Scientists explore the illusion of memory

Every time someone recalls a memory, it's a chance to change it

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Every time you recall a memory, it becomes sensitive to disruption, says Nobel Laureate Dr. Eric Kandel. (Lucas Jackson/Reuters)

A memory might seem like a permanent, precious essence carved deep into the circuits of the brain. But it is not. Instead, scientists are discovering that a memory changes every time you think about it.

"Every time you recall a memory, it becomes sensitive to disruption. Often that is used to incorporate new information into it." That's the blunt assessment from one of the world's leading experts on memory, Dr. Eric Kandel from Columbia University.

And that means our memories are not abstract snapshots stored forever in a bulging file in our mind, but rather, they're a collection of brain cells — neurons that undergo chemical changes every time they're engaged.

So when we think about something from the past, the memory is called up like a computer file, reviewed and revised in subtle ways, and then sent back to the brain's archives, now modified slightly, updated, and changed.

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As scientists increasingly understand the biological process of memory, they are also learning how to interrupt it, and that means they might one day be able to ease the pain of past trauma, or alter destructive habits and addictions, as though shaking an Etch A Sketch, erasing the scribbles on the mind, and starting fresh.

In his McGill University lab, researcher Karim Nader routinely erases the memory of his laboratory rats. But first he has to give them a memory and he does that by putting them in an isolation cubicle, playing a tone, and then delivering a small electrical shock to

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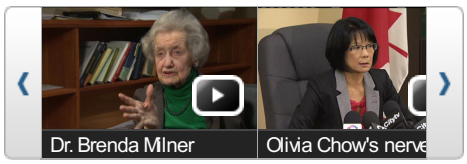

their feet.

Experiments to erase memory

"So that's the traumatic memory," he says. For the rat, the sound of the tone equals an unpleasant experience. The next time the animal hears the tone, it is afraid, even though it doesn't get the foot shock.

How do you tell that the rat remembers pain? It freezes.

"If you are in the dark, and you're scared. You freeze. It's the same as a rat, the same brain mechanism that controls our fear response controls the rat's fear response," Nader said.

The next step in erasing the memory is to put the animal back in the conditioning chamber and play the tone, so the memory is freshly recalled in the rat's brain. Then Nader experiments with drug that blocks the chemical process needed to restore the memory. The old memory of the tone followed by a foot shock is replaced by a new memory of a tone followed by nothing at all.

Nader puts the rat back into the isolation cubicle, plays the tone and watches what happens. The previously shocked rat no longer freezes in fear when it hears the tone. Instead, it moves around the box calmly exploring the environment, the bad memory of tone-plus-shock apparently erased, as though the whole unpleasant foot-shocking business never happened.

Weakening memories essentially erases them. (iStock)

The point of this research? If you can erase a memory in a rat brain, you should also be able to erase a memory in a human brain.

"The memories can become unstored and have to be restored. And when they're being restored, it's an opportunity to either strengthen them, change their content to possible false memories, or weaken them," Nader said. "And if you weaken them, essentially it's the same as erasing memories."

"The old view of memory processing was that our memories got stored in the brain and once they're stored, you can't touch them," Nader said. But scientists now realize that memories are evolving all the time. "Every time someone recalls a memory, it's a chance to change it," Nader added.

That's because the memory has to be restored using a biochemical pathway that is very similar to the original storage. And there are ways to interfere with this memory "reconsolidation" using a drug. "You have to change the strength of the connection between neurons. It's almost like you've unwired the memory," Nader said.

For some, the idea that memories are unstable is an unsettling concept. But Eric Kandel says understanding the biology of memory doesn't dehumanize it.

"This does not take the magic out of it," Kandel said. "You know that your heart is a muscular pump that pushes blood around the circulation, but that doesn't mean you can't lose your heart to somebody. The metaphorical meaning is not in any way altered, but there is a biological underpinning to what the brain actually does."

"The modern view is that everything you and I do, from the most simple reflex act of hitting a racket in tennis to the most creative flights of ideas, comes from the brain," Kandel said. He won the Nobel Prize in 2000 for his research on the biological basis of memory. "You are who you are and I am who I am because of what we learn and what we remember and these are all biological processes," he said.

It was a controversial concept when Karim Nader published his first scientific paper about interfering with memory, more than a decade ago. Back then, he faced many skeptics and he was surprised at the hostile the reaction.

