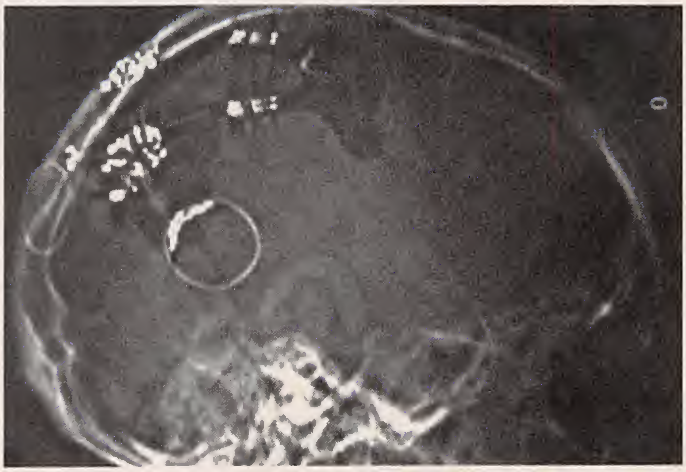
A BRAIN/COMPUTER INTERFACE

An amazing breakthrough could one day allow the paralyzed to communicate and interact with the world around them.



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As someone who has experienced complete paralysis from spinal cord surgery, this author knows the utterly demoralizing frustration of not being able to communicate with the outside world. Fortunately, I recovered (essentially) completely. Many people don't, and as a result have to live in complete isolation with ideas and words that can't be shared with anyone.

There is a chance, however, that all of that could change. Dr. Roy E. Bakay and Dr. Phillip R. Kennedy, neuroscience researchers at Emory University in Atlanta, GA have achieved a breakthrough that promises a way for those left paralyzed and unable to speak from a spinal cord injury, stroke, or diseases like Lou Gehrig's disease to communicate.

More than 700,000 Americans suffer from stroke each year and tens of thousands more suffer spinal cord injuries or from diseases like Lou Gehrig's that threaten their ability to communicate. Stroke is currently the leading cause of permanent adult disability in the U.S.

The researchers have developed a neurotrophic electrode (an electrode implanted with nerve-growth factors) that can be implanted in the brain to allow speech-incapable patients to communicate via a computer. According to Dr. Bakay, "A person can interact with the world if they can use a computer." If someone can move the cursor on a computer, that person can stop on icons to produce phrases, send e-mail, turn on or off a light, and, in general, interact with the outside world in an effective manner.

How It Works. The heart of the concept is the neurotrophic electrode that makes the connection with the brain. The neurotrophic electrode, which is housed in a tiny cone-shaped glass casing, is implanted into the motor cortex. The electrode is about 1.5 mm long and 0.1 to 0.4 mm in diameter. Nerve growth factors are implanted into the glass cone, and the cortical brain cells are induced to grow into the electrode's tip and form contacts. It takes several weeks to three months for the cortical tissue to grow into the electrode; the process is considered complete when the resulting signals become stable.

The neurons in the brain transmit an electronic signal when they "fire." Gold recording wires are placed inside the glass cone to pick up the neural signals from the ingrown brain tissue and transmit them through the skin to a receiver and amplifier outside the scalp. The system is powered by an induction coil placed over the scalp so wires for powering the device do not have to pass through the skull. Signal processors are used to separate individual signals from the multiple signals that are recorded from inside the conical electrode tip. These signals are used to drive the computer cursor in the same way a computer mouse is moved back and forth. Indeed, the recorded neural signals substitute for the mouse cursor.

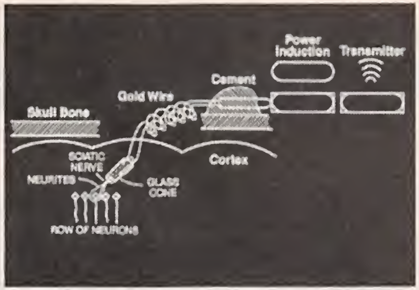
The neurotrophic electrode shown here is the key development in a new system that could someday help paralyzed individuals communicate with the world around them.

Unlike other electrode techniques that have been tried in the past—those primarily used miniature antennae that pierced the surface of the brain and usually lasted for only short periods—this electrode forms an intimate and long-lasting connection with the brain. This basic neurotrophic electrode technology was developed and patented by Dr. Kennedy while at the Georgia Institute of Technology. It was tested and developed using animals for over 12 years before it was implanted in humans. Both Federal Drug Administration and Institutional ethical approvals were obtained before the implants were made.

"The trick is teaching the patient to control the strength and pattern of the electric impulses being produced in the brain," Dr. Bakay said. "After some training, they are able to 'will' a cursor to move and then stop on a specific point on the computer screen."

First Tests. The electrodes have been successfully implanted into the brains of two patients at Emory University Hospital, one with amyotrophic lateral sclerosis (ALS or Lou Gehrig's disease) and one with a brainstem stroke. The first patient was able to control computer signals in an on/off manner for 76 days before she died from her terminal ALS condition.

The second patient, who is at the Atlanta Veterans Affairs Medical Center, is paralyzed except for his face due to a stroke and a subsequent heart attack. While dependent on a ventilator and unable to speak, he is fully alert and intelligent.



As shown in this block diagram, the electrode, which is housed in a cone-shaped glass enclosure, is implanted into the cortex of the brain and brain cells are induced to grow onto its tip. Neurons transmit an electronic signal when they "fire." Gold recording wires pick up the neural signals and transmit them through the skull. The system is powered by an induction coil placed over the scalp.

The electrodes were implanted in the part of the patient's brain that once controlled his arm and facial motion. All he has to do is think about moving his arm to create the electrical signals that are translated by the computer into movement of the cursor from icon to icon in a horizontal direction. As each icon is encountered, a phrase such as "See you later. Nice talking with you." is spoken by the computer.

The researchers are now working to help the patient communicate with the computer to produce speech, as well as provide word processing, control of his environment, and maybe even access the internet. The future includes implanting the electrode in the brains of other "locked-in" patients.

Other Applications. The brain-implant technology has other applications. For instance, it could be used as a "spinal bypass" for those with spinal cord injuries that left them with stiff and uncontrollable muscles. Here neural signals could provide some control of electrical stimulators that activate the paralyzed muscles, therefore bypassing the area of spinal-cord injury.

The technique can also be used for basic research on understanding how the brain works. Never before have recordings been made from a human brain for so long and with such stability. For example, the firings of recorded neurons may change in response to differing inputs from different body parts: If neurons fire with taps to the arm, their firing may change over time from repeated taps to the face. This will help researchers understand how the brain communicates with other parts of the body. Ω