Study finds brain locale of metamemory in macaque monkeys

January 16 2017, by Bob Yirka

Retrospection: self-reflection of one's own past

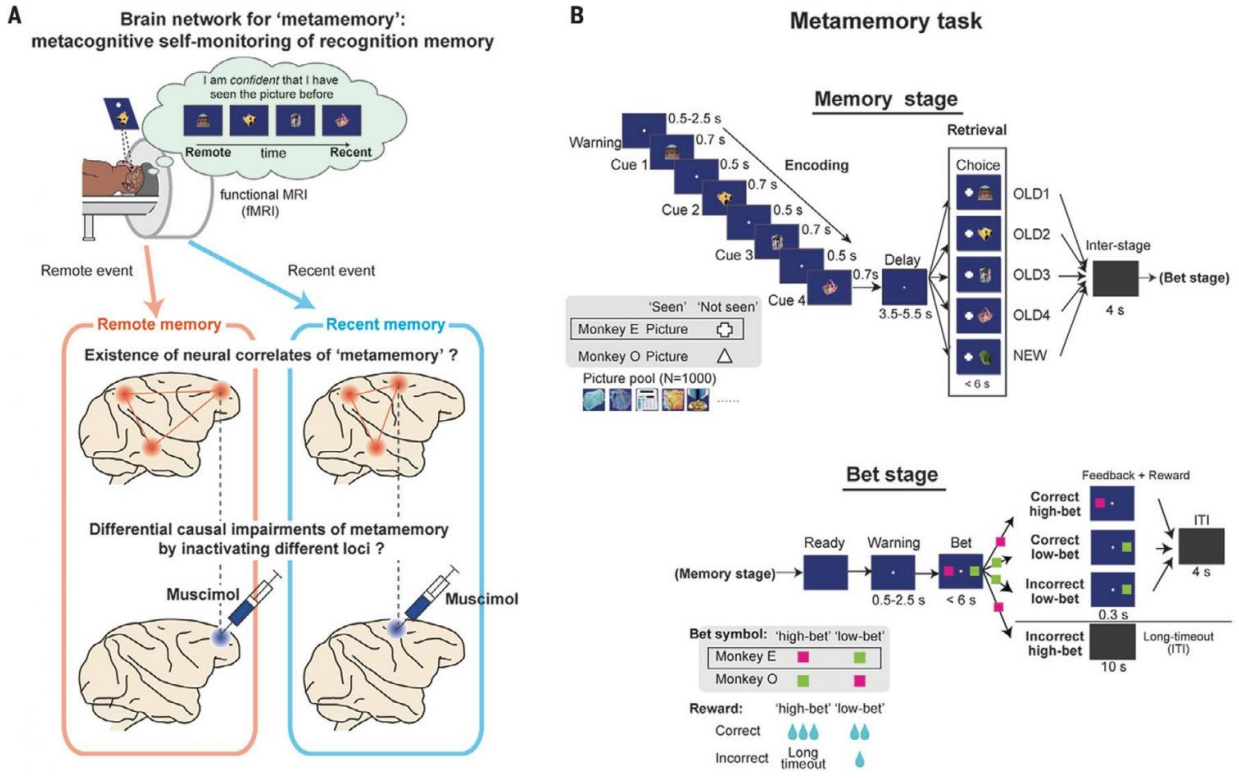
Retrospection: Self-reflection of one's own past. Credit: Yasushi Miyashita

(Phys.org)—A team of researchers with the University of Tokyo School of Medicine has found strong evidence for the location in the brain of metamemory in macaque monkeys. In their paper published in the journal *Science*, the team describes their three-pronged approach to search for the location and what they found.

Metamemory is the ability to gauge how strongly someone believes they remember something. After cooking and eating dinner, for example, how much confidence do you have that you turned off the oven? That moment when you search your memory and then make a judgment on how strongly you feel about your degree of recall is your metamemory at work. Until recently, many scientists believed that only humans had metamemory, but subsequent studies have shown that other primates have it, as do some birds and rodents. But until now, it was not known where in the brain metamemory takes place. To find out, the researchers devised a three-pronged approach.

The first part of their study involved teaching a group of macaque monkeys to play a memory game—the monkeys were rewarded with differing amounts of juice based on how confidently they remembered images they had been shown earlier and if they were correct.

The second step involved having the monkeys play the same game while inside of an MRI machine and watching which parts of the brain lit up. Doing so allowed the researchers to discern a pattern of lighting up in a region of the prefrontal brain.



Experimental design and metamemory task. Whole-brain functional localization of metamemory networks for "remote" and "recent" events via functional magnetic resonance imaging (fMRI) and behavioral reversible inactivation with a GABA-A receptor agonist (muscimol) in macaque monkeys performing a metamemory task. Credit: Courtesy of *Science*

Realizing that brain portions lighting up does not always prove that an area of the brain is actually involved in a given activity, the researchers embarked on the third step, numbing the part of the brain in the monkeys that lit up in the MRI machine and then seeing if it impacted their ability to play the memory game. The researchers report that it did, disabling the same part of the prefrontal brain reduced their confidence in their ability to recall a memory, though doing so did not reduce their ability to build new memories or to recall those they already had.

The researchers suggest their research might be broadened to the study of metamemory in other animals and perhaps even in humans—and their approach could possibly be applied to other brain functions such as judging how strongly a person or animals feels about the strength of an emotion.

More information: Kentaro Miyamoto et al. Causal neural network of metamemory for retrospection in primates, *Science* (2017). DOI: 10.1126/science.aal0162

Abstract
We know how confidently we know: Metacognitive self-monitoring of memory states, so-called "metamemory," enables strategic and efficient information collection based on past experiences. However, it is unknown how metamemory is implemented in the brain. We explored causal neural mechanism of metamemory in macaque monkeys performing metacognitive confidence judgments on memory. By whole-brain searches via functional magnetic resonance imaging, we discovered a neural correlate of metamemory for temporally remote events in prefrontal area 9 (or 9/46d), along with that for recent events within area 6. Reversible inactivation of each of these identified loci induced doubly dissociated selective impairments in metacognitive judgment performance on remote or recent memory, without impairing recognition performance itself. The findings reveal that parallel metamemory streams supervise recognition networks for remote and recent memory, without contributing to recognition itself.