Researchers find that the brain smells what it expects rather than what it sniffs (w/ video)

October 7 2011

(Medical Xpress) -- In the moments before you “stop and smell the roses,” it’s likely your brain is already preparing your sensory system for that familiar floral smell. New research from Northwestern Medicine offers strong evidence that the brain uses predictive coding to generate “predictive templates” of specific smells -- setting up a mental expectation of a scent before it hits your nostrils.

Predictive coding is important because it provides animals -- in this case, humans -- with a behavioral advantage, in that they can react more quickly and more accurately to stimuli in the surrounding environment.

The study, published in the Oct. 6 issue of the journal *Neuron*, was led by Christina Zelano, a postdoctoral fellow in the lab of Jay Gottfried, M.D., associate professor of neurology at Northwestern University Feinberg School of Medicine and attending physician at Northwestern Memorial Hospital.

The researchers used functional MRI techniques and cutting-edge, pattern-based analysis to identify the existence of predictive coding in the olfactory cortex of the brain, where the sense of smell is housed.

While it may not be obvious that predictive templates in the olfactory system give modern-day humans a behavioral advantage, Zelano said people often overlook the power of the sense of smell.

“If somebody hands you a bottle of milk and asks, ‘Is this milk rotten?’ there may not be any visual clues to help you accurately determine if the milk has spoiled, so you rely on your sense of smell,” Zelano said. “Our study indicated that if your brain can successfully form a template of a rotten milk smell, then you would more accurately determine whether that milk is rotten and therefore you are less likely to get sick. These predictive templates can give us an important advantage.”

In the study, subjects performed “odor search tasks” while being monitored inside an MRI scanner. The two scents used in the study were a watermelon smell and a Play-Doh-like smell.

Before each trial began, subjects were told which of two target smells they should try to identify. A visual countdown, informing the subjects that they should get ready to receive a specific odor was administered and then, after smelling the odor, subjects indicated by pressing a button whether they thought the target smell was present. Sometimes the target scent administered was the same as the subject was foretold, sometimes it was different, and sometimes the target scent was hidden in a mixture of other scents.

The researchers were able to look at the activity pattern of the brain before any odor arrived and found that, for trials where the target was the same, the activity pattern was more correlated than when the target was different.

“Our study confirmed the existence of predictive coding mechanisms in olfaction,” said Gottfried, senior author of the study. “We found that the entirety of the olfactory cortex we looked at did form predictive templates that were very specific to the targeted smell. “

Predictive templates have been studied in the visual system, but this is the first study to examine the spatiotemporal evolution of activity

patterns in the human olfactory cortex.

This study was supported by the National Institute on Deafness and Other Communication Disorders.

More information: The title of the paper is "Olfactory Predictive Codes and Stimulus Templates in Piriform Cortex."

Provided by Northwestern University