Mice Kept Memories After a Brain Connection Reset

A hibernation-like experiment challenges a simple idea of how the brain stores what it learns.

An abstract mouse and neuron network show brain connections disappearing and returning.

Researchers put mice into a hibernation-like state, watched more than half of certain brain connections disappear, and then found that the mice still seemed to remember what they had learned. According to reporting by Ars Technica on a recent study in Science, the experiment does not prove that scientists have misunderstood memory completely. But it does sharpen a puzzle at the center of neuroscience: if memories depend on physical connections in the brain, how can they survive when those connections are constantly changing?

The basic idea many scientists use is that learning changes **synapses**, the tiny junctions where one **neuron** passes signals to another neuron. When an animal learns something, the relevant synapses may become stronger, larger or more likely to pass along a signal. That sounds straightforward until another fact is added: synapses are plastic, meaning they can change, disappear or form again over time. A memory can last for years, but some of the brain's wiring can look different after only days. The tension is not whether the brain is physical; it is how a lasting experience can be stored in parts that do not stay fixed.

To push that problem, Kazumasa Tanaka of the Okinawa Institute of Science and Technology Graduate University and colleagues used an artificial hibernation-like condition in mice. Mice do not naturally hibernate in the wild, but mammals share a brain circuit that can trigger a deep slowdown. The researchers activated Q neurons, a population of nerve cells in the hypothalamus, a brain region involved in body regulation. The result is called Q-neuron-induced hypothermia and hypometabolism, or QIH: body temperature falls to about 20° Celsius, and heart rate and breathing slow sharply. In the experiments, mice stayed in this state for 48 hours and then woke up.

The researchers then looked at the hippocampus, a brain region important for memory and **navigation**. They recorded brain activity using **tetrodes**, which are bundles of fine **electrodes** that can detect individual neurons firing. Once the hibernation-like state began, activity dropped by about 70 percent. The team also used serial block-face scanning electron **microscopy**, an imaging method that takes extremely detailed pictures of tissue layer by layer. Those images showed that hibernation eliminated more than half of the synapses. If each memory depended on keeping the same set of synapses in the same condition, that should have caused serious damage to memory.

That is not what the behavioral tests showed. Before the hibernation-like period, mice had been trained on two memory tasks. In one, called **contextual** fear conditioning, an animal learns to associate a particular box with a mild electric shock. In another, a plus-maze task, the mouse learns how to find a reward. Both tasks depend on the hippocampus; the researchers confirmed that by damaging that region after training in some mice, which made the memories disappear. But mice that went through QIH and woke up performed about as well as mice that had not been placed into the hibernation-like state.

The brain recordings pointed in the same direction. Place cells, which are hippocampal neurons that fire when an animal is in a particular location, still fired in the same locations after the mice woke up. A decoder, a computer method that reads patterns in neural activity, could still reconstruct where a mouse was just as accurately as before. The synapses were not simply gone forever, either. When researchers watched the same **dendrites**, the branchlike parts of neurons that receive signals, over eight days, many vanished synapses reappeared after arousal. About 82 percent came back at the same spot on the same dendrite, much more often than random chance would predict.

The study also found that not all memory-linked synapses behaved the same way. The researchers used a method called eGRASP, which makes a connection glow green when two neurons involved in the same learning event connect. These memory-linked connections are called **engram** synapses; an engram is the physical trace of a memory in the brain. Engram synapses that sat alone on a dendrite were often lost during hibernation. Engram synapses packed into tight **clusters** were more likely to survive. Some of those clusters connected through multisynaptic boutons, rare structures where one sending terminal connects with more than one receiving spine. Why clustering offers protection is still unknown; Tanaka said, “Mechanism-wise, we don’t know.”

The trade-off in interpreting the study is important. One tempting conclusion is that memories are not stored in individual synapses at all. Another is more cautious: memories may depend on larger patterns, protected clusters, or instructions that allow the brain to rebuild key connections in the same places. The experiment was done in mice, with specific tasks, during an artificial hibernation-like state, so it should not be stretched into claims about human memory loss or perfect brain backup systems. Still, it forces a harder question than the old model did. Maybe memory is not a photograph preserved unchanged, but a structure that can survive partial disassembly because the brain knows how to put enough of it back together.

Written from reporting by Ars Technica.

THINK IT THROUGH

1. If memories can survive after many synapses disappear and return, should scientists change the basic model of memory storage, or treat this as an exception that still fits the model?

> **A strong answer:** A strong answer should weigh the evidence from behavior, brain recordings and synapse regrowth against the limits of one mouse experiment.

2. What is the danger of explaining memory with a simple metaphor, such as a file saved on a computer or a photograph stored in an album?

> **A strong answer:** A strong answer should discuss how metaphors can clarify an idea while hiding the brain's plastic, rebuilding nature.

3. If future research showed that clustered connections protect memories, how might that change the questions scientists ask about learning or memory loss?

> **A strong answer:** A strong answer should connect the finding to new priorities, such as studying patterns of connections rather than only individual synapses.

