Medical Xpress

# Outsmarting amnesia: Research points to a new way of forming memories

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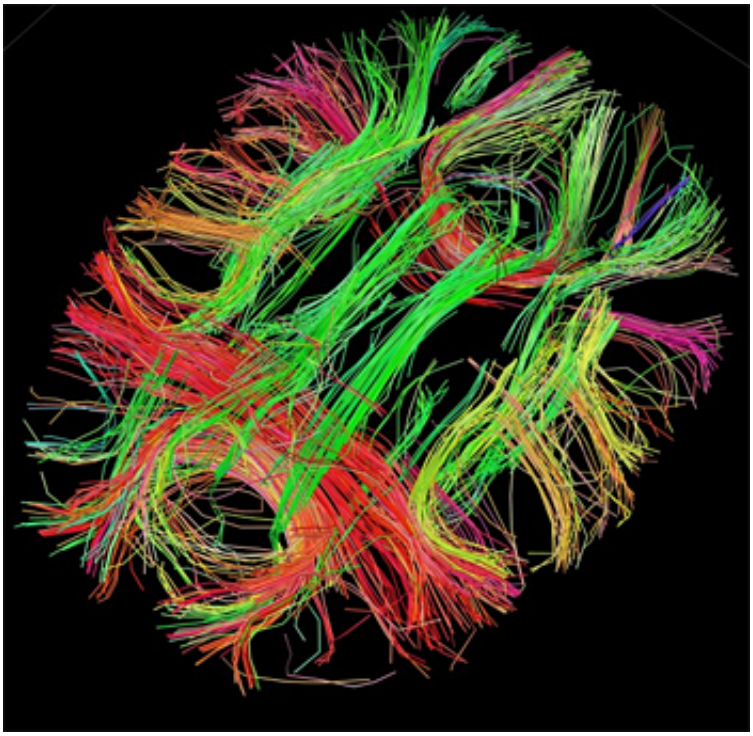

White matter fiber architecture of the brain. Credit: Human Connectome Project.

The scene plays out like a horrifying movie. A woman wakes up in a hospital bed, with no idea how she got there, or even who she is. For another patient down the hall, things are even worse—he can recall his past, but can no longer make new memories, and so exists in a perpetual state of limbo. He forgets new faces as soon as they leave from sight.

He's unable to recall any recent conversations, or even his own age.

These conditions are called, respectively, retrograde and anterograde amnesia, usually caused by traumatic accident, infection, or a loss of oxygen to the brain. Just imagining them is enough to send a shiver down your spine. Memories, after all, are vital to our sense of self. Without them, we're set adrift in a mental void.

"Everyone's really terrified by this sort of thing. If you lose your memories, you lose your identity," says Elizabeth Race, an assistant professor of psychology.

Race studies patients like the hypothetical duo above, and those who have a mix of both conditions. She says that although amnesia makes forming new memories difficult, she and her team are starting to uncover new ways of coping with the disorder. Even in severe cases, she notes, certain long-term memories that were stored before amnesia set in are preserved—and those isolated islands of stable memory, if accessed, could be used as a scaffold or "hook" for forming new memories.

## A Personal Connection

As Race describes her work, her empathy for the dozens of patients she has studied is palpable. She speaks about their predicaments tenderly, as if they were members of her own family, and her voice takes on an urgent tone as she details possible treatments. This personal connection stems from her experience as a child, she says: she watched her grandfather slowly succumb to Alzheimer's disease.

"That fear and sadness of potentially losing our memories is what drives me as a researcher," she says. "We're not going to stop memory loss, but maybe we can make the people suffering from it a little better."

Besides improving life for patients coping with amnesia, studying the disorder can also shed light on how we recall memories in the first place. Unlike diseases such as Alzheimer's, which gradually spread throughout the brain, amnesia is caused by sudden injury to a neural region called the medial temporal lobe (MTL). Because it always occurs in that one specific area of the brain, researchers can follow each patient's patterns of behavior to understand which actions the region controls.

"You can see what abilities are preserved, and what are impaired, and that can tell us what this region is or isn't doing," Race notes. "It gives us a much better sense of what the MTL does for cognitive function."

## Anatomy of Memory

As it turns out, says Race, the MTL—a chunk of tissue nestled deep inside the middle of the brain—plays an important role as a sort of neural melting pot. It's an anatomical "convergence" zone that blends different memories together into a cohesive whole. And that's not a small job. In the course of its work, the MTL must pull information stored in dozens of different areas throughout the brain.

Long-term memory is itself divided into a number of sub-flavors: there's procedural memory (how to ride a bike or play piano), episodic memory (where you parked the car), semantic memory (knowing that the capitol of Maine is Augusta). There's also spatial, temporal, visual and topographic memory—the list goes on.

To get a sense of how all these disparate types of memory come together in the MTL, think back to where you left your car this morning. In order to visualize that parking spot, you first have to pull basic information about time, spatial location and even object identity (recognizing that a boxy metal thing with wheels is, in fact, a car). Under the surface, a simple memory turns out to be a complex collection of several different

thoughts. Yet thanks to the MTL, we can recall it instantaneously as a single thought.

This small region of the brain might also be responsible for our ability to think about the future. When we imagine events that haven't yet happened, Race notes, we draw on our existing store of experiences and information, and put them together again in novel ways. You and I might have no trouble describing our next trip to Paris in detail, for example—exactly where we'll go, what we'll do, and what we'll eat as we stroll along the Seine. Ask amnesia patients to do the same thing, and they'll often be flummoxed.

In short, a damaged MTL makes it nearly impossible to form new cohesive memories. But Race says many patients can still access knowledge gained before their injury, sometimes unconsciously. Older "semantic" memories, like the spelling of a specific word, or the layout of computer keyboard, remain stable in the face of MTL damage—and she is finding that they can be used to anchor new ideas in amnesiacs' minds.

"If you have information that's familiar to you, it's a really powerful memory cue. What we're looking at now is, can you take advantage of these potent memories to enhance learning that would otherwise be disrupted," she says.

## Bypassing Damage

Race and her team tested this idea with a group of amnesia patients in 2015. Using an image of a traditional telephone keypad, the group highlighted numbers in a specific sequence, then asked patients to read the sequence back. Next, they showed the same patients a slightly different version: a keypad of the same basic grid shape, but with its numbers scrambled randomly. Patients were able to remember number

sequences far more reliably when they were using the familiar keypad, she says.

"A keypad is something you've probably seen a million times throughout your life, so it's a strong memory stored in your semantic knowledge," says Race. "We found that even people with amnesia could use that existing memory to help them learn new sequences of numbers. It's very exciting, because it tells us that not all types of memory integration are impaired in amnesiacs."

In other words, she notes, the results of the keypad study may suggest a method for bypassing a damaged MTL, allowing amnesiacs to hold on to some of their short-term memories. The same finding applies to people with healthy brains, she says. If you're trying to remember a phone number and the digits happen to include your birth date, for example, you're more likely to be successful, just because of the extra help you're sure to get from semantic memory.

The implications of having functional semantic memory could be much more far-reaching for amnesia patients, however. Such people could gain a means to retain and use new knowledge consciously, an ability that would otherwise be out of reach.

Race is quick to add that it may be a while before her research can be used to improve rehabilitative therapy. Identifying which types of knowledge are intact in patients—and helping them make meaningful connections to that knowledge—will be challenging, as efforts will have to be tailored to each individual patient's background. Still, she says, her work does offer a ray of hope for her patients, who, for now, greet each day as if waking from a dream.

Provided by Tufts University

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