MedicalXpress

Pavlov's neurons: Researchers find brain cells that are a key to learning

December 8 2008

More than a century after Ivan Pavlov's dog was conditioned to salivate when it heard the sound of a tone prior to receiving food, scientists have found neurons that are critical to how people and animals learn from experience.

Using a new imaging technique called Arc catFISH, researchers from the University of Washington have visualized individual neurons in the amygdalas of rat brains that are activated when the animals are given an associative learning task.

Associative, or Pavlovian, conditioning is a fundamental form of learning throughout the animal kingdom and is a widely researched model for studying plasticity, or how the circuits in the brain can change as a result of experience, said Ilene Bernstein, senior author of a new study and a UW professor of psychology.

The findings will appear online in the *Early Edition of the Proceedings of the National Academy of Sciences* this week (Dec. 8-12).

In experiments the researchers directly observed the convergent neurons where learning is suspected of taking place. These neurons responded to both a conditioned stimulus, in this case a novel saccharine solution, and an unconditioned stimulus, in the form of lithium chloride that made rats sick. Convergent activation is considered a key event for subsequent plasticity, according to Bernstein. Until now, however, there has been scant direct evidence of this activation during learning in the mammalian

brain.

Using the new imaging technique, the researchers were able to visualize convergent activation that took place over a 30-minute time span. To do this, they subjected animals to conditioned taste aversion training. Taste aversions have evolved in many animals to help them avoid toxic substances.

In the study thirsty rats were allowed to drink the saccharine solution for five minutes. After 25 minutes they were injected with lithium chloride, which caused nausea, and then five minutes later they were killed. Slices of the animals' brain were examined under a microscope.

The imaging technique showed that some neurons were activated by the saccharine, or the conditioned stimulus, and others were activated by the lithium chloride or the unconditioned stimulus. In addition, a small number of neurons were activated by both stimuli.

"We believe that within any given learning trial the number of neurons activated by both conditioned and unconditioned stimuli is likely to be very sparse," said Bernstein. "In the area we looked at only about 4 percent of about 300 neurons show this response."

In a follow-up experiment, the researchers reversed the order of the stimuli – giving the injection first and the saccharine later. Reversing the order of stimuli is a procedure known to be ineffective in producing learning. Under these conditions and although animals were exposed to identical stimuli, convergent neurons were not activated.

Bernstein and her colleagues also proposed a model that associative learning takes place when a conditioned stimulus is followed by an unconditioned stimulus, triggering convergent neurons. To further explore this model they plan to use the imaging technique and fear

learning.

Source: University of Washington