In learning, the brain forgets things on purpose

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Scientists have known that newly acquired, short-term memories are often fleeting. But a new study in flies suggests that kind of forgetfulness doesn't just happen. Rather, an active process of erasing memories may in some ways be as important as the ability to lay down new memories, say researchers who report their findings in the February 19th issue of the journal *Cell*.

"Learning activates the biochemical formation of memory," says Yi Zhong of Tsinghua University and Cold Spring Harbor Laboratory. "But you need to remove memories for new information to come in. We've found that forgetting is an active process to remove memory."

The researchers have traced that process to a molecular pathway including a small protein known as Rac. When that mechanism is blocked, flies hold on to newly acquired memories for longer than they otherwise would.

At the psychological level, scientists have debated about the reasons we forget. One theory held that new memories are simply unstable and evaporate over time. On the other hand, some thought that interference caused earlier short-term memories to be overridden as new information comes in.

Now it appears that those competing notions are, at the molecular level at least, one and the same.

Zhong's team made their discovery by training flies with two aversive odors. To add to the aversion with one of the two odors, the researchers delivered a foot shock to the insects as they smelled it. That education normally leads flies to avoid the odor associated with a shock in favor of the alternative.

In the first set of experiments, the researchers simply left the flies alone after their training session was over and then tested them at particular time points as their memory weakened. In a second experiment, the researchers interfered with the new memories by exposing flies to a new pair of odors. Finally, they reversed the flies' lesson by delivering the foot shock in conjunction with the opposite odor.

In all cases, the flies forgot what they learned after some period of time in a process driven by Rac. Rac switches on when flies simply forget with the passage of time, they report. It just switches on faster when the insects either get distracted by new information or "confused" by conflicting experiences.
When Rac was blocked, new memories decayed more slowly, extending their life from a few hours to more than a day. When Rac levels were artificially increased in fly neurons, the insects' new memories were erased more rapidly.

The findings open up a whole new avenue of study in neuroscience of the process of forgetting, Zhong said. Ironically, this line of exploration may turn out to reveal much about how memories are made.

"We still don't really understand the substrate of memory in terms of what is formed and what is erased," Zhong said. "The study of forgetting may be a better way to identify the material basis of memory."

He suspects the forgetting mechanism uncovered in flies will apply to other organisms, noting that there are already some hints in that direction in mice. Intriguingly, mutations in other players in the Rac pathway have also been linked to mental retardation in humans, he said.

More information: "Forgetting Is Regulated through Rac Activity in Drosophila" appears online ahead of print in *Cell* February 19. The authors are: Yichun Shuai, Binyan Lu, Ying Hu, Lianzhang Wang, Kan Sun and Yi Zhong. The paper is available online at: DOI 10.1016/j.cell.2009.12.044

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