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Q&A: The science behind Christine Blasey Ford's testimony to Senate judiciary committee

What happened to Christine Blasey Ford's epinephrine, hippocampus

Christine Blasey Ford arrives to testify before the Senate Judiciary Committee on Capitol Hill in Washington, Thursday, Sept. 27, 2018. (Michael Reynolds/Pool Photo via AP)

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Psychology researcher and professor Christine Blasey Ford's clinical description

"Indelible in the hippocampus is the laughter, the uproarious laughter between the two and they're having fun at my expense," she said, referring to the region of the brain responsible for emotion and memory in describing what she most vividly remembers from the day she said Brett Kavanaugh pinned her on a bed and attempted to sexually assault her as a friend cheered him on three decades ago when they were all in high school.

"Just basic memory functions and also just the level of norepinephrine and the epinephrine in the brain that sort of, as you know, encodes — that neurotransmitter that codes memories into the hippocampus and so the trauma-related experience is locked there whereas other details kind of drift."

Not only is Blasey Ford the key to the future of Kavanaugh's Supreme Court nomination, she is a clinical and research psychologist who teaches at Palo Alto University with master's degrees from Pepperdine and Stanford and a PhD from the University of Southern California.

Her testimony described how a traumatic event can have a powerful effect on brain areas involved in memory and emotion.

But strong emotions are not always associated with accurate, lasting recall, according to Larry Cahill, professor of Neurobiology and Behavior in UC-Irvine's School of Biological Sciences.

"From all we know about memory, one can say nothing confidently about any one particular case, especially when in the range of extreme emotion," he wrote.

Here is the biology behind what she said:

Q: Why are some memories so indelible?

A: The ability to learn and remember is essential for our survival.

But our brains, remarkable as they are, could not begin to contain and give equal weight to our every moment of life. Many moments are not given equal weight in memory, wrote neurobiologist James L. McGaugh of the Center for the Neurobiology of Learning and Memory at UC-Irvine.

Experiences of unpleasant occasions — such as an automobile accident, a mugging, or learning about the death of a loved one — are remembered better than those experiences of a routine day. The strength of memories of events varies with the emotional significance of the events.

For instance, three years after the terrorist attack on Sept. 11, 2001, individuals who were in downtown Manhattan at the time had more detailed memories of the attack compared with individuals who were in midtown Manhattan, several miles from the attack, according to research led by Tali Sharot of the Department of Psychology at New York University in New York City.

Q: How does biology make those memories so strong?

A: Fear and trauma boosts the storage of memories, creating lasting memories of our more important experiences, according to McGaugh. Blasey Ford described memories of the bedroom, bed, bathroom and "the uproarious laughter."

Research suggests that's because emotional arousal causes the neurons in the brain to fire more frequently, making the experience more intense – and triggering the release of the adrenal stress hormones epinephrine, commonly known as adrenaline.

But while that fact is rock solid from animal research, where brain chemicals can be manipulated, it is less well supported in human studies.

The relationship between arousal and memory is non-linear, according to research by UC-Irvine's Cahill. That finding suggests an "inverted-U" relationship between levels of stress hormones and memory. In other words, learning is enhanced by arousal up to a certain optimal point — but beyond that may decline into impairment.

"Our work basically leaves open what may or may not happen in cases of extreme emotion," Cahill wrote. "Intrusive — and presumably accurate — recall, lack of recall, and even completely false recall have all been documented from very highly emotional experiences, and it is not clear to me that one is more likely than the other given any one case, and it is even less clear when alcohol is involved."

Q: What is the stress hormone epinephrine?

A: This chemical regulates the consolidation and cementing of long-term memory.

It also allows us to fight off danger, increasing our strength and our blood pressure. Blasey Ford credited epinephrine with helping "multiple attempts to escape, and the ability to do so."

Q: How does epinephrine help memories "stick"?

A: Stress hormones like epinephrine are thought to influence the metabolism of a part of the brain called the hippocampus, located under the cerebral cortex.

Q: What is the hippocampus?

A: It is a brain area involved in learning and memory that is known to be particularly sensitive to stress.

Whenever you have an experience, the sensations are sent to the hippocampus. It's a "sorting center" – comparing new experiences with previous ones, and deciding whether the new experience will be committed to long-term memory, according to research by a team led by John T. Wixted of the Department of Psychology at UC San Diego.

That's what Blasey Ford meant by "encoding." The delivery of information to the hippocampus, strengthened by a surge of epinephrine, is the crucial first step to creating a new memory.

The information is securely stored in the brain, and then later retrieved and recalled, researchers say.

Q: Why does this lead to continued symptoms — called "sequelae" by Ford — later in life?

The brain is very impressionable during youth, so trauma-induced changes may go on to trigger symptoms in adulthood, such as Blasey Ford's anxiety, claustrophobia and PTSD.

That's because the brain keeps developing until the age of 17, sometimes beyond. Blasey Ford was age 15 at the time of her assault — an age when there is a progressive increase in the brain's white matter, the relay and coordinating center, which affects learning and other brain functions.

Specifically, trauma causes changes to a region of the brain called the insula, which plays a key role in emotional regulation, self-awareness and deciding how much or how little attention one pays to sensory information within the body, according to research at the Stanford University School of Medicine and the Early Life Stress and Pediatric Anxiety Program.

There are gender differences in how the mechanism behind the release stress hormones acts on men and women, said Cahill.

It women, it enhances memory for details; in men, it enhances memory for the central essence of an experience. This raises "the remarkable possibility," wrote Cahill, "that a woman in particular may recall details of an emotional event accurately, while not accurately recalling central information."

Tags: **Brett Kavanaugh**, **Health**, **Medicine**, **Regional**, **Science**

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