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Sleep frees up the hippocampus for new memories

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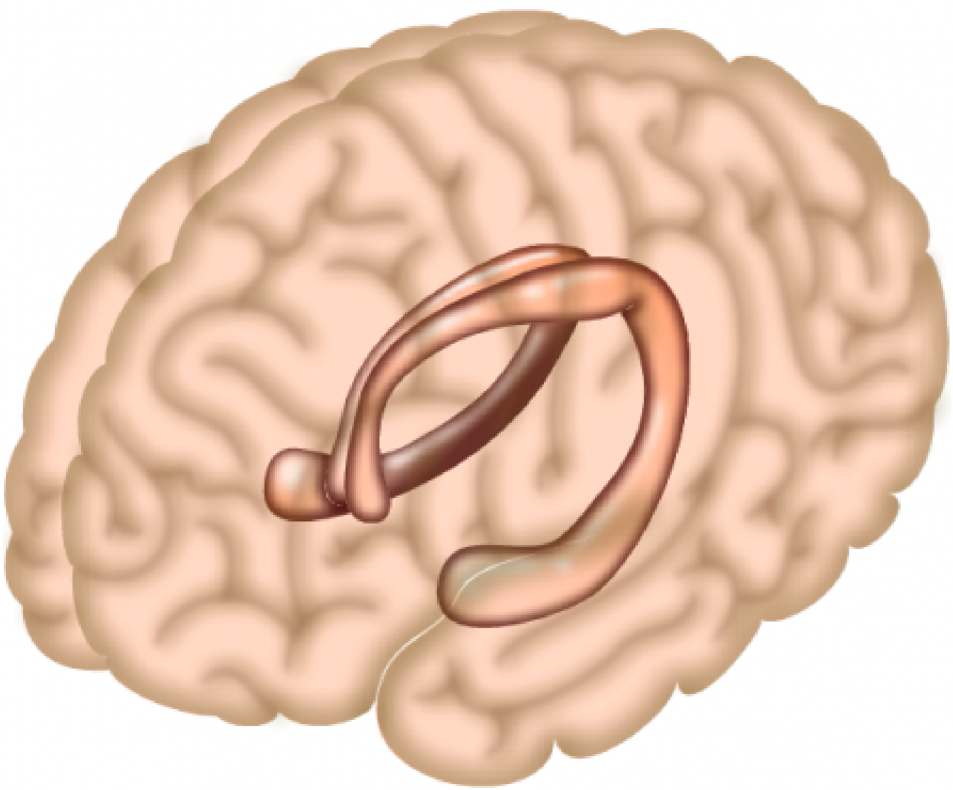

The hippocampus is a region of the brain largely responsible for memory formation. Credit: Salk Institute

Two regions of our brain are central for storing memories: the hippocampus and the neocortex. While the hippocampus is primarily responsible for learning new information and its short-term storage, the neocortex is able to store large amounts of information for a long time. Lea Himmer, Dr. Monika Schönauer and Professor Steffen Gais of the Institute of Medical Psychology at the University of Tübingen and their team investigated how these brain areas interact during the consolidation of new memories and which role sleep plays in that process. The team of researchers used functional neuroimaging to show that repeated rehearsal can lead to the establishment of memory traces in the neocortex within a short timeframe. However, these traces are only sufficiently stable if a sleep phase follows learning – otherwise the brain continuously needs to call on the hippocampus to help with long-term storage of new memories. The new study is published in *Science Advances*.

In this new study, the researchers had their participants study a list of words, which was repeated seven times. While they conducted this task, their brain activity was recorded by an MRI scanner. Twelve hours later, the participants repeated the task with the learned words and a new word list. Half of the subjects had slept in the meantime, while the other half had remained awake. Repeated practice led to increased involvement of the posterior parietal cortex, a region of the neocortex, within an hour. At the same time, the hippocampus became less and less engaged in the process.

Fast formation of memory traces

"This pattern indicates a swift formation of memory traces in the neocortex," Monika Schönauer says. "Furthermore, the parietal cortex shows stronger activity for previously-learned words compared to new words even after twelve hours, which indicates that these memory traces are long-term stable." However, the hippocampus remained uninvolved only if participants slept for several hours after the first learning session. If they stayed awake, the hippocampus was still needed – for the words learned earlier as much as for the new words. "Our findings show that memory processes during sleep go beyond mere repetition. Repeatedly rehearsing material can create long-term memory traces. But in order to permanently store that material independently of the hippocampus sleep is crucial," says Lea Himmer.

In the experiment, sleep mainly had an effect on the hippocampus. "How the hippocampus and the neocortex interact still is not well understood," says Steffen Gais, head of the working group. "Investigating this interaction is an important step in the development of current theories of memory formation and consolidation." Identifying the conditions under which memory can be directly stored in the neocortex and the role of the hippocampus in this process is also important for understanding the fundamental mechanisms of learning and memory disorders, he adds.

More information: L. Himmer et al. Rehearsal initiates systems memory consolidation, sleep makes it last, *Science Advances* (2019). DOI: 10.1126/sciadv.aav1695

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