Memory can be strengthened by unrelated experiences, study finds

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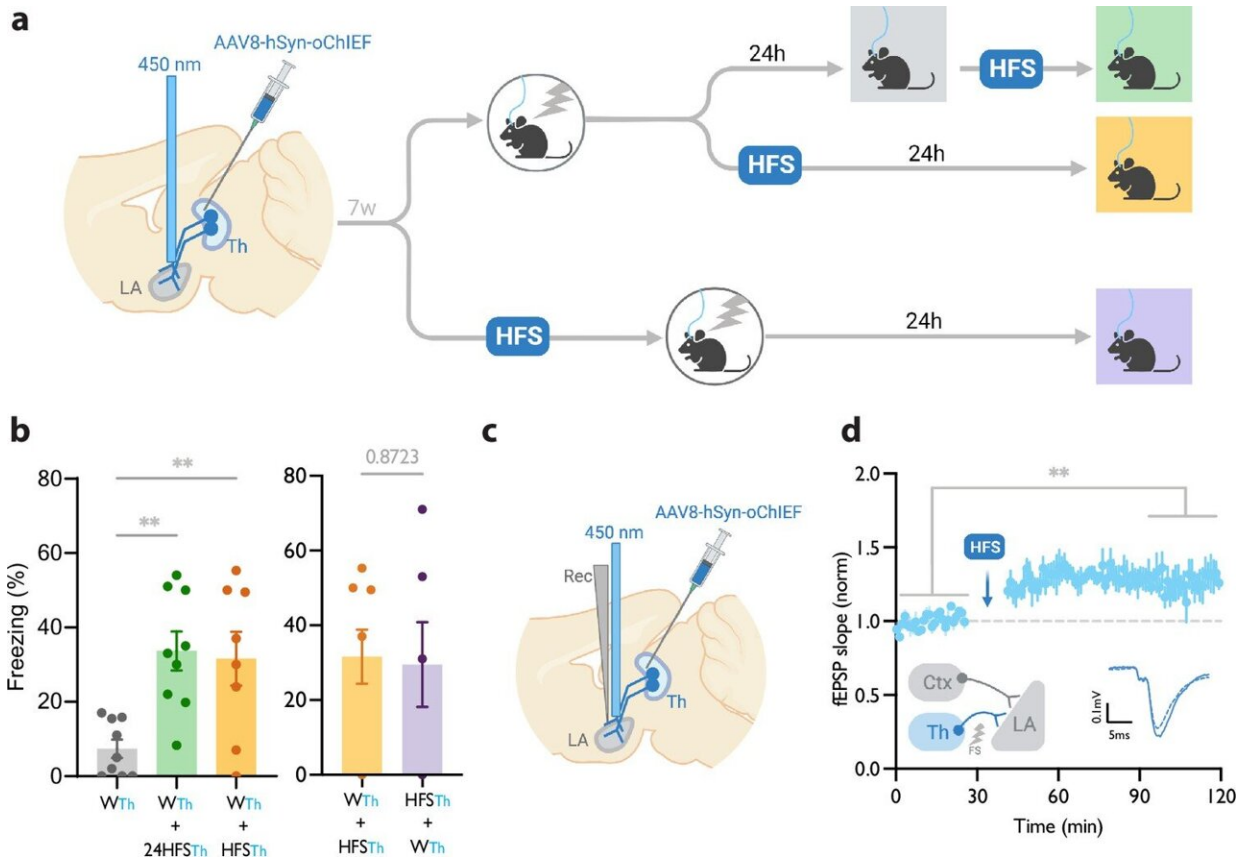

Homosynaptic long-term potentiation (LTP) stimulus minutes before, after, or 24 hr after a weak associative conditioning produces lasting memory. Credit: *eLife* (2023). DOI: 10.7554/eLife.91421

There is a legend that many hundreds of years ago—long before printing

presses, computers, or telephones existed—a special method was used to remember significant events, such as land transfers, crucial agreements, or weddings. According to the legend, a child was chosen to witness the event and immediately thrown into a river. This extreme combination of events was believed to ensure that the child would never forget that specific event.

But why might such a method have worked? Although this historical method may seem extreme, our ancestors may have been onto something crucial: When an event is combined with a strong emotional reaction, it becomes easier to remember.

For a long time, researchers have been able to offer a specific explanation for why some events are stored in our long-term memory while others are not. However, learning and memory may not be as straightforward as once thought. New research from DANDRITE shows that experiences that are not directly relevant to a memory can still impact the strength of that memory, paving the way for the development of entirely new memory-focused learning tools.

New research expands the dominant memory model

Traditionally, learning and memory formation have been explained by the Hebbian model, which suggests that synapses in the brain are strengthened through repeated simultaneous activation of neurons. This means that when two neurons are repeatedly activated, the connection between them becomes stronger—what we call "synaptic plasticity." According to Hebb's rule ("neurons that fire together, wire together,") this process is strictly input-specific and depends on both neurons being activated simultaneously.

However, new research from Sadegh Nabavi's lab at DANDRITE shows that learning and memory are not so simple.

Synaptic plasticity is not necessarily limited to simultaneous activation at specific synapses. Synaptic changes can occur at nearby synapses that were not directly activated during the original experience—a process known as "heterosynaptic plasticity."

In a recent article in the journal *eLife*, researchers from DANDRITE demonstrate that memory can also be strengthened through subsequent, non-related experiences—if they evoke a strong response. This means that the process of turning a fleeting experience into a lasting memory is not confined to the time when the experience occurred or to the specific synapses that were activated. Instead, this process can be influenced by both past and future events, with delays of up to a day.

This contrasts with the Hebbian model, which focuses on the simultaneous activation of neurons as the primary mechanism for learning and memory formation.

Paving the way for new learning technologies

These new insights provide a deeper understanding of how we can address cognitive functions and memory-related disorders. By gaining a more precise knowledge of how weak memories are strengthened, innovative therapies can be developed to enhance memory and learning in individuals with cognitive challenges.

If we return to the legend from the beginning, we see that our ancestors were ahead of their time in understanding memory. Their method, although extreme, reflects an early insight into how strong experiences can enhance memory—something we are now beginning to understand on a more scientific level.

More information: Islam Faress et al, Non-Hebbian plasticity transforms transient experiences into lasting memories, *eLife* (2024).

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