# Rewiring a damaged brain

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Researchers in the Midwest are developing microelectronic circuitry to guide the growth of axons in a brain damaged by an exploding bomb, car crash or stroke. The goal is to rewire the brain connectivity and bypass the region damaged by trauma, in order to restore normal behavior and movement.

Pedram Mohseni, a professor of electrical engineering and computer science at Case Western Reserve University, and Randolph J. Nudo, a professor of molecular and integrative physiology at Kansas University Medical Center, believe repeated communications between distant neurons in the weeks after injury may spark long-reaching axons to form and connect.

Their work is inspired by the traumatic brain injuries suffered by ground troops in Afghanistan and Iraq. Despite improvements in helmets and armor, brain trauma continues to be the signature injury of these wars.

Brain damage carries a heavy toll that may include loss of coordination, balance, mobility, memory and problem-solving skills, with soldiers suffering from mood swings, depression, anxiety, aggression, social inappropriateness and emotional outbursts.

Scientists believe that as the brain develops, it naturally establishes and solidifies communication pathways between neurons that repeatedly fire together.

Nudo and others have found that during the month following injury the brain is redeveloping, with fibers that connect different parts of the brain undergoing extensive rewiring.

"The month following injury is a window of opportunity," Mohseni said. "We believe we can do this with an injured brain, which is very malleable."

Mohseni has been building a multichannel microelectronic device to bypass the gap left by injury. The device, which he calls a brain-machine-brain interface, includes a microchip on a circuit board smaller than a quarter. The microchip amplifies signals, called neural action potentials, produced by the neurons in one part of the brain and uses an algorithm to separate these signals - brain spike activity - from noise and other artifacts. Upon spike discrimination, the microchip sends a current pulse to stimulate neurons in another part of the brain, artificially connecting the two brain regions.

The miniature device currently remains outside the body, connecting to microelectrodes implanted in two regions of the brain.

Nudo has been studying and mapping brain connectivity in a rat model and developing a traumatic brain injury model to test the device and the neuroanatomical rewiring theory.

The researchers began collaborating in 2007. This month they received a $1.44 million grant from the Department of Defense Congressionally Directed Medical Research Program to continue their work and begin testing and improving the device.

During the next four years, they expect to understand the ability to rewire the brain in a rat model and to determine whether the technology is safe enough to test in non-human primates. If tests show the treatment is successful in helping recovery from traumatic brain injury, the researchers foresee the possibility of using the approach in patients 10 years from now.

Provided by Case Western Reserve University