Scientists identify mechanism of long-term memory

April 13 2011

Using advanced imaging technology, scientists from the Florida campus of The Scripps Research Institute have identified a change in chemical influx into a specific set of neurons in the common fruit fly that is fundamental to long-term memory.

The study was published in the April 13, 2011 issue of The Journal of Neuroscience.

"In studying fruit flies' learning and long-term memory storage, we observed an increase in calcium influx into a specific set of brain neurons in normal fruit flies that was absent in 26 different mutants known to impair long-term memory,," said Ron Davis, chair of the Scripps Research Department of Neuroscience, who led the study. "This logical conclusion is that this increase, which we call a memory trace, is a signature component of long-term memory."

The memory trace in question is an increased influx of calcium into a set of neurons after long-term memory forms in a part of the insect brain known as mushroom bodies, a pair of oversized lobes known to mediate learning and memory, particularly the memories of smell. They have been compared to the hippocampus, a site of memory formation in humans.

Increases in calcium influx also occur with learning in other animal models, Davis said, and it seems highly likely a similar correlation exists in humans.

Measuring Memory Traces

To measure the changes in the Drosophila neurons, Davis and his colleagues used functional optical imaging, an advanced technology that his laboratory helped pioneer for the study of learning and memory. Using protein sensors that become fluorescent when calcium levels are increased, the team was able to highlight changes in the levels of calcium influx into the mushroom body neurons in response to odor learning. These observed memory traces occur in parallel with behavioral changes.

Interestingly, these memory traces occur only with spaced conditioning – where the insects receive multiple episodes of learning but with periods of rest between each episode. Spaced conditioning is required for long-term memories to form.

In an earlier study last December, also published in The *Journal of Neuroscience*, Davis found not only that fruit flies receiving spaced conditioning exhibited a long-term memory trace, but also that their memories lasted between four and seven days. In flies that were given a single episode of learning, memory formation lasted only a day and the long-term memory trace failed to form. These two studies are the newest in a series of six studies on the topic, including those published in the journal *Neuron* in 2004 and 2006, *Cell* in 2005, and *Nature Neuroscience* in 2008. Davis reviewed all of his studies of memory traces in the most recent issue of *Neuron*.

"The phenomenon of spaced conditioning is conserved across all species," Davis said. "No one really knows why it's important to long-term memory formation but there appears to be something magical about that rest period during learning."

More information: The co-authors of the most recent study, "The Long-Term Memory Trace Formed in the Drosophila α/β Mushroom

Body Neurons Is Abolished in Long-Term Memory Mutants," are David-Benjamin G. Akalal and Dinghui Yu of the Baylor College of Medicine.

Provided by The Scripps Research Institute

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