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Scientists discover an organizing principle for our sense of smell

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The fact that certain smells cause us pleasure or disgust would seem to be a matter of personal taste. But new research at the Weizmann Institute shows that odors can be rated on a scale of pleasantness, and this turns out to be an organizing principle for the way we experience smell. The findings, which appeared today in *Nature Neuroscience,* reveal a correlation between the response of certain nerves to particular scents and the pleasantness of those scents. Based on this correlation, the researchers could tell by measuring the nerve responses whether a subject found a smell pleasant or unpleasant.

Our various sensory organs are have evolved patterns of organization that reflect the type of input they receive. Thus the receptors in the retina, in the back of the eye, are arranged spatially for efficiently mapping out visual coordinates. The structure of the inner ear, on the other hand, is set up according to a tonal scale. But the organizational principle for our sense of smell has remained a mystery: Scientists have not even been sure if there is a scale that determines the organization of our smell organ, much less how the arrangement of smell receptors on the membranes in our nasal passages might reflect such a scale.

A team headed by Prof. Noam Sobel of the Weizmann Institute's Neurobiology Department set out to search for the principle of organization for smell. Hints that the answer could be tied to pleasantness had been seen in research labs around the world, including that of Sobel, who had previously found a connection between the chemical structure of an odor molecule and its place on a pleasantness

scale. Sobel and his team thought that smell receptors in the nose – of which there are some 400 subtypes – could be arranged on the nasal membrane according to this scale. This hypothesis goes against the conventional view, which claims that the various smell receptors are mixed -- distributed evenly, but randomly, around the membrane.

In the experiment, the researchers inserted electrodes into the nasal passages of volunteers and measured the nerves' responses to different smells in various sites. Each measurement actually captured the response of thousands of smell receptors, as these are densely packed on the membrane. The scientists found that the strength of the nerve signal varies from place to place on the membrane. It appeared that the receptors are not evenly distributed, but rather, that they are grouped into distinct sites, each engaging most strongly with a particular type of scent. Further investigation showed that the intensity of a reaction was linked to the odor's place on the pleasantness scale. A site where the nerves reacted strongly to a certain agreeable scent also showed strong reactions to other pleasing smells and vice versa: The nerves in an area with a high response to an unpleasant odor reacted similarly to other disagreeable smells. The implication is that a pleasantness scale is, indeed, an organizing principle for our smell organ.

But does our sense of smell really work according to this simple principle? Natural odors are composed of a large number of molecules – roses, for instance, release 172 different odor molecules. Nonetheless, says Sobel, the most dominant of those determine which sites on the membrane will react the most strongly, while the other substances make secondary contributions to the scent.

'We uncovered a clear correlation between the pattern of nerve reaction to various smells and the pleasantness of those smells. As in sight and hearing, the receptors for our sense of smell are spatially organized in a way that reflects the nature of the sensory experience,' says Sobel. In

addition, the findings confirm the idea that our experience of smells as nice or nasty is hardwired into our physiology, and not purely the result of individual preference. Sobel doesn't discount the idea that individuals may experience smells differently. He theorizes that cultural context and personal experience may cause a certain amount of reorganization in smell perception over a person's lifetime.

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