Medical Xpress

Ode to recall: To remember events in order, we rely on the brain's 'symphony'

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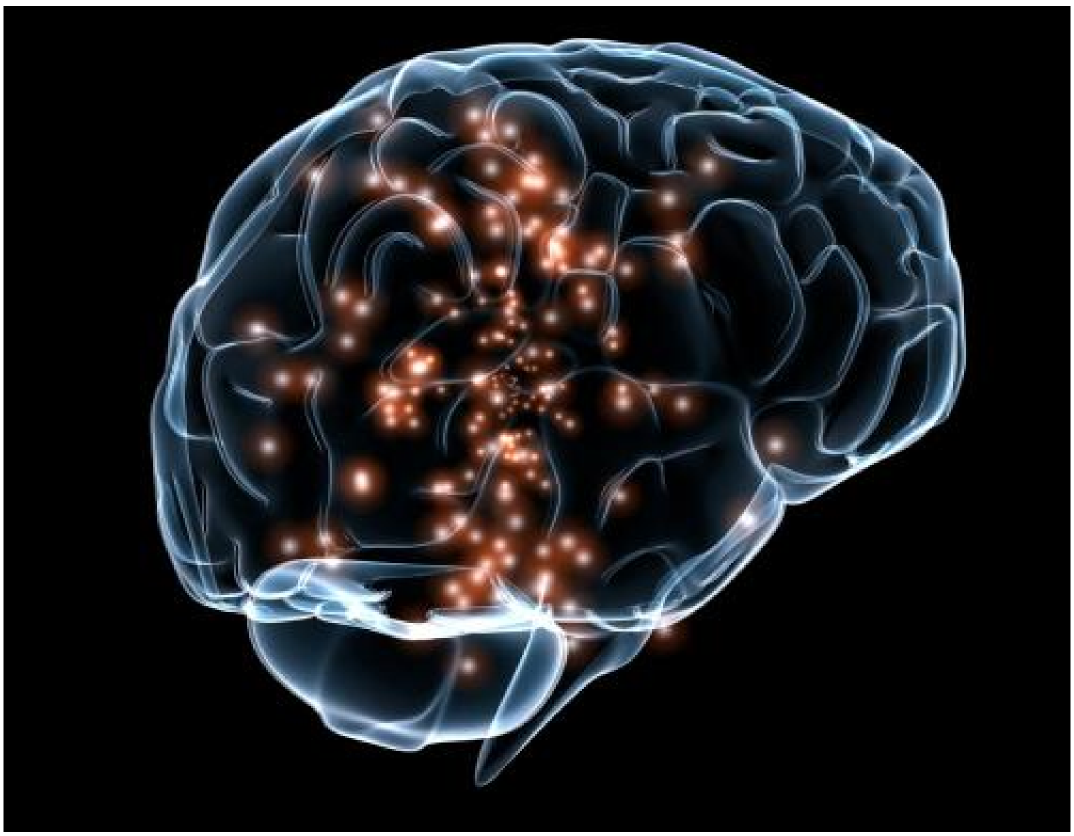

Credit: Wikimedia Commons

To remember events in the order they occur, the brain's neurons function in a coordinated way that is akin to a symphony, a team of New York University scientists has found. Their findings offer new insights into how we recall information and point to factors that may disrupt certain types of memories.

"The findings enhance our understanding of how the brain keeps track of what happened and when it happened relative to other events," explains Lila Davachi, associate professor in NYU's Department of Psychology and Center for Neural Science and the study's senior author. "We've known for some time that neurons increase their activity when we encode memories. What our study shows is there's a rhythm to how they fire in relation to one another—much like different instruments in a symphony orchestra."

The study's first author was Andrew Heusser, a doctoral candidate in NYU's Department of Psychology. Its collaborators were David Poeppel, a professor in NYU's Department of Psychology and Center for Neural Science, and Youssef Ezzyat, also a doctoral candidate in NYU's Department of Psychology at the time of the research and now a postdoctoral fellow at the University of Pennsylvania.

The research, which appears in the journal *Nature Neuroscience*, sought to determine the validity of a long-standing hypothesis, proposed in 1995 by neuroscientists John Lisman and Marco Idiart, which outlines how the order of memories is encoded. The "theta-gamma phase coding" model states that when our brains create a memory for a specific event, our neurons oscillate in a coordinated fashion, with cells firing at high (gamma) frequencies. To encode the order of multiple events, cells representing each event fire in a sequence that is coordinated by a lower (theta) frequency brain rhythm.

To test this, the scientists had the study's participants view a series of six objects (e.g., a butterfly, headphones, etc.), one at a time, on a computer screen. During the experiment, researchers examined the subjects' neural activity using magnetoencephalography (MEG), which captures measurements of the tiny magnetic fields generated by the brain.

Later, they asked subjects to recall the order of the objects they viewed.

In their analysis, the researchers examined the neuronal activity of the subjects when they first viewed the objects, then matched it to the results of the recall test.

Their data showed notable differences in the patterns of neural activity when the order of the objects was correctly encoded compared to when it was not.

Specifically, when the order of the objects was correctly encoded, the gamma activity associated with each object was temporally ordered along a slower theta oscillation so that the gamma activity for object 1 preceded that for object 2 and so on. By contrast, when subjects incorrectly recalled the order in which the objects were presented, gamma activity was just as high—but there was no discernible pattern.

"When particular oscillations are in step with each other, we remember the order," Davachi observes. "But when they are not, we don't."

More information: Episodic sequence memory is supported by a theta–gamma phase code, *Nature Neuroscience*, DOI: 10.1038/nn.4374

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