Medical Xpress

How waves of 'clutches' in the motor cortex help our brains initiate movement

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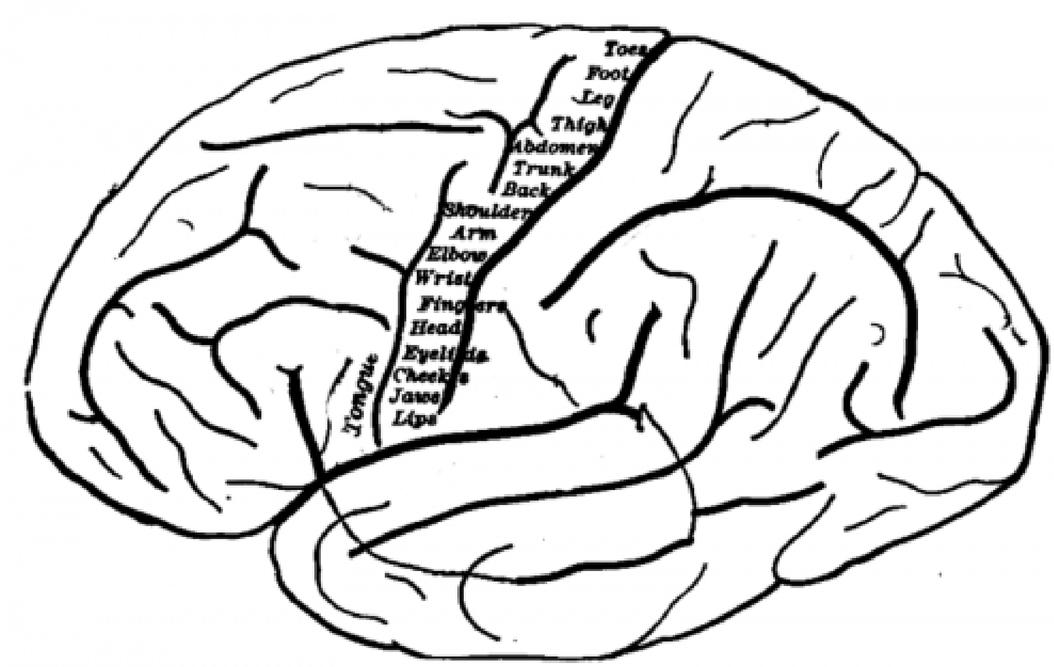

Topography of the primary motor cortex, on an outline drawing of the human brain. Different body parts are represented by distinct areas, lined up along a fold called the central sulcus. Credit: public domain

For decades, scientists have wondered why specific cells in the brain that control movement fire when people simply plan or imagine making a movement, or observe someone else making a movement—but do not actually move themselves.

Now, University of Chicago scientists working on this mystery have discovered that signals in the motor cortex act like a series of clutches when it comes to moving, and that these signals can be disrupted to slow the brain's initiation of movement.

The findings, published in the journal *Neuron*, potentially could lead one day to treatments for people with Parkinson's disease, a movement disorder.

"This work provides the first evidence that large-scale, spatially organized brain patterns are behaviorally relevant," said neuroscientist Nicho Hatsopoulos, Ph.D., a professor of organismal biology and anatomy and the senior author of the study.

It's long been known that when a person thinks about or plans a movement, neurons fire in the motor cortex and create a signal called a beta oscillation. Hatsopoulos compares the function of this signal to a clutch in a car with a manual transmission: If you push in a clutch pedal, then press on the gas, the car engine will rev—but it won't move because the car is not in gear. Likewise, if you simply imagine moving your arm or observe someone else moving their arm, this signal in your motor cortex is maintained or even intensifies—but you don't move your arm. It's only when you're ready to actually move that the beta oscillations cease—essentially, the clutch engages the engine to the transmission of the car—and your arm moves.

Hatsopoulos and his team have discovered that this 'clutch' signal in the motor cortex is better understood as not one, but rather multiple clutches that engage in an organized spatial pattern that can begin at either end of the motor cortex and terminate at the other. Every time a movement is initiated, this organized wave of clutches—in actuality, groups of firing neurons—engages.

"While this clutch-like mechanism has been previously observed at single sites in the motor cortex, we've discovered that movement initiation is associated with a propagating wave of clutches across the cortical surface," said Hatsopoulos. "Moreover, we've provided the first causal evidence that this wave is a necessary condition for movement initiation."

The researchers studied three rhesus macaque monkeys who were rewarded with juice each time they won a video game. The game required the monkeys to use a joystick to move a cursor across a screen to a target. Electrodes implanted in the arm/hand area of the monkeys' motor cortices recorded the neuronal activity of the arm movement involved in manipulating the joystick.

By electrically microstimulating multiple sites in the arm/hand area of the motor cortex to create waves of stimulation, the researchers were able to disrupt the monkeys' reaction time under certain conditions. When they applied stimulation in a way that followed the natural wave of the clutches releasing, the monkey's initiation of movement remained unchanged. But when they stimulated the cells in the opposite direction of the wave, reaction time slowed.

"This study provides for the first time a characterization of this clutch-like mechanism on a trial-by-trial basis," said Karthikeyan Balasubramanian, Ph.D., a senior researcher in the Department of Organismal Biology and Anatomy, who led the study. "Moreover, our stimulation results suggest that we are causally disrupting the wave-like neural dynamics when we stimulate against the natural wave that is linked to movement initiation."

The stimulation approach could perhaps one day aid people with diseases like Parkinson's by helping them initiate movement through spatio-temporally organized, electrical stimulation of electrodes in their motor cortices. Importantly, this novel stimulation approach may be useful in understanding large-scale neural patterns throughout the brain.

The team is now studying whether similar patterns of signals occur in the motor cortex when moving the tongue, and whether movement initiation of the tongue can also be manipulated through micro stimulation.

More information: Karthikeyan Balasubramanian et al, Propagating Motor Cortical Dynamics Facilitate Movement Initiation, *Neuron* (2020). DOI: 10.1016/j.neuron.2020.02.011

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