Tiny electronic chip, interacting with the brain, modifies pathways for controlling movement

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Researchers at the University of Washington are working on an implantable electronic chip that may help establish new nerve connections in the part of the brain that controls movement. Their most recent study, to be published in the Nov. 2, 2006, edition of *Nature*, showed such a device can induce brain changes in monkeys lasting more than a week. Strengthening of weak connections through this mechanism may have potential in the rehabilitation of patients with brain injuries, stroke, or paralysis.

The authors of study, titled "Long-Term Motor Cortex Plasticity Induced by an Electronic Neural Implant," were Dr. Andrew Jackson, senior research fellow in physiology and biophysics, Dr. Jaideep Mavoori, who recently earned a Ph.D. in electrical engineering from the UW, and Dr. Eberhard Fetz, professor of physiology and biophysics. For many years Fetz and his colleagues have studied how the brains of monkeys control their limb muscles.

When awake, the brain continuously governs the body's voluntary movements. This is largely done through the activity of nerve cells in the part of the brain called the motor cortex. These nerve cells, or neurons, send signals down to the spinal cord to control the contraction of certain muscles, like those in the arms and legs.

The possibility that these neural signals can be recorded directly and used to operate a computer or to control mechanical devices outside of the body has been driving the rapidly expanding field of brain-computer interfaces, often abbreviated BCI. The recent *Nature* study suggests that the brain's nerve signals can be harnessed to create changes within itself.

The researchers tested a miniature, self-contained device with a tiny computer chip. The devices were placed on top of the heads of monkeys who were free to carry out their usual behaviors, including sleep. Called a Neurochip, the brain-computer interface was developed by Mavoori for his doctoral thesis.

"The Neurochip records the activity of motor cortex cells," Fetz explained, "It can convert this activity into a stimulus that can be sent back to the brain, spinal cord, or muscle, and thereby set up an artificial connection that operates continuously during normal behavior. This recurrent brain-computer interface creates an artificial motor pathway that the brain may learn to use to compensate for impaired pathways."

Jackson found that, when the brain-computer interface continuously connects neighboring sites in the motor cortex, it produces long-lasting changes. Namely, the movements evoked from the recording site changed to resemble those evoked from the stimulation site.

The researchers said that a likely explanation for these changes is the strengthening of pathways within the cortex from the recording to the stimulation site. This strengthening may have been produced by the continuous synchronization of activity at the two sites, generated by the recurrent brain-computer interface.

Timing is critical for creating these connections, the researchers said. The conditioning effect occurs only if the delay between the recorded activity and the stimulation is brief enough. The changes are produced in a day of continuous conditioning with the recurrent brain-computer interface, but last for many days after the circuit is turned off.

"This unusually long-lasting plasticity may be related to the fact that the conditioning is associated with normal behavior," Fetz said.

Source: University of Washington