

Anticipation Plays a Powerful Role in Human Memory

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Psychologists have long known that memories of disturbing emotional events - such as an act of violence or the unexpected death of a loved one - are more vivid and deeply imprinted in the brain than mundane recollections of everyday matters.

Probing deeper into how such memories form, researchers at the University of Wisconsin-Madison have found that the mere anticipation of a fearful situation can fire up two memory-forming regions of the brain - even before the event has occurred.

That means the simple act of anticipation may play a surprisingly important role in how fresh the memory of a tough experience remains.

The findings of the brain-imaging study, which appear in the current issue of the *Proceedings of the National Academy of Sciences*, have important implications for the treatment of psychological conditions such as post-traumatic stress disorder (PTSD) and social anxiety, which are often characterized by flashbacks and intrusive memories of upsetting events.

"The main motivation for this study was a clinical one, in terms of understanding and applying knowledge about memory so that we can better inform the treatment of disorders that have a large memory component, like PTSD," says lead author Kristen Mackiewicz, a graduate student at the University of Colorado who worked on the anticipation study while a student at UW-Madison.

The project also builds on a relatively new body of work on the role of anticipation in emotion and clinical disorders, says senior author Jack Nitschke, a UW-Madison assistant professor of psychiatry and psychology.

"Our study illustrates how the power of expectancy can extend to memory formation as well," says Nitschke, also an associate of UW-Madison's Waisman Laboratory for Brain Imaging and Behavior. "Just the expectation of seeing something bad can enhance the memory of it after it happens."

A teacher who struggles with stage fright, for example, might feel anxious before every class she has to teach. The UW-Madison work suggests that the longer she spends dreading her next lecture, the stronger her memory of the uncomfortable experience is likely to be when it is over. Unfortunately, that sets a vicious cycle in motion, because the stronger her memory of discomfort, the worse her performance anxiety is likely to get.

The UW-Madison scientists found that two key regions of the brain - the amygdala and the hippocampus - become activated when a person is anticipating a difficult situation. Scientists think the amygdala is associated with the formation of emotional memories, while the hippocampus helps the brain form long-term recollections, Nitschke says.

The researchers studied the brain activity of 36 healthy volunteers using a technique known as functional magnetic resonance imaging, which produces high-contrast images of human tissue. They began by showing the volunteers two kinds of signals. One was neutral, but the other indicated that some type of gruesome picture was soon to follow, such as explicit photos of bloody, mutilated bodies.

Thirty minutes after the researchers had shown dozens of violent images,

they quizzed study participants on how well they remembered the pictures they had just seen.

"We found that the more activated the amygdala and hippocampus had been during the anticipation [of the pictures], the more likely it was that a person would remember more of them right away," says Nitschke.

Two weeks after the experiment, scientists met with the study subjects again to measure how well they remembered the same disturbing images. This time, they found that people who best remembered them had shown the greatest amygdala and hippocampus activity during the picture-viewing exercise two weeks before. That suggested that those subjects' brains had already started converting short-term memories of the images into longer-lasting ones.

Mackiewicz says the anticipation of an uncomfortable situation probably kick-starts a kind of "arousal or fear circuitry" in the brain, which in turn helps to reinforce old memories.

"In the future, we could look for ways to dampen that arousal response in patients so that they do not evoke negative memories so easily," she adds.

Scientists Issidoros Sarinopoulos and Krystal Cleven at the Waisman Laboratory for Brain Imaging and Behavior also contributed to the study.

Source: University of Wisconsin-Madison

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