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O	N	F	E	R	T	D	H	E	D	M	D	R	I	S	N	H	D
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CLUSTERS CONTEXTUAL DENDRITES ELECTRODES ENGRAM

MICROSCOPY NAVIGATION NEURON SYNAPSES TETRODES

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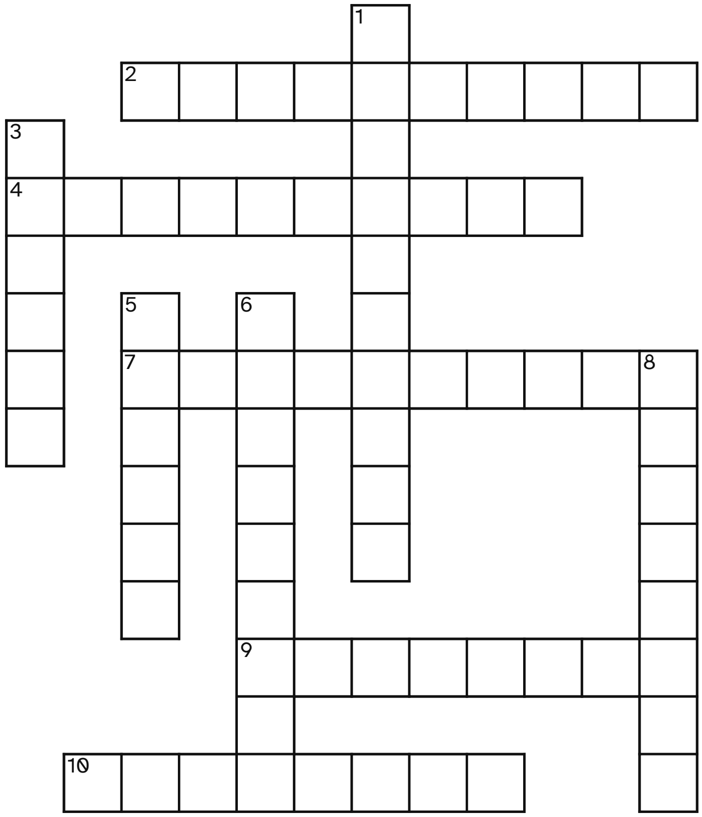

ACROSS

2 Technique using special tools to see extremely tiny structures

4 Finding a route or locating a place in space

7 Conducting devices that detect or deliver _______ signals in tissue.

9 Four-wire bundles for recording single-cell firing

10 Closely packed groups of connections

DOWN

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3 Brain's physical record of a past experience

5 Nerve cell that receives and sends information

6 Branching signal-receiving extensions of nerve cells

8 Tiny gaps where nerve cells pass messages

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— answer key

O	N	F	E	R	T	D	H	E	D	M	D	R	I	S	N	H	D
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R	I	I	E	T	E	T	X	S	A	C	S	A	N	R	E	A	N
C	T	C	L	E	E	L	E	C	T	R	O	D	E	S	R	H	T
T	O	H	D	O	N	T	E	T	R	O	D	E	S	N	C	O	S
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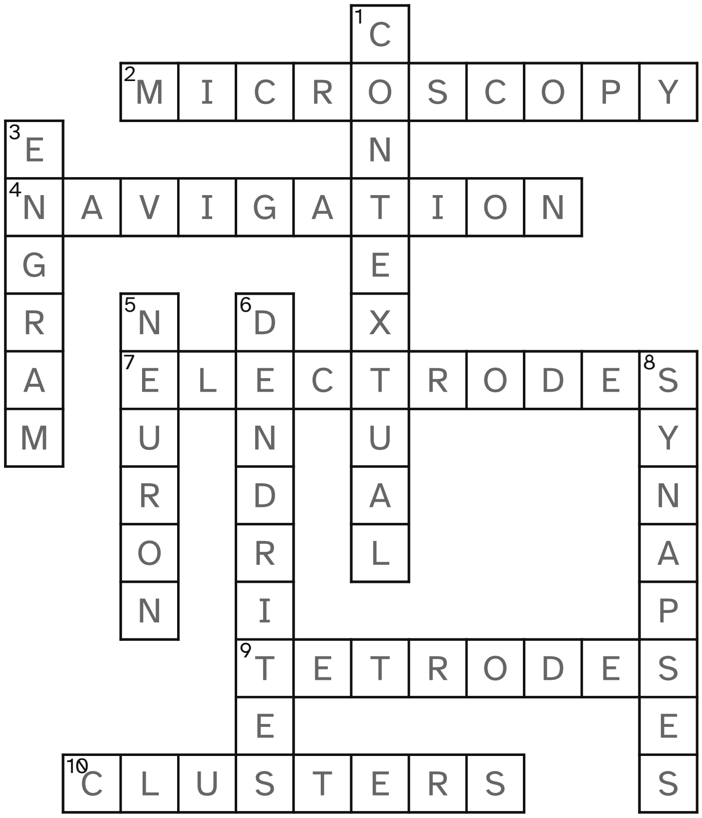

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Where this came from

This article was written for 3andB from the reporting below. It is not a reprint — the wording is ours and the facts are theirs.

Ars Technica

"Putting mice into hibernation causes a major loss of synapses"

Published	Saturday, August 22, 2026
Read by us on	Friday, August 21, 2026

https://arstechnica.com/science/2026/08/memories-stick-around-even-after-half-the-synapses-are-gone/

WHAT IS IN THIS PACKET

The article with a note on each question, a word search, a crossword, and the answer key to both.

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