Specific regions of the hippocampus connected to discrete steps of task mastery, study finds

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(Medical Xpress)—In a study published in *Nature Neuroscience*, neurobiologists from the Friedrich Miescher Institute for Biomedical Research have been linking synapse formation in the hippocampus to distinct learning steps. They show how different regions of the hippocampus have specific and sequential functions in the mastery of a complex task.

The setup is natural. The mouse finds herself in the water and is looking for a dry place. But how does she solve this task? And what happens if she finds herself in the same situation again? Here is what the scientists observed: At the beginning, the mouse swims all around the little pool, randomly searching for the platform. After two days, there is a change in search approach: The mouse has learned where about the platform is and will start to search right away in the area of the platform. Finally, after another five days, the mouse knows exactly where the platform is and swims directly for it. What is astonishing is that every mouse behaves same way and all the mice learn to find the platform in about the same time, through the same trial and error search strategy stages.

Pico Caroni, senior group leader at the Friedrich Miescher Institute for Biomedical Research, and his team not only described for the first time how mice learn to master such a complex task step by step, but they have also been able to show how one region of the brain, the hippocampus, is engaged in these learning processes. The hippocampus is the region of

the brain that is the relay station for a lot of sensory information. In this function, the hippocampus is extremely important for learning and the consolidation of memory. The hippocampus can be divided into three areas termed ventral (vH), intermediate (iH) and dorsal hippocampus (dH). Even though the composition of the neuronal networks in each area is comparable, they differ in gene expression, connectivity, tuning and function.

Caroni and his team could now show that this difference has functional implications in learning. It has been known that during learning new synapses are formed in the hippocampus by so called mossy fibers. In their study published in Nature Neuroscience the scientists show that each search strategy, each level of learning, is associated with a different region of the hippocampus. First, mossy fiber synapses are formed in vH. With the first change in search strategy, mossy fiber formation moves to iH. The mice now have a clear understanding of the relative position of the platform, e.g. distance from the pool wall. Finally, synapse formation moves to dH. By now the mouse has a clear map of the pool, the platform and her position in these surroundings. From now on the mouse will always know where the platform is and will directly head for it.

"We believe that many complex learning tasks are achieved through sub-tasks and that the three areas of the hippocampus are involved in similar ways," comments Caroni. "Our experiments indicate further that this approach is innate, which indicates that similar processes may play as we learn to bike or become proficient in playing tennis."

More information: Ruediger S, Spirig D, Donato F, Caroni P (2012) Goal-oriented searching mediated by ventral hippocampus early in trial-and-error learning. *Nat Neurosci*. 2012 Sep 23 [Epub ahead of print] www.nature.com/neuro/journal/v … nt/full/nn.3224.html