A New Look at How Memory and Spatial Cognition are Related

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In a study that sheds new light on how memory and spatial cognition are related to each other in the brain, researchers at the University of California, San Diego School of Medicine and the Veteran Affairs (VA) San Diego Healthcare System studied memory-impaired patients as they navigated their environment.

Path integration, or the ability of the brain to compute the distance and direction of a traveled path, is an important aspect of spatial cognition – an ability long-thought to be dependent on the medial temporal lobe structures of the brain.

However, the researchers discovered that the hippocampus and entorhinal cortex – two major medial temporal lobe structures – are not essential for path integration. Their findings will be published in the early on line edition of *Proceedings of the National Academy of Sciences (PNAS)* the week of August 4.

The study, led by Larry R. Squire, Ph.D., professor of psychiatry, neurosciences and psychology at UCSD School of Medicine and research career scientist at the VA San Diego Healthcare System, was designed to measure whether these structures of the brain are essential for spatial cognition.

"For decades, the medial temporal lobe structures have been linked to both memory and spatial cognition," said Squire. One important aspect of spatial cognition is keeping track of a reference location during movement by using internal cues, Squire explained, yet such tracking also relies on memory. "So we set out to test how these two abilities related to one another and to the temporal lobe area of the brain."

The researchers looked at five memory-impaired patients with lesions of the medial temporal lobe along with seven matched controls, testing each for their path integration ability. Participants, who were blindfolded and wore noise-canceling earphones, were led by researchers on 16 paths and asked to keep their starting point in mind. After walking the path, participants were asked to point to their start location.

Due to their lesions, the five patients all had long-term memory impairment, so the paths were short enough that the task could be performed within the span of their working, or short-term, memory. Building on the idea that working memory is independent of the medial temporal lobe, the researchers theorized that these patients should succeed at the task if performed within the span of their short-term memory, unless this section of the brain was also necessary for spatial cognition.

The memory-impaired patients pointed to and estimated their distance from the start location as accurately as the controls.

"We concluded that the hippocampus and entorhinal cortex are not essential for path integration, since we showed that the tests could be successfully accomplished despite damage to these brain regions," said Squire.

Co-authors Yael Shrager, UCSD Department of Neurosciences, and C. Brock Kirwan, UCSD Department of Psychiatry, also contributed to this study, which was supported by the Medical Research Service of the Department of Veterans Affairs, the National Institute of Mental Health, the Metropolitan Life Foundation and a National Science Foundation pre-doctoral fellowship.

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