

## SCIENCE

# Memories Weaken Without Reinforcement, Study Finds

By **PAM BELLUCK** MARCH 16, 2015

What happens to forgotten memories — old computer passwords, friends' previous phone numbers?

Scientists have long held two different theories. One is that memories do not diminish but simply get overshadowed by new memories. The other is that older memories become weaker, that pulling to mind new passwords or phone numbers degrades old recollections so they do not interfere.

The difference could be significant. If old memories stay strong and are merely papered over by new ones, they may be easier to recover. That could be positive for someone trying to remember an acquaintance's name, but difficult for someone trying to lessen memories of abuse. It could suggest different strategies for easing traumatic memories, evaluating witness testimony about crimes, or helping students study for tests.

Now, a study claims to provide evidence of memory's weakening by showing that people's ability to remember something and the pattern of brain activity that thing generates both appear to diminish when a competing memory gets stronger.

Demonstrating sophisticated use of brain scans in memory research, authors of the study, published Monday in the journal *Nature Neuroscience*, appear to have identified neural fingerprints of specific memories, distinguishing brain activity patterns produced when viewing a

picture of a necklace, say, from a picture of binoculars or other objects.

The experiment, conducted by scientists in Birmingham and Cambridge, England, involved several stages with 24 participants first trained to associate words to two unrelated black and white pictures from lists of famous people, ordinary objects or scenes.

They then completed several tasks in a brain scanner. First, they were shown a cue word and asked to recall the image they had been trained to link to that word so that image would become the dominant memory. (For consistency, they were asked to recall the first image they were trained on.)

For example, if the word “sand” was associated first with Marilyn Monroe and then with a hat, scientists wanted participants to indicate that they were recalling Monroe by pressing a button. Each cue word was sprinkled into the test four times, so scientists could see if participants looking at the word “sand” increasingly chose Monroe over the competing memory of the hat. They did.

Next, scientists wanted to see what happened to the hat memory: Did it stay as intact as Monroe although it was not being used, or did it become weaker? To gauge this, scientists showed people two different pictures of Monroe and two hat pictures, asking them which version they had been trained to recognize. If the hat memory had not degraded, scientists reasoned, people would pick the right hat as often as they picked the right Monroe.

To measure success, scientists devised a standard: how well people recalled the correct picture of an unrelated famous person or object. These were images they had been shown early in the study but would have no reason to recall well because they had not been cued to remember them.

For faces, a standard was two Albert Einstein pictures, and people picked the right Monroe about as well as they picked the right Einstein. For objects, a standard was two pictures of goggles. It turned out people were worse at picking the correct hat; they remembered the correct goggles

better, even though their memory of goggles had not been reinforced.

Brice Kuhl, a psychology professor at New York University who was not involved in the study, said that strongly suggested that competing memories get weaker, that when people repeatedly pulled out the memory of Monroe in the word test, their recollection of the hat diminished so they did worse at recalling it later.

“You might think it would be better or at least the same” as the standard pictures, he said, “because you’ve just actually had a reminder for the hat, the cue word” in the previous scanner test.

That people had trouble remembering the right hat, he said, makes it less likely the hat memory was simply overshadowed by Monroe. “It’s pretty hard to think that your inability to pick the right hat has anything to do with Marilyn Monroe at that point.”

Next, researchers obtained a “neural signature” of Monroe, the hat and other images by recording brain activity in the prefrontal cortex as participants viewed each picture six times, said a study author, Maria Wimber, a cognitive neuroscientist at the University of Birmingham.

Matching those signatures to brain patterns from the “cue word” test, researchers saw that when the word “sand” was first shown, people’s brains reflected both Monroe and hat patterns, but with subsequent “sand” cues, their brains produced fewer hat traces.

“We watched the memories being suppressed, actively degraded,” said Dr. Wimber, whose collaborators included Michael C. Anderson, a longtime proponent of the memory suppression theory. “It’s not just that the target memories get stronger; the other memories get weaker.”

That interpretation is not necessarily accepted by proponents of memory overshadowing and similar theories.

“I buy that the brain patterns becomes less and less similar to the hat,” said David E. Huber, a professor of psychological and brain sciences at the

University of Massachusetts, Amherst, calling the neural signature technique exciting. “Their interpretation of that is that the memory of the hat has been degraded. It’s also possible that increasingly, you’ve learned to think about something other than the hat.”

Dr. Huber noted that while people performed below the standard level at picking the right hat, it was surprising they were not better than standard with Monroe. Dr. Wimber said that had surprised her, too, but her theory is that mental blurring occurs “the more often you bring a picture back to mind,” so details get lost.

Kenneth Norman, a Princeton neuroscientist who was also not involved in the study, said he believed it showed a memory-weakening effect, but that “forgetting is multiply determined, and the two main explanations, they’re not mutually exclusive.”

He said therapeutic applications of memory weakening could include extinguishing fears of something like snakes.

“If you show someone a cartoon image of a snake, cute, funny,” he said, “in the moment you’ve caused liking the snake to overcome not liking the snake. If you want to actually weaken a memory, what you need to do is flush it out. It’s the process of the memory coming to mind as a competitor, but losing the competition.”

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