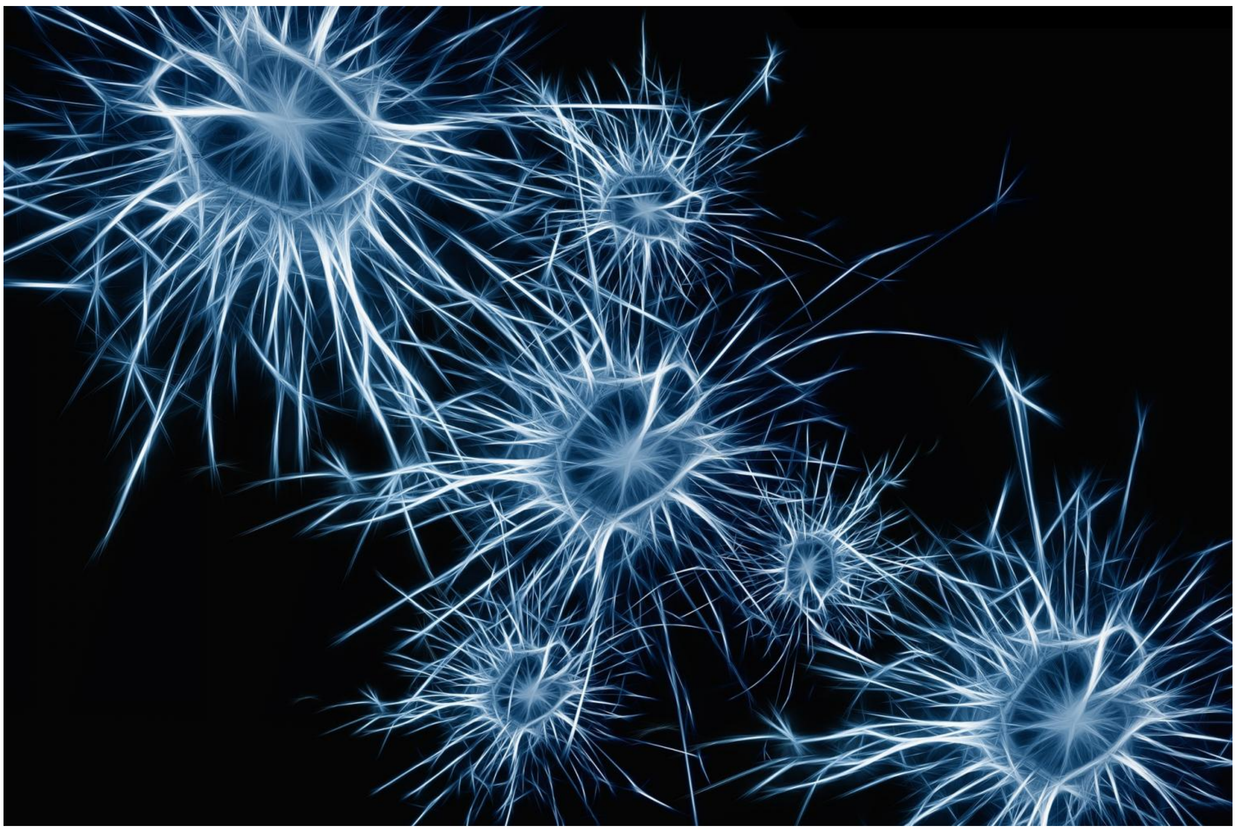
Neurons in the brain work as a team to guide movement of arms, hands

December 11 2018



Credit: CC0 Public Domain

The apparent simplicity of picking up a cup of coffee or turning a doorknob belies the complex sequence of calculations and processes that the brain must undergo to identify the location of an item in space, move the arm and hand toward it, and shape the fingers to hold or manipulate the object. New research, published today in the journal *Cell Reports*, reveals how the nerve cells responsible for motor control modify their activity as we reach and grasp for objects. These findings upend the established understanding of how the brain undertakes this complex task and could have implications for the development of neuro-prosthetics.

"This study shows that activity patterns in populations of neurons shift progressively during the course of a single movement," said Marc Schieber, M.D., Ph.D., a professor in the University of Rochester Medical Center (URMC) Department of Neurology and the Del Monte Institute for Neuroscience and a co-author of the study. "Interpreting these shifts in activity that allow groups of neurons to work together to perform distinctive and precise movements is the first step in understanding how to harness this information for potential new therapies."

The established model of how the brain performs these movements dates back to the 1980's and contends that separate populations of neurons in the brain are dedicated to reaching versus grasping. The analogy is akin to the organization of a football team, with one set of players dedicated to defense and another to offence. The new study shows that these cells act more like a basketball team, with the same group of players switching from defensive to offensive responsibilities depending upon the circumstances at any given moment.

"Reaching and grasping traditionally have been thought to be driven concurrently by two separate channels in the brain with one controlling the reaching arm and another controlling the grasping hand," said Adam Rouse, M.D., Ph.D., a research assistant professor in the Del Monte Institute for Neuroscience and co-author. "We have found, however, that individual neurons in the motor cortex transition from encoding the reach location early in a movement to encoding the object to be grasped later on."

The new findings were possible because of advanced microelectrode arrays that allowed the researchers to simultaneously monitor and record hundreds of neurons in the motor cortex—the part of the brain responsible for controlling movement—of animals as they reached for and manipulated objects.

Using new analysis designed for the large dataset, the researchers observed that the neurons altered their firing patterns as the animals transitioned from projecting the arm and hand toward an object's location to then shaping the hand and arm as needed to grasp the object. Both patterns of activity would spread rapidly through the motor cortex, a phenomenon akin to the ripples formed when dropping pebbles in a pond. The findings imply that, instead of specializing in specific motor control tasks, the individual motor neurons work collectively to carry out multiple functions.

The research has significant implications for the creation of brain-computer interfaces which tap into the electrical activity of the brain and use this information to control prosthetic devices, like a mechanical arm. While previous efforts have sought to tap into the electrical activity of individual or groups of neurons, the new findings show that these systems will likely need to employ more advanced machine learning algorithms to interpret the shifting patterns of activity.

"These finding could revolutionize how we extract information from the brain," said Rouse. "Instead of individual neurons, we now have a foundation that will enable us to build systems that decode brain activity to recognize patterns and this information could be employed to develop a new generation of assistive devices."

Provided by University of Rochester Medical Center