Researchers illuminate the gap between experience and association

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(Medical Xpress) -- In the moments after lightning streaks through the sky, we wait for the clap of thunder that experience has told us is likely to follow. In a finding that may have implications for treating Alzheimer's disease, researchers at the RIKEN-MIT Center for Neural Circuit Genetics in the Picower Institute for Learning and Memory at MIT report in the Dec. 9 issue of *Science* that they have identified for the first time the part of the brain responsible for that delayed association.

The entorhinal cortex, or EC, is one of the first brain areas affected in Alzheimer's disease. Interestingly, early onset Alzheimer's affects performance in memory tasks with a delay between learning and recalling items. "Our findings provide new insights into how patients with Alzheimer's disease develop deficits in working memory with consequent failure of the formation of episodic memory," said study co-author Junghyup Suh, research scientist at the Picower Institute. " In addition, by identifying the circuits responsible for the cognitive deficits in human patients with the disease, we begin to lay a potential framework for selective therapeutic intervention in Alzheimer's disease."

Anticipating thunder after seeing lightning or a bee sting after hearing a buzzing insect is called temporal association because the first sensory experience is separated from its associated experience by a short gap in time.

RIKEN-MIT Center researchers found that inputs from a part of the brain called the EC layer III to the hippocampus, the seahorse-shaped part of the brain responsible for memory formation and retrieval, are crucial for temporal associations. “This study shows for the first time that the EC is important for processing non-spatial information such as a time element of episodic memory,” Suh said. The research was conducted in the laboratory of Susumu Tonegawa, Picower Professor of Biology and Neuroscience at the Picower Institute. In addition to Suh, study authors include Picower Institute postdoctoral associate Alexander J. Rivest; Toshiaki Nakashiba, research scientist; Takashi Tominaga of Tokushima Bunri University in Japan; and Susumu Tonegawa, Picower Professor of Neuroscience at the Picower Institute.

The EC acts as an interface between the hippocampus and the neocortex. The EC is thought to play a role in retrieving and consolidating spatial memories and in fine-tuning place cells in the hippocampus. Previous research outside of MIT had found that different kinds of cells in the EC are tied to where an animal is in space, suggesting the EC relays spatial information to the hippocampus. In addition, studies have shown that certain cells in the EC can fire continuously for tens of seconds; this type of persistent firing can help maintain sensory information (such as buzzing and lightning) through time in absence of sensory inputs.

“This study is among the first to examine the interactions between the hippocampus and its adjacent cortical areas in cognitive processes using genetic tools with great temporal and spatial specificity,” Suh said. “It also opens the door to future research with regard to how the hippocampus and EC communicate, process information and guide behaviors.”

Provided by Massachusetts Institute of Technology

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