Making temporary changes to brain could speed up learning, study reports

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In a breakthrough that may aid treatment of learning impairments, strokes, tinnitus and chronic pain, UT Dallas researchers have found that brain nerve stimulation accelerates learning in laboratory tests.

Another major finding of the study, published in the April 14 issue of *Neuron*, involves the positive changes detected after stimulation and learning were complete. Researchers monitoring brain activity in rats found that brain responses eventually returned to their pre-stimulation state, but the animals could still perform the learned task. These findings have allowed researchers to better understand how the brain learns and encodes new skills.

Previous studies showed that people and animals that practice a task experience major changes in their brains. Learning to read Braille with a single finger leads to increased brain responses to the trained digit. Learning to discriminate among a set of tones leads to increased brain responses to the trained tones.

But it was not clear whether these changes are just coincidence or whether they truly help with learning. The current research demonstrates that changes in the brain are meaningful and not merely coincidental, said Dr. Amanda Reed, who wrote the article with colleagues from The University of Texas at Dallas' School of Behavioral and Brain Sciences.

Reed and her fellow researchers used brain stimulation to release neurotransmitters that caused the brain to increase its response to a small set of tones. The team found that this increase allowed rats to learn to perform a task using these tones more quickly than animals that had not received stimulation. This finding provides the first direct evidence that a larger brain response can aid learning.

Future treatments that enhance large changes in the brain may also assist with recovery from stroke or learning disabilities. In addition, some brain disorders such as tinnitus or chronic pain occur when large-scale brain changes are unable to reverse. So this new understanding of how the brain learns may lead to better treatments for these conditions.

Researchers examined the laboratory animals' brains again after the rats had practiced their learned task for a few weeks. The brains appeared to have returned to normal, even though the animals had not forgotten how to perform the task they had learned. This means that, although large changes in the brain were helpful for initial learning, those changes did not have to be permanent, Reed wrote.

"We think that this process of expanding the brain responses during learning and then contracting them back down after learning is complete may help animals and people to be able to perform many different tasks with a high level of skill," Reed said. "So for example, this may explain why people can learn a new skill like painting or playing the piano without sacrificing their ability to tie their shoes or type on a computer."

The study by Reed and colleagues supports a theory that large-scale brain changes are not directly responsible for learning, but accelerate learning by creating an expanded pool of neurons from which the brain can select the most efficient, small "network" to accomplish the new skill.

This new view of the brain can be compared to an economy or an ecosystem, rather than a computer, Reed said. Computer networks are designed by engineers and operate using a finite set of rules and solutions to solve problems. The brain, like other natural systems, works by trial and error.

The first step of learning is to create a large set of diverse neurons that are activated by doing the new skill. The second step is to identify a small subset of neurons that can accomplish the necessary computation and return the rest of the neurons to their previous state, so they can be used to learn the next new skill.

By the end of a long period of training, skilled performance is accomplished by small numbers of specialized neurons not by large-scale reorganization of the brain. This research helps explain how brains can learn new skills without interfering with earlier learning.

The researchers used anesthesia when inserting electrodes into the laboratory rats' brains. The brain stimulation was painless for the rats, Reed said. Co-authors of the study were Drs. Jonathan Riley, Ryan Carraway, Andres Carrasco, Claudia Perez, Vikram Jakkamsetti and Michael Kilgard of UT Dallas.

Provided by University of Texas at Dallas