Medical Xpress

Imagining sounds is just as good as hearing them for removing negative associations

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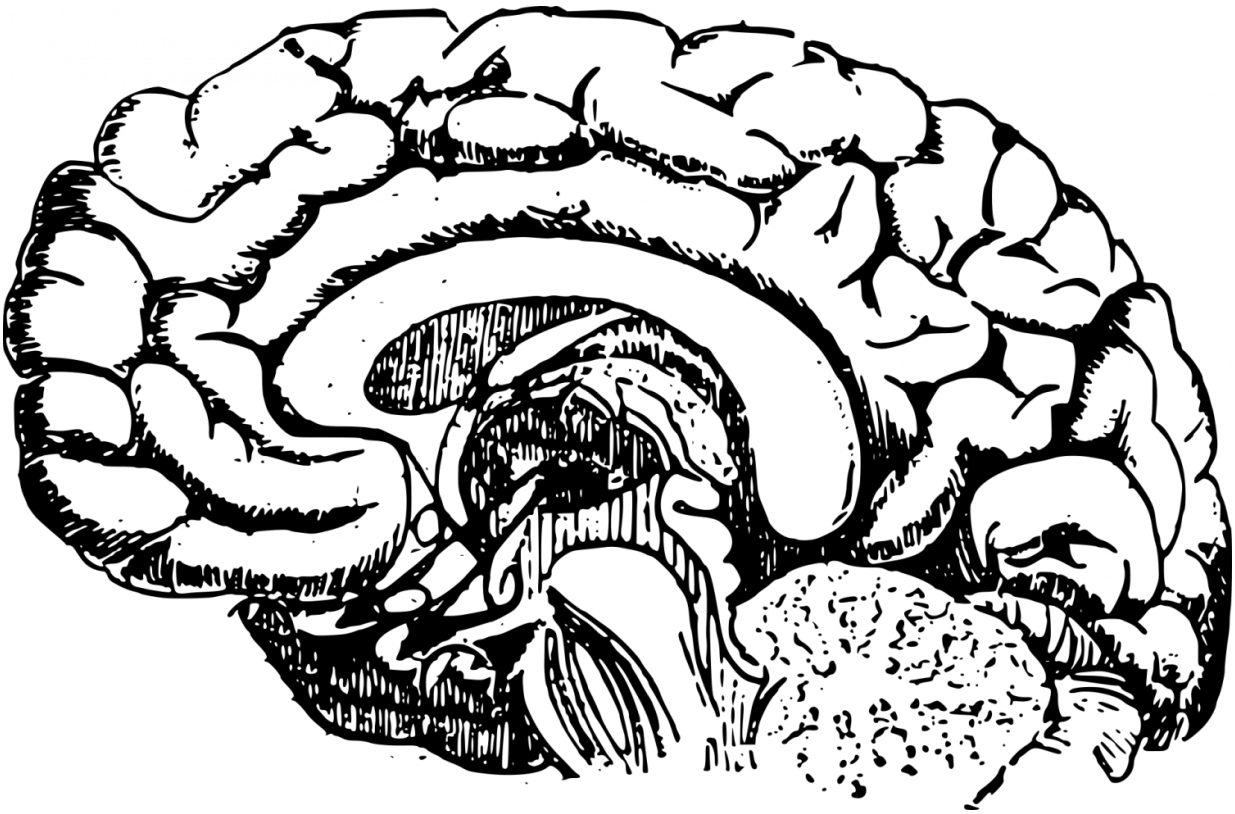

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Researchers at the Icahn School of Medicine at Mount Sinai and the University of Colorado, Boulder, have found that imagining a sound can be just as effective in breaking an association between that sound and a negative experience as hearing the sound in real life. And, their work

shows, there are parallels in where in the brain this process of undoing the behavioral impact of the association, called extinction, happens for both these real and imagined sounds. The findings, publishing November 21 in the journal *Neuron*, help to explain why imagination, already widely used as a therapy tool, can help with anxiety disorders.

"This was an attempt to measure our mental action and how it affects our reaction to real life," says co-senior author Daniela Schiller, a neuroscientist at the Icahn School of Medicine at Mount Sinai. "In many cases, when we study how we react to important stimuli, we use actual cues in the environment and then measure our responses to them. But at the same time, many internal processes happen in our brains: we imagine, we plan, we ruminate, we have expectations, we make predictions."

The 68 healthy participants in this study were trained to associate either a high-pitched sound or a low-pitched sound with an uncomfortable, but not painful, electric shock. Then, they were either exposed to the same sounds, asked to imagine the same sounds, or asked to imagine pleasant bird and rain sounds—all without experiencing further shocks.

This procedure is well known to lead to extinction, where the formerly fear-inducing experiences no longer cause a fear reaction. The question was whether imagining the sound would work as well as really hearing it. Here, the researchers found that it did: those who had imagined the sounds without experiencing the shocks decreased their fear responses to the real sounds just as well as those who really heard them without experiencing the shocks.

In the clinic, patients with anxiety disorders are often asked to visualize a situation that triggers stress, anxiety, and fear in order to re-experience it in a safe, controlled way. It's often successful, but how imagination can have such powerful effects is not well understood. "Some non-invasive,

behavioral methods we use in the clinic have been developed by trial and error, rather than by a theory-driven or mechanistically-driven approach. By examining the basic features of these methods in the laboratory, we might capture the mechanism that could explain how they work and why they are successful," says Schiller.

Observing the participants' brain activity with fMRI allowed the researchers to see that there were overlaps in brain activity in the real and imagined extinction conditions: while each condition did have activity uniquely associated with it, activity in both conditions centered around the ventromedial prefrontal cortex (vmPFC). The vmPFC has been shown in many species to be associated with extinction, and its activation during the imagined sound condition suggests that imagined extinction happens by a process similar to real extinction.

"It's exciting to me that you can do something with your imagination and it has an impact we can see in the brain. And it's not just that your imagination does something right now, but that it influences the trajectory of what your brain learns from experience," says co-senior author Tor Wager (@torwager), a professor of psychology and neuroscience at University of Colorado Boulder.

It's not, however, just any kind of imagination that has this effect. The condition in which participants were asked to imagine birds and rain didn't affect the relationship between the sound and the learned fear response. "Even though we've been studying the extinction of threat for over one hundred years, we're still learning new things," says Wager.

The researchers acknowledge that there are still unknowns. While there are parallels between the networks in the brain involved in extinction with imaginary and heard cues, this study may be too small to pinpoint specific similarities and differences. The study also wasn't designed to look at the long-term effectiveness of imaginary cues or at whether the

extinction process comes about by creating a new memory or by modifying the original one. "Even though we've been studying the extinction of threat learning for over 100 years, we're still learning new things," says Wager.

Schiller is excited about what that knowledge could allow us to do. "I think that the more that we understand how the brain functions and the mechanisms underlying specific behaviors, the more we could actually influence these mechanisms behaviorally," she says. "We could become more sophisticated users of our brain because we understand how it works."

More information: *Neuron*, Reddan et al.: "Attenuating neural threat expression with imagination" www.cell.com/neuron/fulltext/S0896-6273(18)30955-3 , DOI: 10.1016/j.neuron.2018.10.047

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