Scientists explore the illusion of memory

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"Definitely," he said. "There was a huge shock and backlash. After years of scientific rigour and argument, I did manage to inspire a lot of the younger generation to at least test it. So very quickly after that it had been shown across species, across tasks, using different kinds of tools, so at that point it became impossible for anyone to say, 'this can't be real.' I mean it has to real, they find it in snails, they find it in humans, they find it in dogs."

Nader Karim believes memory disruption could be helpful in a wide range of psychiatric disorders.

Understanding memory could lead to treatments

Understanding the neurochemical process of memory opens up possibilities for therapy in situations where memory is causing pain.

"People think that post-traumatic stress disorder might be susceptible to treatments of this kind. No one has shown this in a convincing way. But this is certainly an interesting avenue of investigation," Kandel said.

"There are many disorders of memory. Obviously, age-related memory loss, Alzheimer's disease, schizophrenia, working memory loss, PTSD which is a hyperactivity of memory if you will," he explained.

Nader believes memory disruption could be helpful in a wide range of psychiatric disorders. He is collaborating with other researchers on drug addiction, and others are investigating the implications for obsessive compulsive disorder (OCD).

"So if you imagine OCD, what happens over time is somebody becomes more and more obsessive in a certain compulsion, then the neurons that contribute and maintain that behavior, they're going to undergo a reconsolidation process," Nader says.

"So every time they have another episode, that circuit controlling the compulsion is going to have to be hypothetically unstored and then restored. And so if you had a tool just to block that restorage process, then, in theory, what should happen is you should be able to make somebody better and go from their compulsive behavior to something relatively more normal."

Early research on post traumatic stress disorder has been encouraging, Nader said. In studies, subjects have been asked to remember the trauma, and then take a drug that has been shown to block memory reconsolidation, and that seems to reduce the strength of the traumatic memory to non-PTSD levels.

Researchers finding other ways to change memory

Other research has suggested that it might even be possible to block the memory reconsolidation without drugs, by asking a person to remember something and then, in those moments of remembering, replace the old memory with new information.

"The memory becomes unstored and during that time you just tell them a different kind of information is correct and you allow time for that other information to be restored. It's almost as if the new information, can, in some cases, replace the old information," Nader said.

"It's great theoretically, because you don't have to give anyone any kind of a drug," he said. "Every time you remember something, it's an opportunity to change the content of it, that's just the way the brain is."

Sitting in his McGill University lab, watching his rats calmly exploring the chamber they once feared, Karim Nader agrees that memory is much more transient than most people think.

"Yes, but that's not to say it's bad," he said. "The fact that memory turns out to be far from permanent is a positive thing for human survival. Evolution thinks it's the best way for it to work. Therefore, it's not a bad way. If it was a bad way, then we would have been extinct a while ago."

This is the conclusion of a four part series called Inside Your Brain on CBC's The National, World at Six and CBC.ca exploring how modern neuroscience is changing the way we think about the way we think.

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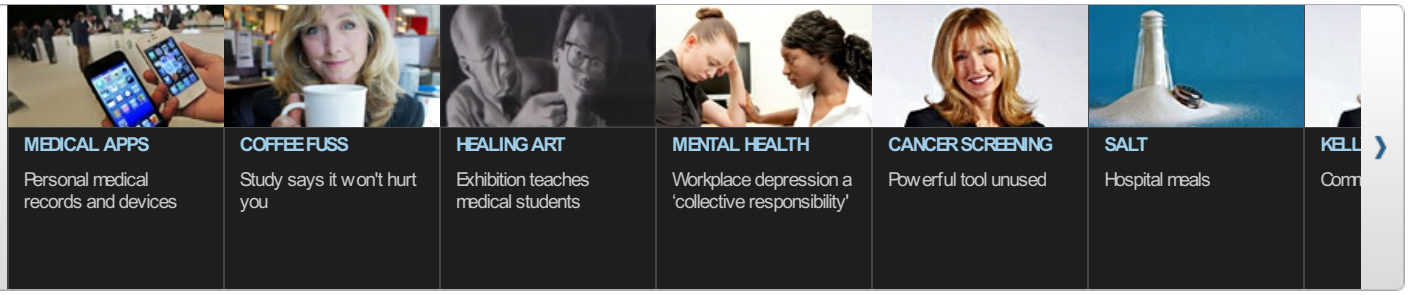

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