Medical Xpress

Could prosthetic limbs one day be controlled by human thought?

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The power of thought, literally. Credit: Kevin Craft

For almost two decades, Stanford electrical engineering professor Krishna Shenoy and neuroscientists in his Neural Prosthetics Translational Laboratory have been working on implantable brain sensors that allow them to record and decipher the electrical activity of neurons that control body movement.

The long-term goal: to build prosthetics that amputees and those with paralysis can control with their thoughts.

Currently, the process of analyzing neural activity is time consuming and laborious. But in a paper in the journal *Neuron*, Shenoy and his team reveal that they have established a vastly simpler way to study the brain's electrical activity. Their findings could one day open the door to a new age of super-compact, low-power, potentially wireless brain sensors that would bring thought-controlled prosthetics into much wider use.

In essence, the team has circumvented today's painstaking process of tracking the activity of individual neurons in favor of decoding neural activity in the aggregate. Each time a neuron fires it sends an electrical signal—known as a "spike"—to the next neuron down the line. It's the sort of intercellular communication that turns a notion in the mind into muscle contraction elsewhere in the body. "Each neuron has its own electrical fingerprint and no two are identical," says Eric Trautmann, a postdoctoral researcher in Shenoy's lab and first author of the paper. "We spend a lot of time isolating and studying the activity of individual neurons."

Neuroscientists call that process "spike sorting," and it must be done for every neuron in every experiment, an endeavor that eats up many thousands of hours of researcher time each year and is only going to get more time consuming as scientists build implants with greater numbers of electrodes. Indeed, researchers estimate that sensors will have 1,000 or more electrodes—up from 100 today—at which point, it would take a neuroscientist 100 hours or more to sort the spikes by hand for every experiment.

To record the activity of a number of neurons without the complexity of spike sorting, the researchers borrowed a theory from statistics that suggested how they could uncover patterns of brain activity even when several neurons are recorded on a single electrode. They then demonstrated their approach experimentally. They used a new type of electrode that was designed to pick up brain signals in mice, and adapted this technology to record the brain signals of rhesus monkeys. They recorded hundreds of neurons at the same time and showed that they could get an accurate portrait of the monkey's brain activity without spike sorting.

The researchers believe their work will ultimately lead to neural implants that use simpler electronics to track more neurons than ever before, and also do so more accurately. The key is to combine their sophisticated new sampling algorithms with these small electrodes. So far, such small electrodes have only been employed to control simple devices like a computer mouse. But combining this hardware for recording brain signals with the sampling algorithms creates new possibilities. Researchers might be able to deploy a network of small electrodes through larger sections of the brain, and use the algorithms to sample a great many neurons. This could deliver enough accurate brain signal information to control a prosthetic hand capable of fast and precise motions like pitching a baseball or playing the violin.

Better yet, Trautmann said, the new electrodes, coupled with the sampling algorithms, should eventually be able to record brain activity without the many wires needed today to carry signals from the brain to whatever computer controls the prosthesis. Wireless functionality would completely untether users from bulky computers needed to decode neuronal activity today.

"This study has a bit of a hopeful message in that observing activity in the brain turns out to be easier than we initially expected," says Shenoy, the Hong Seh and Vivian W.M. Lim Professor of Engineering, and senior author of the paper.

More information: Eric M. Trautmann et al. Accurate Estimation of Neural Population Dynamics without Spike Sorting, *Neuron* (2019). DOI: 10.1016/j.neuron.2019.05.003

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