Scientists Discover What You Are Thinking

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By decoding signals coming from neurons, scientists at the California Institute of Technology have confirmed that an area of the brain known as the ventrolateral prefrontal cortex (vPF) is involved in the planning stages of movement, that instantaneous flicker of time when we contemplate moving a hand or other limb. The work has implications for the development of a neural prosthesis, a brain-machine interface that will give paralyzed people the ability to move and communicate simply by thinking.

By piggybacking on therapeutic work being conducted on epileptic patients, Daniel Rizzuto, a postdoctoral scholar in the lab of Richard Andersen, the Boswell Professor of Neuroscience, was able to predict where a target the patient was looking at was located, and also where the patient was going to move his hand. The work currently appears in the online version of Nature Neuroscience.

Most research in this field involves tapping into the areas of the brain that directly control motor actions, hoping that this will give patients the rudimentary ability to move a cursor, say, or a robotic arm with just their thoughts. Andersen, though, is taking a different tack. Instead of the primary motor areas, he taps into the planning stages of the brain, the posterior parietal and premotor areas.

Rizzuto looked at another area of the brain to see if planning could take place there as well. Until this work, the idea that spatial processing or movement planning took place in the ventrolateral prefrontal cortex has been a highly contested one. "Just the fact that these spatial signals are there is important," he says. "Based upon previous work in monkeys, people were saying this was not the case." Rizzuto's work is the first to show these spatial signals exist in humans.

Rizzuto took advantage of clinical work being performed by Adam Mamelak, a neurosurgeon at Huntington Memorial Hospital in Pasadena. Mamelak was treating three patients who suffered from severe epilepsy, trying to identify the brain areas where the seizures occurred and then surgically removing that area of the brain. Mamelak implanted electrodes into the vPF as part of this process.

"So for a couple of weeks these patients are lying there, bored, waiting for a seizure," says Rizzuto, "and I was able to get their permission to do my study, taking advantage of the electrodes that were already there." The patients watched a computer screen for a flashing target, remembered the target location through a short delay, then reached to that location. "Obviously a very basic task," he says.

"We were looking for the brain regions that may be contributing to planned movements. And what I was able to show is that a part of the brain called the ventrolateral prefrontal cortex is indeed involved in planning these movements." Just by analyzing the brain activity from the implanted electrodes using software algorithms that he wrote, Rizzuto was able to tell with very high accuracy where the target was located while it was on the screen, and also what direction the patient was going to reach to when the target wasn't even there.

Unlike most labs doing this type of research, Andersen's lab is looking at the planning areas of the brain rather than the primary motor area of the brain, because they believe the planning areas are less susceptible to damage. "In the case of a spinal cord injury," says Rizzuto, "communication to and from the primary motor cortex is cut off." But the brain still performs the computations associated with planning to move. "So if we can tap into the planning computations and decode where a person is thinking of moving," he says, then it just becomes an engineering problem--the person can be hooked up to a computer where he can move a cursor by thinking, or can even be attached to a robotic arm.

Andersen notes, "Dan's results are remarkable in showing that the human ventral prefrontal cortex, an area previously implicated in processing information about objects, also processes the intentions of subjects to make movements. This research adds ventral prefrontal cortex to the list of candidate brain areas for extracting signals for neural prosthetics applications."

In Andersen's lab, Rizzuto's goal is to take the technology they've perfected in animal studies to human clinical trials. "I've already met with our first paralyzed patient, and graduate student Hilary Glidden and I are now doing noninvasive studies to see how the brain reorganizes after paralysis," he says. If it does reorganize, he notes, all the technology that has been developed in non-paralyzed humans may not work. "This is why we think our approach may be better, because we already know that the primary motor area shows pathological reorganization and degeneration after paralysis. We think our area of the brain is going to reorganize less, if at all. After this we hope to implant paralyzed patients with electrodes so that they may better communicate with others and control their environment."

Source: California Institute of Technology

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