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Artificial 'nose' tells people when certain smells are present

Technology that uses a less known sensory system to substitute for olfaction could one day help anosmic people detect some odors

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An experimental device helps people detect the presence of certain odors without using their sense of smell. KITTYFLY/SHUTTERSTOCK

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Researchers have tested a proof-of-concept device that enabled people who had lost their normal sense of smell to detect the presence of certain odors. Rather than exploiting the smell pathway, in which nasal cells send signals along olfactory nerves to the brain, the technology makes use of a less known nerve highway in the nose that transmits other sensations, including the kick of wasabi and the coolness of mint.

“It’s an interesting study,” says Zara Patel, a rhinologist at Stanford Medicine who was not involved in the work, published [today in Science Advances](#). “This is not recovering a sense of smell, this is activating a different system.” But she and others caution it remains to be seen how beneficial this kind of technology could be for people with smell loss, or anosmia.

Humans have about 400 different olfactory receptors that are thought to enable the nose to detect [billions of odors](#). But people can lose some or all of their sense of smell for a variety of reasons, including head trauma and viral infections such as COVID-19.

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People with long-term anosmia describe a significantly reduced quality of life and are at higher risk of mental health disorders, notes Halina Stanley, a research scientist at CNRS, the French national research agency, and co-author on the new paper. “The idea that if you lose your sense of smell, this isn’t as bad as losing another sense, I think is actually quite wrong.”

Research by another team in 2018 found that [electrodes placed in the sinuses near the olfactory bulb](#), the brain region that processes odor signals, could stimulate perception of smell, with people reporting onion or fruity scents, for example. Scientists are now working to develop implants that could more directly and specifically stimulate the olfactory bulb—akin to cochlear implants, which replace lost hearing by detecting sounds and stimulating the auditory nerve. However, such technology would be complex and invasive, and, at present, is a long way from becoming a therapy.

The current study opts for an alternative solution. The trigeminal nerve receives signals from all over the face, including in the nasal cavity, where it helps detect the temperature of inhaled air as well as the presence of irritants. (Certain chemicals from food that trigger trigeminal nerve endings, such as capsaicin in chili, contribute to the sensation of hot, cooling, or burning tastes, for example.)

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“We wanted to try to recruit this sense to have people who lost their sense of smell detect and discriminate odors,” explains Moustafa Bensafi, a research director at CNRS. To do so, he, Stanley, and colleagues designed a system with a chemical sensor developed by the France-headquartered company Aryballe to detect certain odors and encode each as a distinctive pattern of electrical signals, rather like a nasal Morse code. Those signals are then delivered via electrodes clipped onto the nose’s inner wall.

In initial experiments, researchers hooked up nine people—five with normal smell and four with olfactory disorders—to the device to see whether they could detect electrical signals sent up their nostrils. Both groups of participants could feel the stimulations, describing them as slightly unpleasant and irritating.



This device uses a sensor to detect scents presented on odor sticks and then sends an electric signal into a participant’s nose. MOUSTAFA BENSAFI

The scientists also tested whether people could distinguish four different smells using the setup. They held scented sticks close to the opening of the odor sensor to be encoded into an electrical signal. The device translated the smell of lilac, for example, into two pulses separated by 400 milliseconds, whereas raspberry became four zaps 100 milliseconds apart.

Some participants could discriminate among stimulations for different odors, although they could not say what the corresponding smells were. But others

struggled with the task. Following tweaks to simplify it, the team found that in at least some experiments, carried out at different research centers, participants could reliably discriminate between two smells. With training, people would probably be able to learn to associate certain electrical patterns with real-world scents, Stanley says.

Eric Holbrook, an otolaryngologist at the Massachusetts Eye and Ear hospital and Harvard Medical School studying how to stimulate the olfactory bulb, says the approach has potential applications. A miniaturized version of the technology might serve to warn anosmic people of a few key odors indicating hazards such as natural gas, where a wearable in-nose sensor may be more convenient than a handheld gadget.

But the technology isn’t likely to capture the overall experience of smell, according to Holbrook and other researchers. Even with training to associate smells and stimulation patterns, the technique couldn’t encode the vast range of odors humans experience, let alone trigger the emotions and memories associated with them in the brain, he says.

Stanley says the researchers are exploring ways to better encode smell digitally, and to generate some patterns of electrical stimulation that are more pleasant to the wearer.

Still, she acknowledges the team faces numerous technical challenges, particularly in the design of the odor sensor itself. Unlike a microphone, which can record any sound from any source, today’s most sensitive odor sensors typically only detect a few smells at most. The sensor also needs to work quickly and accurately in different temperatures and humidities, and over a range of smell intensities. “The chemistry is pretty complicated,” Stanley says.

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