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Speeding up long-term memory

Svenja Brodt uses MRI brain scans to investigate how impressions become memories. A better understanding of how long-term memories are formed could help Alzheimer's patients cope with their daily lives. Impaired memory formation could be compensated for by targeted repetition.

Why can many people with dementia vividly remember their way to school as children, yet have trouble finding their current home? To understand this, it is useful to take a look at the healthy brain first. Imagine meeting a new neighbor in the hallway: the information about their face first reaches the hippocampus. This working memory, located deep within the brain, then forwards the content to its permanent storage location: the cerebral cortex. Subsequently, the hippocampus repeats this process many times, until the neighbor's appearance is firmly anchored in memory. This happens unconsciously and typically during sleep.

This mechanism is precisely what is disrupted in Alzheimer's patients. Even in the early stages of the disease, their ability to form new, lasting memories begins to decline. This occurs because nerve cells in the hippocampus degenerate. While in theory the neocortex can still absorb new information, it lacks the continuous reactivation provided by the hippocampus. As a consequence, patients may forget important appointments, rely on memos to navigate daily life, or become unable to find their way around their own home.

Making memories visible

But there is also some good news: the hippocampus may not be as essential for memory consolidation as previously believed. Under the right conditions, the cerebral cortex can also quickly learn on its own, as Svenja Brodt, a research group leader at the Max Planck Institute for Biological Cybernetics, proved in several studies using magnetic resonance imaging (MRI). This noninvasive imaging technique can highlight regions of the brain that are currently consuming more oxygen—the particularly active areas. This allows researchers to see which neural circuits are activated by a stimulus.

“We asked healthy test subjects to memorize images. Shortly after, we had them actively repeat what they had learned,” Brodt explains her approach. “During the learning phase, we observed increased activity in the neocortex on the MRI scans.” This suggests that the long-term memory appears to take shape already very early, during active learning. A slightly different MRI method can reveal lasting structural changes in the brain: “After only one hour, we were able to detect changes in the microstructure which indicate that the image had been stored,” Brodt continues. “Even hours later these changes are still present.” In other words: through repetition, the cerebral cortex can learn quickly and may be able to bypass the lengthy automated training provided by the hippocampus.

From the photo camera straight to the cerebral cortex

This mechanism suggests strategies that may help people with Alzheimer's maintain their independence for a longer time: when patients rehearse new information after a few hours, they reactivate its trace in the brain. Some people with dementia already use so-called lifelogging devices such as wearable cameras that automatically take photos throughout the day. Looking at the pictures, patients memorize the information they contain. Thus, lifelogging not only compensates for declining memory performance, but actually stimulates it.

Next, Brodt plans to investigate the conditions for rapid memory formation in the cerebral cortex in more detail. This includes determining how often and exactly when stored knowledge should be reactivated. “It also remains to be seen how memories formed in this way differ from ‘normal’ memories,” says Brodt. “How stable and accurate are they? Can we connect them well to other information?”

One thing is already certain: rapid memory formation works for different types of information. Little does it matter whether we try to remember our new neighbor’s face or name; in either case we can create lasting memories through active repetition, possibly even when we can no longer rely on the hippocampus.

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Further information

- Max Planck Institute for Biological Cybernetics