying to formulate a pleasant-tasting product still has to rely on trial and error, because of the lack of knowledge about why flavour responds as it does to the addition of substances with different odours.

Some information about how the brain responds to odours is now emerging, however, from experiments with rats. Research in a Norwegian laboratory has shown that a young animal, when exposed to one odour continuously for a number of weeks or months, suffers changes in the cells in a portion of its brain associated with the sense of smell.



The odour these 18-day-old rats are exposed to enters through the top of the cage and leaves through the bottom.

Subsequent work by Dr David Laing and Mr Helmut Panhuber, of the Division of Food Research, has thrown additional light on the processes involved and provided information on the specific effects produced by different odours.

Rats, humans, and

probably all other vertebrates possess very similar apparatus for detecting smell. At the back of the nose is the 'olfactory epithelium', where odours are detected by receptor cells. We have about 10 million of these.

The receptor cells pass their information on to a portion of the forebrain known as the 'olfactory bulb', which in turn passes it on to higher centres in the brain. Some processing of the information must occur in this bulb, because the number of output fibres to the higher centres is only about one-thousandth of the number of fibres bringing the information in from the receptor cells.

Most of this processing apparently occurs in the olfactory bulb's 'mitral' cells, which exist in a layer one cell thick. These are the cells being studied in rats.

The Norwegian scientists placed 14-day-old animals in boxes where each was exposed for between 2 weeks and 11 months to a low concentration of a single odour. Afterwards, they examined the rats' mitral cells under the microscope and found that, in each case, changes had occurred in some of the cells. The cells affected varied with the odour used.

The changes, involving darkening and shrinking, resembled those that occur when the nerves carrying information to the cells are cut. However, no degeneration was detected in the nerves or their terminals.

Dr Laing and Mr Panhuber linked rat-behavioural studies with examination of the mitral cells to find out more about the relation between exposure to odours and changes in the cells. They found that, after 4 months' exposure to a single odour, young rats placed in a box with other rats showed a preference for that odour. Their sensitivity to it was normal, but they appeared to be less sensitive than other rats to a similar but novel odour.

The scientists take this to indicate that the mitral cells that remain normal during exposure are those stimulated by the odour, and that lack of stimulus is the reason why the other cells degenerate. Perhaps the process is something like one that has been shown to occur when a cat's eye is covered at birth; changes in the brain eventually make the eye useless.

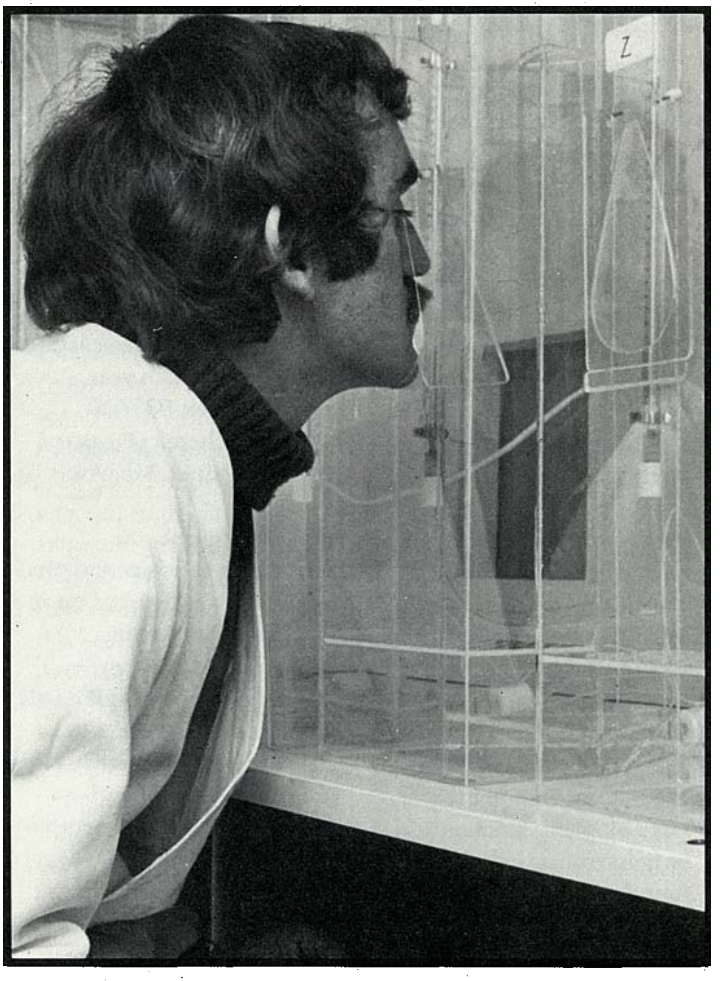
Evidence supporting this somes from an experiment in which the CSIRO scientists kept young rats for 2 months in an environment from which all odours were excluded. Almost all their mitral cells were altered.

