New research puts distinct memories of similar events in their place

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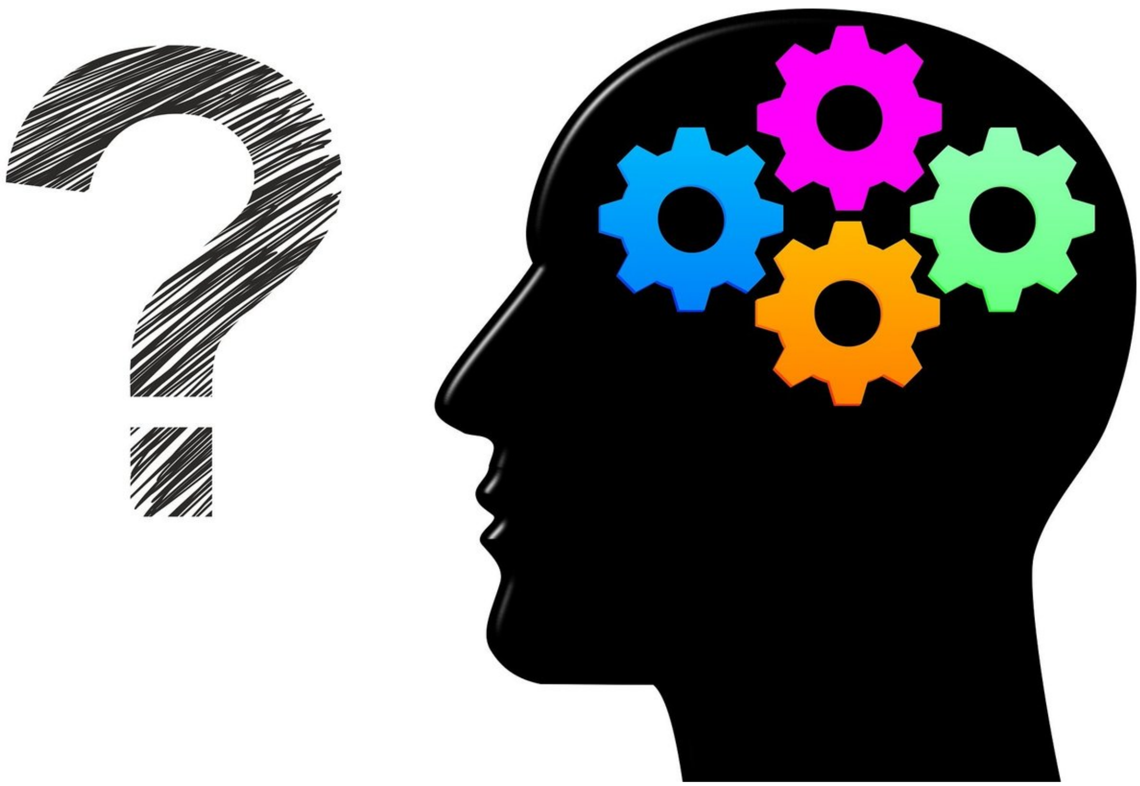

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Neuroscientists have found new evidence on how distinct memories of similar events are represented in the brain.

Its findings, which appear in the journal *Neuron*, correct a previous misconception of how such memories are stored in the hippocampus—a part of the brain crucial for memory and understanding space.

"Previous research suggested that brain cells were 're-mapped' in making distinctions between memories of similar and distinct experiences," says André Fenton, a professor in New York University's Center for Neural Science and the senior author of the paper. "However, it's clear from our results that neuron activity is, in fact, synchronous—like a flock of starlings that takes on different formations while still maintaining cohesion as a flock.

"These new findings provide strong evidence in favor of a fresh, dynamic conceptualization of how neurons signal information."

The study was co-authored with Milenna Tamara van Dijk, a doctoral student at NYU's Langone Medical Center, working in the Center for Neural Science. It may be downloaded here.

It's been established that the electrical discharge of hippocampus cells signals places; each "place cell" contributes to a neural map-like representation of space by discharging only when we are in discrete parts of an environment called the cell's "place field." As we move from place to place through a space, one set of discharging place cells ceases to fire while another set starts to discharge and then ceases as we move away while the next set discharges, and so on to trace out the real-world path in neural activity such that the same particular sets of place cells are active whenever we return to the same places. Scientists John O'Keefe, May-Britt Moser, and Edvard Moser were awarded the 2014 Nobel Prize in Physiology or Medicine for their discovery of these and related cells.

While place fields have aided neuroscientists' understanding of how the brain represents memories and information, a specific question remains unanswered: how do brains learn and discriminate between similar and distinct experiences of similar things?

For instance, consider a commonplace experience such as parking your car in a familiar garage on different days of the week. Sometimes you remember parking in the same parking spot and other times you remember parking in different parking spots. How does the hippocampus discriminate between multiple memories, storing some as the same and others as different?

The prevailing view is that distinct memories are signaled by distinctive neural activity in a part of the hippocampus, dentate gyrus. Prior work has shown that a given set of dentate gyrus place cells readily change the relative locations of their firing fields in different environments, so if the fields of two cells overlapped in one environment, they would probably not overlap in the other, and vice versa. This "remapping" is assumed to underlie distinctive memories. However, dentate place cell remapping was never tested during a rigorous memory discrimination task.

In the *Neuron* study, the researchers explored this dynamic through a series of memory tests using mice.

Their results showed that, in fact, dentate place cells did not remap; their place fields were constant. Moreover, instead of remapping, memory discrimination was controlled by increases in the co-firing of dentate place cells and the neurons that organize which place cells discharge synchronously and asynchronously.

In other words, the firing of dentate place cells occurs globally, but are timed in different ways in order to express distinctive memories—instead of changing where cells fire overall.

"Different flock patterns occur when just a small number of starlings change course, with each starling maintaining strongly correlated movements with its nearest neighbors," explains Fenton, who also holds appointments at the Neuroscience Institute at NYU Langone Medical Center and SUNY Downstate. "Similarly, differences in the timing of the co-firing of neurons can signal differences in memory formation—all within a globally maintained spatial tuning and correlation structure."

More information: Milenna Tamara van Dijk et al, On How the Dentate Gyrus Contributes to Memory Discrimination, *Neuron* (2018). DOI: 10.1016/j.neuron.2018.04.018

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