

PRESS RELEASE

Another step towards decoding smell

Researchers from Bonn and Aachen elucidate the role of individual brain neurons in human odor perception

Bonn, October 9 – We often only realize how important our sense of smell is when it is no longer there: food hardly tastes good, or we no longer react to dangers such as the smell of smoke. Researchers at the University Hospital Bonn (UKB), the University of Bonn and the University of Aachen have investigated the neuronal mechanisms of human odor perception for the first time. Individual nerve cells in the brain recognize odors and react specifically to the smell, the image and the written word of an object, for example a banana. The results of this study close a long-standing knowledge gap between animal and human odor research and have now been published in the renowned journal "Nature".

Imaging techniques such as functional magnetic resonance imaging (fMRI) have previously revealed which regions of the human brain are involved in olfactory perception. However, these methods do not allow the sense of smell to be investigated at the fundamental level of individual nerve cells. "Therefore, our understanding of odor processing at the cellular level is mainly based on animal studies, and it has not been clear to what extent these results can be transferred to humans," says co-corresponding author Prof. Florian Mormann from the Department of Epileptology at the UKB, who is also a member of the Transdisciplinary Research Area (TRA) "Life & Health" at the University of Bonn.

Nerve cells in the brain identify odors

Prof. Mormann's research group has now succeeded for the first time in recording the activity of individual nerve cells during smelling. This was only possible because the researchers worked together with patients from the Clinic for Epileptology at the UKB, one of the largest epilepsy centers in Europe, who had electrodes implanted in their brains for diagnostic purposes. They were presented with both pleasant and unpleasant scents, such as old fish. "We discovered that individual nerve cells in the human brain react to odors. Based on their activity, we were able to precisely predict which scent was being smelled," says first author Marcel Kehl, a doctoral student at the University of Bonn in Prof. Mormann's working group at the UKB. The measurements showed that different brain regions such as the primary olfactory cortex, anatomically known as the piriform cortex, and also certain areas of the medial temporal lobe, specifically the amygdala, the hippocampus and the entorhinal cortex, are involved in specific tasks. While the activity of nerve cells in the olfactory cortex most accurately predicted which scent was smelled, neuronal activity in the hippocampus was able

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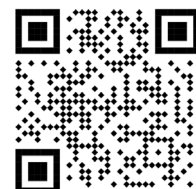
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to predict whether scents were correctly identified. Only nerve cells in the amygdala, a region involved in emotional processing, reacted differently depending on whether a scent was perceived as pleasant or unpleasant.

Nerve cells react to the smell, image and name of the banana

In a next step, the researchers investigated the connection between the perception of scents and images. To do this, they presented the participants in the Bonn study with the matching images for each odor, for example the scent and later a photo of a banana, and examined the reaction of the neurons. Surprisingly, nerve cells in the primary olfactory cortex responded not only to scents, but also to images. "This suggests that the task of the human olfactory cortex goes far beyond the pure perception of odors," says co-corresponding author Prof. Marc Spehr from the Institute of Biology II at RWTH Aachen University.

The researchers discovered individual nerve cells that reacted specifically to the smell, the image and the written word of - for example - the banana. This discovery indicates that semantic information are processed early on in human olfactory processing. The results not only confirm decades of animal studies, but also show how different brain regions are involved in specific human odor processing functions. "This is an important contribution on the way to decoding the human olfactory code," says Prof. Mormann. "Further research in this area is necessary in order to one day develop olfactory aids that we can use in everyday life as naturally as glasses or hearing aids."

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Image material:



Caption: Another step towards decoding smell:

(from left) Prof. Florian Mormann and Marcel Kehl are on the trail of the neuronal mechanisms of human odor perception.

Picture credits: University Hospital Bonn (UKB) / Rolf Müller

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About Bonn University Hospital: The UKB treats around 500,000 patients per year, employs around 9,500 staff and has total assets of 1.8 billion euros. In addition to the 3,500 medical and dental students, 550 people are trained in numerous healthcare professions each year. The UKB is ranked first among university hospitals (UK) in NRW in the Focus Clinic List, had over 100 million third-party funds in research in 2023 and has the second highest case mix index (case severity) in Germany. The F.A.Z. Institute awarded the UKB first place among university hospitals in the category "Germany's Training Champions 2024".