New study suggests an unconventional way for memories to form

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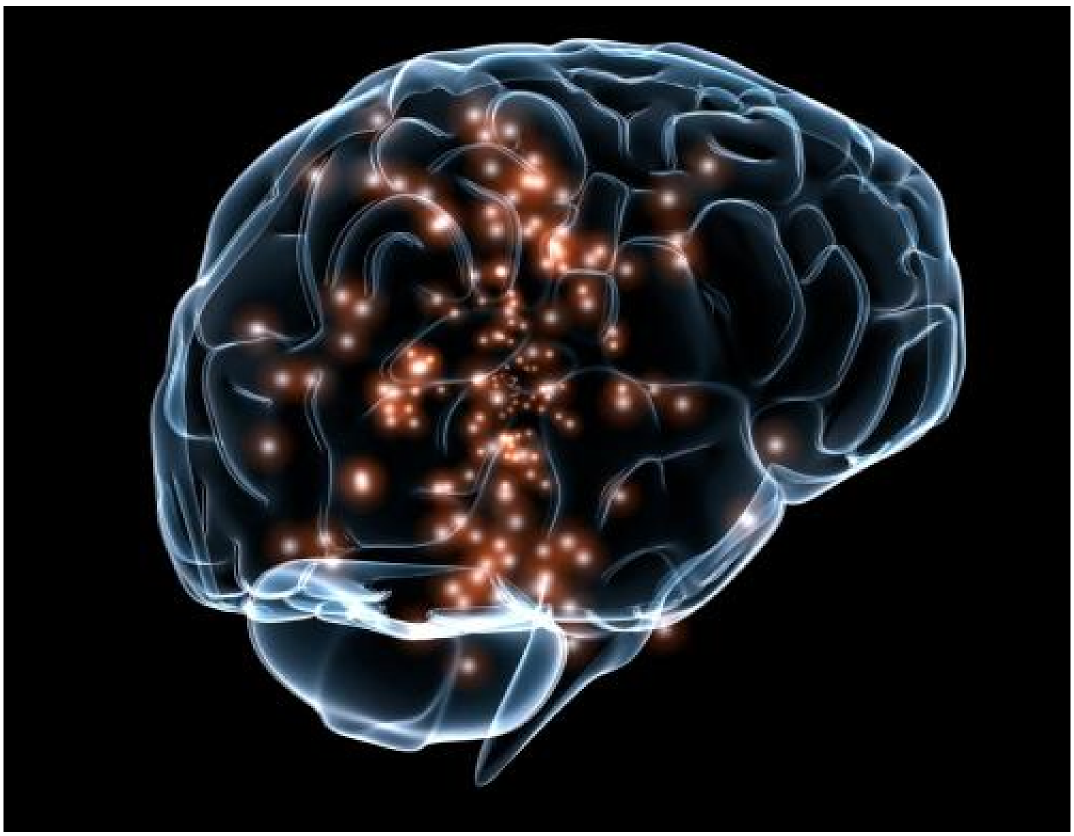

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(Medical Xpress)—A team of researchers working at Howard Hughes Medical Institute has found possible evidence of a way for memories to form that differs from conventional theory. In their paper published in the journal *Science*, the team describes their theory, the biophysical model they built and what their findings suggest about the way some memories may form. Julija Krupic with University College London offers a Perspective piece on the study in the same issue and gives some background on memory research in general.

After many years of research, brain scientists have come to some degree of consensus about how the brain forms memories—as Krupic notes, it happens as a result of the creation of neural networks that are strengthened when neurons in the network cause or contribute to activity occurring in a connected neuron—the idea has become known as the Hebbian learning rule. Under the rule, memories are formed due to activities that occur very closely in time, allowing the neurons time to build stronger bonds for those events that are more memorable.

The theory also embraces the idea of plasticity—the network must changeable in order for a memory to strengthen. The theory further suggests that memories are added to or recalled by neurons firing in quick succession in short bursts of activity, a process called long-term potentiation (LTP). In this new effort, the researchers suggest there might be a different type of memory processing that happens over longer periods of time. Such memories, they suggest, could help with remembering events as a sequence, rather than just as snapshots. They call this new memory mechanism behavioral time scale synaptic plasticity (BTSP).

The new theory suggests that there need not be a relationship between interconnected neurons during sequential memory formation to maintain associations that can be long-lasting—instead, place fields are involved. To test the plausibility of their ideas, the researchers built a biophysical model based on what might happen with place fields during times when a mouse is moving faster versus slower—it showed the idea to be plausible. A BTSP mechanism, Krupic notes, could lead to over-representation of places that are important to a mouse—such as the steps required to get to a good food source, allowing it to find such a source when snapshot types of memories alone will not suffice.

More information: Katie C. Bittner et al. Behavioral time scale synaptic plasticity underlies CA1 place fields, *Science* (2017). DOI: 10.1126/science.aan3846

Abstract
Learning is primarily mediated by activity-dependent modifications of synaptic strength within neuronal circuits. We discovered that place fields in hippocampal area CA1 are produced by a synaptic potentiation notably different from Hebbian plasticity. Place fields could be produced in vivo in a single trial by potentiation of input that arrived seconds before and after complex spiking. The potentiated synaptic input was not initially coincident with action potentials or depolarization. This rule, named behavioral time scale synaptic plasticity, abruptly modifies inputs that were neither causal nor close in time to postsynaptic activation. In slices, five pairings of subthreshold presynaptic activity and calcium (Ca2+) plateau potentials produced a large potentiation with an asymmetric seconds-long time course. This plasticity efficiently stores entire behavioral sequences within synaptic weights to produce predictive place cell activity.