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Brain's hippocampus is essential structure for all aspects of recognition memory

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The hippocampus, a brain structure known to play a role in memory and spatial navigation, is essential to one's ability to recognize previously encountered events, objects, or people - a phenomenon known as recognition memory - according to new research from the departments of Neurosurgery and Psychology in the Perelman School of Medicine at the University of Pennsylvania. Their work is published in *PNAS*.

Recognition memory is composed of two processes: recollection, or recognizing something along with vivid details of the initial encounter; and familiarity, a general sense of having previously encountered something. These processes often break down as a result of aging, neurodegenerative disorders (e.g. Alzheimer's disease), or traumatic brain injury, and the new findings provide a roadmap to examine strategies to improve these functions.

"There has been a longstanding debate in the field of recognition memory about how the human hippocampus contributes to our ability to recognize," said lead author Maxwell Merkow, MD, Neurosurgery Chief Resident at the Hospital of the University of Pennsylvania. "One segment of the scientific literature contends that neural activity in the hippocampus only contributes to recollection, whereas some believe hippocampal activity supports both recollection and familiarity. Our study aimed to get to the bottom of this."

The Penn team hypothesized that the hippocampus supported both recollection and familiarity, the twin processes believed to underlie

recognition memory. Showing a clear link between hippocampal activity and recognition memory performance in general has previously proven elusive, having been documented in just a few earlier studies. This paper is the first to also record a link between hippocampal activity and both the processes of recollection and familiarity.

Merkow and colleagues studied 66 patients who were already undergoing intracranial monitoring of their hippocampus for epilepsy. Using these direct electrical recordings, the team was able to test the level of high frequency neuronal activity (a marker of neurons firing) in this region, a very precise measure which captures activity tied to cognition processes lasting mere hundreds of milliseconds.

The team administered a memory task in which participants were shown and asked to remember a series of words. Patients were then tested by being shown a second series of words, some of which they had seen before, and some that were new. Patients had to determine whether or not each word had been part of the group they had learned initially. While all of this was going on, the team recorded electrical data directly from the patient's hippocampus.

They found elevated high frequency activity during those trials in which the patient correctly identified a word they had previously seen. This was opposed to lower activity during trials where they either failed to recognize an old word or in which they saw a new word, whether or not they correctly identified it as new.

Another major finding was that the strength of hippocampal activity predicted behavioral performance, thereby directly linking the hippocampus to recognition memory. Crucially, both the recollection and familiarity components of recognition correlated with hippocampal activity. These data show that the cognitive processes we use for recognition memory are both supported by actions within the

hippocampus.

"This work directly addresses the issue of where in the brain recognition takes place," Merkow said. "We now need to focus our efforts on how these processes occur." The team plans to use the same high frequency recordings from smaller electrodes to answer this question. This work brings science one step closer to understanding how brain activity supports memory and potentially improving memory through future interventions.

More information: Maxwell B. Merkow et al. The human hippocampus contributes to both the recollection and familiarity components of recognition memory, *Proceedings of the National Academy of Sciences* (2015). DOI: 10.1073/pnas.1513145112

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