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Emotion and scent create lasting memories -- even in a sleeping brain

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When French memoirist Marcel Proust dipped a pastry into his tea, the distinctive scent it produced suddenly opened the flood gates of his memory.

In a series of experiments with sleeping mice, researchers at the Duke University Medical Center have shown that the part of the brain that processes scents is indeed a key part of forming long-term memories, especially involving other individuals.

"We can all relate to the experience of walking into a room and smelling something that sparks a vivid, emotional memory about a family member from years or even decades ago," says Stephen Shea, Ph.D., the lead author of the study published in *The Journal of Neuroscience*. "This research sought to understand that phenomenon on a cellular level."

The researchers examined how strong memories are formed by creating new memories in the minds of mice while under sedation and monitoring their response to a memory-inducing stimulus afterwards, when they were awake.

"Our work is unique because it allows us to examine the cellular make-up of a memory, evaluate how the neurons change when a memory is formed and learn how that memory affects behavior," Shea adds.

The researchers created memories by stimulating the release of noradrenaline, a chemical present in the body during strong emotional

events ranging from excitement to fear.

Previous studies have established a link between noradrenaline and the formation of enduring memories, especially during intense social events such as mating and childbirth. In mice and humans, the presence of noradrenaline also creates changes in the odor processing center of the brain, called the olfactory bulb.

"When an animal forms a strong memory about another, it is reliant on odor cues and noradrenaline. Both need to be present at the same time in order for the memory to be formed," Shea says. "Long-term memories created under these conditions often result in a permanent change in behavior."

The Duke team administered anesthesia to a mouse and stimulated the release of noradrenaline with an electrode while wafting the scent of either food or the urine of another mouse under the nose.

"We wanted to see if these two elements – noradrenaline and odor – present at the same time were the key ingredients needed in the recipe for creation of memory – this is a concept that had not been directly tested before this study," Shea says. "In essence, we recreated the chemical reaction that would occur when the mouse experiences a social event, such as giving birth," Shea says.

Researchers knew they could observe brain activity in more detail when the mouse was under anesthesia. If awake, the mouse would be forming memories from the surrounding environment. "When the animal is asleep, you can watch neurons in the brain rewire to store a memory and once awake see what the mouse learned even though it was asleep when the memory was created."

What they saw was an approximate 40 percent reduction in neuron

activation after triggering the noradrenaline release – suggesting that a memory of the odor had been formed.

A day later, after the mouse was awake, the team observed changes in behavior in response to the scents, showing that they remembered the smells from when they were asleep.

"This work may have implications for furthering our understanding of how long-lasting memories are formed that are important to social bonding," says Richard Mooney, Ph.D., co-author and associate professor of neurobiology.

Source: Duke University