How curiosity changes the brain to enhance learning

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Credit: Rice University

The more curious we are about a topic, the easier it is to learn information about that topic. New research publishing online October 2 in the Cell Press journal *Neuron* provides insights into what happens in our brains when curiosity is piqued. The findings could help scientists find ways to enhance overall learning and memory in both healthy individuals and those with neurological conditions.

"Our findings potentially have far-reaching implications for the public because they reveal insights into how a form of intrinsic motivation—curiosity—affects memory. These findings suggest ways to enhance learning in the classroom and other settings," says lead author Dr. Matthias Gruber, of University of California at Davis.

For the study, participants rated their curiosity to learn the answers to a series of trivia questions. When they were later presented with a selected trivia question, there was a 14 second delay before the answer was provided, during which time the participants were shown a picture of a neutral, unrelated face. Afterwards, participants performed a surprise recognition memory test for the faces that were presented, followed by a memory test for the answers to the trivia questions. During certain parts of the study, participants had their brains scanned via functional magnetic resonance imaging.

The study revealed three major findings. First, as expected, when people were highly curious to find out the answer to a question, they were better at learning that information. More surprising, however, was that once their curiosity was aroused, they showed better learning of entirely unrelated information (face recognition) that they encountered but were not necessarily curious about. People were also better able to retain the information learned during a curious state across a 24-hour delay. "Curiosity may put the brain in a state that allows it to learn and retain any kind of information, like a vortex that sucks in what you are motivated to learn, and also everything around it," explains Dr. Gruber.

Second, the investigators found that when curiosity is stimulated, there is increased activity in the brain circuit related to reward. "We showed that intrinsic motivation actually recruits the very same brain areas that are heavily involved in tangible, extrinsic motivation," says Dr. Gruber. This reward circuit relies on dopamine, a chemical messenger that relays messages between neurons.

Third, the team discovered that when curiosity motivated learning, there was increased activity in the hippocampus, a brain region that is important for forming new memories, as well as increased interactions between the hippocampus and the reward circuit. "So curiosity recruits the reward system, and interactions between the reward system and the hippocampus seem to put the brain in a state in which you are more likely to learn and retain information, even if that information is not of particular interest or importance," explains principal investigator Dr. Charan Ranganath, also of UC Davis.

The findings could have implications for medicine and beyond. For example, the brain circuits that rely on dopamine tend to decline in function as people get older, or sooner in people with neurological conditions. Understanding the relationship between motivation and memory could therefore stimulate new efforts to improve memory in the healthy elderly and to develop new approaches for treating patients with disorders that affect memory. And in the classroom or workplace, learning what might be considered boring material could be enhanced if teachers or managers are able to harness the power of students' and workers' curiosity about something they are naturally motivated to learn.

More information: *Neuron*, Gruber et al.: "States of curiosity modulate hippocampus-dependent learning via the dopaminergic circuit." www.cell.com/neuron/abstract/S0896-6273(14)00804-6

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