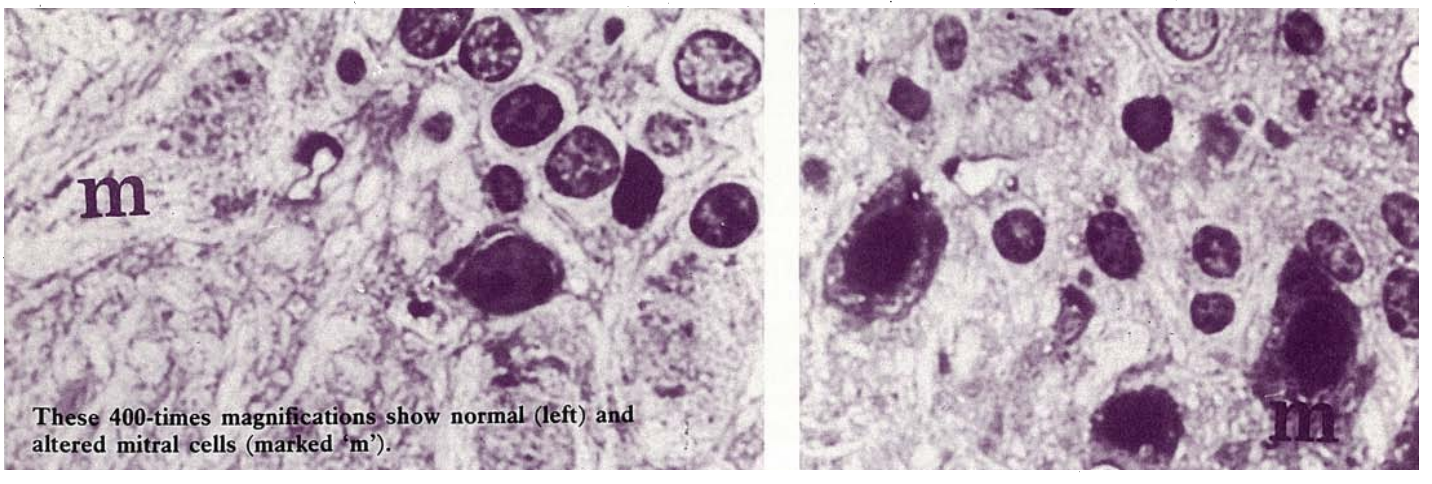
But the cells of rats that spent 4 months in deodorized air and then 5 months in a rat colony were normal. Evidently altered cells can recover, and exposure to normal 'ratty' smells brings this about in the young rats.

Dr Laing and Mr Panhuber have devised a computer-based technique for mapping the patterns of normal and shrunken mitral cells that characterize different odours. They plan to build up a library of such maps, and use these to gain more information about how the sense of smell works. They will be trying to find out, for instance, whether the reason why one odour interacts with another is that some of the mitral cells they affect are shared.

So far, all the experiments have been done with young animals, and it remains to be determined whether lengthy exposure of adults to a single odour produces cell changes. The effects may be confined to animals in which the

The Division's 'olfactometer', which delivers controlled quantities of odorous substances to panels of sniffers.





These 400-times magnifications show normal (left) and altered mitral cells (marked 'm').

nervous system is still developing.

Possible implications of the findings for humans remain to be explored. For example, could people working in factories where smelly substances are handled lose their sensitivity to other odours because of mitral cell changes? If only the very young are affected, presumably they would not. If adults are affected too, the answer may still be no; people would only be exposed to the smell during working hours, not continuously as the rats were.

The effects of lengthy exposure to odours warrant investigation for reasons besides the possibility that people's sense of smell may be affected. The mitral cells are connected to centres in the brain associated not only with smell but also with taste, feeding, sexual activity, and aggression. As a result, changes to them could have wider effects.

A committee appointed by the United States National Academy of Sciences recently examined the effects of odours on community health. It reported that evidence exists that exposure to odours can result in measurable departures from the normal anatomical, physiological, biochemical, or behavioural condition. It found that those exposed may or may not be aware of the change, and the odours involved need not be unpleasant; they can be neutral or even pleasant.

The committee concluded that more research on the effects of exposure to odours is needed.

Neural and behavioural changes in rats following continuous exposure to an odor. D.G. Laing and H. Panhuber. *Journal of Comparative Physiology*, 1978, **124**, 259–65.