Medical Xpress

Your nose knows when it comes to stronger memories

June 19 2019

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Memories are stronger when the original experiences are accompanied by unpleasant odors, a team of researchers has found. The study broadens our understanding of what can drive Pavlovian responses and

points to how negative experiences influence our ability to recall past events.

"These results demonstrate that bad smells are capable of producing memory enhancements in both adolescents and adults, pointing to new ways to study how we learn from and remember positive and negative experiences," explains Catherine Hartley, an assistant professor in New York University's Department of Psychology and the senior author of the paper, which appears in the journal *Learning and Memory*.

"Because our findings spanned different age groups, this study suggests that aversive odors might be used in the future to examine emotional learning and memory processes across development," adds Alexandra Cohen, an NYU postdoctoral fellow and the paper's lead author.

The impact of negative experiences on memory has long been shown—and is familiar to us. For example, if you are bitten by a dog, you may develop a negative memory of the dog that bit you, and your negative association may also go on to generalize to all dogs. Moreover, because of the trauma surrounding the bite, you are likely to have a better recollection of it than you would other past experiences with dogs.

"The generalization and persistence in memory of learned negative associations are core features of anxiety disorders, which often emerge during adolescence," notes Hartley.

In order to better understand how learned negative associations influence memory during this stage of development, the researchers designed and administered a Pavlovian learning task to individuals aged 13 to 25. Mild electrical shocks are often used in this type of learning task. In this study, the researchers used bad smells because they can be ethically administered in studying children.

The task included the viewing of a series of images belonging to one of two conceptual categories: objects (e.g., a chair) and scenes (e.g., a snow-capped mountain). As the study's participants viewed the images, they wore a nasal mask connected to an olfactometer. While participants viewed images from one category, unpleasant smells were sometimes circulated through the device to the mask; while viewing images from the other category, unscented air was used. This allowed the researchers to examine memory for images associated with a bad smell as well as for generalization to related images. In other words, if the image of a chair was associated with a bad smell, would memory be enhanced only for the chair or for objects in general?

What constitutes a "bad" odor is somewhat subjective. In order to determine which odors the participants found unlikable, the researchers had the subjects—prior to the start of the experiment—breathe in a variety of odors and indicate which ones they thought were unpleasant. The odors were blends of chemical compounds provided by a local perfumer and included scents such as rotting fish and manure.

As the subjects viewed the images, the scientists measured perspiration from the palm of the subjects' hands as an index of arousal—a common research technique used to confirm the creation of a negative association (in this case, of a bad smell). A day later, researchers tested participants' memory for the images.

Their findings showed that both adolescents and adults showed better memory specifically for images paired with the bad smell 24 hours after they saw these images. They also found that individuals with larger arousal responses at the point when they might experience either a bad smell or clean air while viewing the image, regardless of whether or not a smell was actually delivered, had better memory 24 hours later. This suggests that unpredictability or surprise associated with the outcome leads to better memory.

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More information: Alexandra O. Cohen et al, Aversive learning strengthens episodic memory in both adolescents and adults, *Learning & Memory* (2019). DOI: 10.1101/lm.048413.118

Provided by New York University

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