Memory task-specific encoding by neuronal networks in the human hippocampus

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Winner of the Philip L. Gildenberg S&F Resident Award, Mark R. Witcher, MD, presented his research, "Memory Task-specific Encoding by Neuronal Networks in the Human Hippocampus," during the 2015 American Association of Neurological Surgeons (AANS) Annual Scientific Meeting. Witcher is the neurosurgery chief resident at Wake Forest Baptist Medical Center.

Epilepsy patients undergoing intracranial monitoring for seizure localization provide an excellent model to study discharge patterns of single neurons within the mesial temporal lobe during memory tasks. Animal models have shown that discharge patterns of CA3 neuronal populations influence the discharge of CA1 neurons. The researchers hypothesized that human hippocampal neurons have regionally and temporally specific and interrelated discharge patterns, which contribute to task specific memory formation and retrieval.

Seven adult epilepsy patients undergoing implantation of hippocampal electrodes for seizure localization were enrolled, and consent was obtained for study participation. Electrodes were stereotactically implanted into the CA3 and CA1 hippocampal subfields. Placement was confirmed using postoperative, high-resolution 3T MRI. Single unit neuronal activity was isolated via extracellular action potential waveform identification and recorded. Neurocognitive experiments consisted of visual object-oriented and spatial-oriented stimuli within Delayed-Match-to-Sample type tasks.

Hippocampal neurons exhibited differential firing rate increases to behavioral events within both object-oriented and spatial-oriented tasks. Specific CA3 and CA1 firing rate changes that related to anterior and posterior hippocampal locations, as well as differences in event-related encoding between the object and spatial tasks, were identified.

Hippocampal neurons exhibited the same differential encoding and correlation to successful versus failed memory performance as shown in prior rodent and nonhuman primate studies. These findings support the utility of this model for the eventual development and testing of a human memory prosthetic.

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