Perceiving the smell of lemon, geranium or eucalyptus: A study on the electrical signals behind human olfaction

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What happens in our nose when neurons come in contact with a smell? As the recent COVID-19 pandemic demonstrated, from a medical and

scientific point of view our sense of smell is as important as it is little known. Now, for the first time, a SISSA study led by Professor Anna Menini has been able to measure the electrical signals produced by cells in the human olfactory epithelium obtained from nasal biopsies.

These signals are the language used by the cells of our nervous system to communicate among themselves and, more specifically, represent the first essential step of a sequence that, after reaching the brain, allows to perceive a smell.

The research, published in *iScience*, has also studied the different reactions to different odorant molecules, such as cineole and eugenol (which produce a smell similar to eucalyptus), limonene (the smell of lemon), isoamyl acetate (used to give foods the smell and taste of banana), and others that we find every day in the food we eat and the environments in which we live.

This result, say the authors, sets the foundation to study the physiological bases of human olfaction required to understand the anomalies that appeared in many patients who contracted coronavirus, such as long-term and short-term anosmia (loss of the sense of smell), parosmia (distorted perception of smells), or phantosmia (perception of smell in the absence of odorant molecules in the environment).

The research was conducted in collaboration with the Aldo Moro University of Bari, the University of Trieste, and the Otorhinolaryngology Clinic of ASUGI—Azienda Sanitaria Universitaria Giuliano Isontina..

The olfactory system

"Very little is known about its physiology even if we use our sense of smell every second of every day. We grasped its importance when it

suddenly captured our attention during the COVID-19 pandemic, as one of the symptoms of Coronavirus was an alteration of the sense of smell that led many patients to lament a deterioration in their quality of life. A dysfunction for which a scientific explanation is yet to be found," says SISSA's Professor Anna Menini.

"Until now, nobody had measured in intact human tissue the electrical activity of cells, neurons and epithelial cells that form the olfactory epithelium of our nose in which odorant molecules are captured. This is exactly what we did in this new study. More specifically, we worked on nasal biopsies collected in the operating theaters at the Otorhinolaryngology Clinic of ASUGI.

"This way, we were able to record the signals on tissue only just collected in operating theater and, together, look at how these signals change in the presence of different odorant molecules: something nobody had done before."

Not just neurons: The unexpected role for support cells

"With this research we have taken an important step towards understanding how the olfactory epithelium works," says Menini. "In the same study we were able to establish that so-called support cells, which surround olfactory neuron cells, have everything but a passive role.

"On the contrary, these cells seem to bring an important contribution to the electrical message that will be sent to the brain and will transport the perception of smell. As noted by other research, these cells, not neurons, carry on their surface ACE2 receptors connected to Coronavirus, highlighting their important role in these processes."

The next developments, explains the Professor, will bring more context to the discovery, extending the number of samples on which the research is carried out. But this is not all. "From a scientific point of view, it could be very interesting to work on tissue samples from patients suffering from long-lasting loss of smell as a consequence of Coronavirus infection. This could help us understand what is not working from a physiological point of view. And from there start developing therapies," says Menini

More information: Andres Hernandez-Clavijo et al, Shedding light on human olfaction: electrophysiological recordings from sensory neurons in acute slices of olfactory epithelium, *iScience* (2023). DOI: 10.1016/j.isci.2023.107186

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