Making the connection between a sound and a reward changes brain and behavior

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If you've ever wondered how you recognize your mother's voice without seeing her face or how you discern your cell phone's ring in a crowded room, researchers may have another piece of the answer.

Their work indicates that once you figure out your mother's voice is a good thing – most days - fairly significant changes occur in the sensory cortex, the part of the brain that responds to sound.

"When something starts to predict a good outcome is going to happen, the sensory part of the brain that responds to those events starts to respond more strongly, making it easier for the brain to cause a behavioral response," says Dr. David T. Blake, neuroscientist at the Medical College of Georgia and lead author on a study in the Oct. 19 issue of *Neuron*.

By monitoring the action potentials of about a dozen key neurons in monkey test subjects, researchers found neuronal responsiveness increases dramatically after just a few training sessions.

These neuronal fireworks were short-lived, replaced by a rewiring of the brain that shows the animal has learned, Dr. Blake says.

In the few monkeys that initially didn't make the connection that a change in pitch in a series of sounds meant they were getting a juice reward, no brain changes occurred.

"The same processes happen to people as we learn, especially in the area of sensory discrimination," Dr. Blake says. "We learn how to tell people's faces apart, we learn how to distinguish different words whether they are delivered orally or written. We can identify different speakers by the tenor and tone of their voice. All of these abilities are part of sensory discrimination, so we are studying how the brain changes as part of sensory discrimination learning."

The findings have wide implications for learning, including improving treatment for children with language learning impairments, such as dyslexia, and increasing literacy, Dr. Blake says. California-based Scientific Learning, a neuroscience company that grew out of the University of California, San Francisco, already is using advances in understanding behavioral learning to develop computer programs that dramatically improve the reading skills of dyslexic children. Another San Francisco-based neuroscience company, Posit Science, is exploring its potential in age-related cognitive decline, he says.

"People have studied since the time of Pavlov how associating sensory stimuli with reward causes behavioral change," Dr. Blake says. "What we have done is identify how that change occurs and over what time course it occurs in one part of these multiple brain systems that are linked together so that Pavlov's dog can start salivating after the bell rings."

More than 100 years ago, while studying the gastric system of dogs, the Russian physiologist found what he called a conditioned reflex: that after a period of ringing a metronome during feeding that the dogs began salivating just hearing the metronome's beat.

Dr. Blake is studying the neuronal responses of more humanlike monkeys with the idea of better understanding why.

Researchers were able to monitor neuronal response using technology

Dr. Blake helped develop that is similar to deep brain stimulation used in patients but with much smaller electrodes.

In work published in 2002 in the Proceedings of the National Academy of Sciences, Dr. Blake first taught monkeys that when they leaned forward to break an infrared beam, a series of sounds would start. "If they leaned back after a change in the sound series, they got an appetitive reward," he says. "When they do this, the response of their neurons to those sounds doubles and triples in the first two days after they learn that very simple behavior. They learn that moving their head at that time will lead to reward."

The new study indicates that the monkeys just have to make the connection between the sound change and juice reward for brain changes to occur and that at least some of them don't have to move a muscle to make that happen.

"This work suggests the learning does not have to be active for some animals, that they don't all have to cause the reward to make the brain changes," says Dr. Blake. "They just have to learn that the stimulus predicts the reward."

"It's an important computational point because there is a lot of interest right now in the brain's ability to backtrack in time from rewards to find out the earliest thing that predicts that reward. When the monkey identifies the sound change as the cue it's supposed to respond to get rewarded, learning and brain changes happen."

Source: Medical College of Georgia

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