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Monkey Thinks Robot into Action

A monkey is able to feed itself with a robotic arm.

By Emily Singer on May 28, 2008

In a dramatic display of the potential of prosthetic arms, a monkey at the University of Pittsburgh was able to use his brain to directly control a robotic arm and feed himself a marshmallow. The research, published today in the journal *Nature*, is the first to show that an interface that converts brain signals directly into action is sophisticated enough to perform a practical function: eating. Researchers who led the work have just begun human tests of a related technology.

"It's the first time a monkey–or a human–is directly, with their brain, controlling a real prosthetic arm," says Krishna Shenoy, a neuroscientist at Stanford University who was not involved in the research.

People who suffer from strokes or spinal cord injury, or from some neurodegenerative diseases, such as amyotrophic lateral sclerosis (ALS), are often left paralyzed. But their cerebral cortices–the parts of the brain that control movement, planning, and other functions–may remain largely intact. Scientists hope to capitalize on that with the development of brain machine interfaces–devices that convert brain activity into action, such as movement of a cursor on a computer screen.

People who are completely paralyzed can now use brain machine interfaces that noninvasively measure signals recorded from the surface of the scalp, but the devices are slow and require sustained concentration to operate. To create a prosthesis that works like a real arm–the user thinks about moving his arm, and it moves–will most likely require that electrical activity be recorded directly from the brain.

That has become possible in recent years, thanks to advances in the tiny arrays of electrodes used to record neural signals. In previous research, John Donoghue and his colleagues at Brown University showed that electrodes implanted into the brain of a paralyzed man could be used to move a cursor on a computer screen and even make a simple movement with a robotic arm. But that and other research have been limited to one- or two-dimensional movements, and, other than a few cases using a mechanical arm or gripper, were performed virtually, on a screen.

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See the monkey manipulate the robotic arm so that he can lick the robotic hand.

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In the latest research, headed by neuroscientist Andrew Schwartz at the University of Pittsburgh, the monkey was able to perform a more complicated task. "Andy has taken this one step further, to a practical device that could be of use in the real world," says John Kalaska, a neuroscientist at the University of Montreal, in Canada, who wrote a commentary accompanying the publication. "The animal can simply, through a kind of mental practice, get the robot to move toward where the [food] is, close the hand, and bring it back to the mouth and let him eat it."

To achieve the feat, two monkeys had a grid of microelectrodes implanted into the motor cortex, part of the brain that controls motor planning and execution. The animals had previously been trained to move an anthropomorphic robotic arm, with moveable joints at the shoulder, elbow, and wrist, using a joystick. To learn to control the prosthesis with their minds, the monkeys had their arms temporarily restrained as they watched a computer move the arm through the required motions–to extend the arm to the piece of food, grip it, bring it to the mouth, and release it. "They imagine themselves doing the task, like athletes do for sports," says Schwartz. "The neurons are active as they observe the movement, and then we can capture the [neural signals] and use them for our own control."

Credit: Andrew Schwartz et al.

Tagged: Biomedicine, prosthesis, robotic arm, brain-machine interface, ALS, paralysis

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