McGowan Institute for Regenerative Medicine
A program of the University of Pittsburgh and UPMC

Study Findings Could Lead to Improved Treatments for Stroke, Other Brain Injuries

Learning a new skill is easier when it is related to ability that we already possess. For example, a trained pianist might learn a new melody more easily than learning how to hit a tennis serve. Neural engineers from the Center for the Neural Basis of Cognition (CNBC)—a joint program between the University of Pittsburgh and Carnegie Mellon University—have discovered a fundamental constraint in the brain that may explain why this happens. McGowan Institute for Regenerative Medicine faculty member Elizabeth Tyler-Kabara, MD, PhD, an assistant professor in the Departments of Neurological Surgery, Bioengineering, and Physical Medicine and Rehabilitation at the University of Pittsburgh, the director of the Spasticity and Movement Disorder Program at Children's Hospital of Pittsburgh of UPMC, and the director of the Surgical Epilepsy Program in the Department of Neurological Surgery, is a co-author of the study.

Published as the cover story in a recent issue of *Nature*, the researchers found for the first time that there are constraints on how adaptable the brain is during learning and that these constraints are the key determinant for whether a new skill will be easy or difficult to learn. Understanding the ways in which the brain's activity can be "flexed" during learning could eventually be used to develop better treatments for stroke and other brain injuries.

Lead author Patrick T. Sadtler, a PhD candidate in Pitt's Department of Bioengineering, compared the study's findings to cooking. "Suppose you have flour, sugar, baking soda, eggs, salt, and milk. You can combine them to make different items—bread, pancakes, and cookies—but it would be difficult to make hamburger patties with the existing ingredients," Mr. Sadtler said. "We found that the brain works in a similar way during learning. We found that subjects were able to more readily recombine familiar activity patterns in new ways relative to creating entirely novel patterns."

For the study, the research team trained animals to use a brain-computer interface (BCI), similar to ones that have shown recent promise in clinical trials for assisting tetraplegics and amputees. The researchers recorded neural activity in the motor cortex and directed the recordings into a computer, which translated the activity into movement of a cursor on the computer screen. This technique allowed the team to specify the activity patterns that would move the cursor. The subjects' goal was to move the cursor to targets on the screen, which required them to generate the patterns of neural activity that the experimenters had requested. If the subjects could move the cursor well, that meant that they had learned to generate the neural activity pattern that the researchers had specified.

The researchers found that their subjects learned to generate some neural activity patterns more easily than others, since they only sometimes achieved accurate cursor movements. The harder-to-learn patterns were different from any of the pre-existing patterns, whereas the easier-to-learn patterns were combinations of pre-existing brain patterns. Because the existing brain patterns likely reflect how the neurons are interconnected, the results suggest that the connectivity among neurons shapes learning.

"We wanted to study how the brain changes its activity when you learn and also how its activity cannot change. Cognitive flexibility has a limit—and we wanted to find out what that limit looks like in terms of neurons," said Aaron P. Batista, PhD, assistant professor of bioengineering at Pitt and co-principal investigator on the study with Byron M. Yu, PhD, assistant professor of electrical and computer engineering and biomedical engineering at Carnegie Mellon. Dr. Yu believes this work demonstrates the utility of BCI for basic scientific studies that will eventually impact people's lives.

"These findings could be the basis for novel rehabilitation procedures for the many neural disorders that are characterized by improper neural activity," Dr. Yu said. "Restoring function might require a person to generate a new pattern of neural activity. We could use techniques similar to what were used in this study to coach patients to generate proper neural activity."

The CNBC is devoted to investigating the neural mechanisms that give rise to human cognitive abilities. The center integrates the strengths of the University of Pittsburgh in basic and clinical neuroscience with Carnegie Mellon's strengths in psychology, computer science, biological sciences, and statistics and sponsors an interdisciplinary graduate training program. The CNBC will celebrate its 20th anniversary of advancing brain, computation, and behavior through research and education the Fall 2014.

Read more…

[University of Pittsburgh News](#)

McGowan Institute for Regenerative Medicine
A program of the University of Pittsburgh and UPMC

University of Pittsburgh Swanson School of Engineering News

YouTube: Flexing the Brain: Carnegie Mellon, Pitt Scientists Discover Why Learning Tasks Can Be Difficult

Abstract (Neural constraints on learning. Patrick T. Sadtler, Kristin M. Quick, Matthew D. Golub, Steven M. Chase, Stephen I. Ryu, Elizabeth C. Tyler-Kabara, Byron M. Yu & Aaron P. Batista. Nature; 512, 423–426 (28 August 2014).)

Back to Home Page