BRAIN-COMPUTER INTERFACES & REFLEX CONDITIONING: NEW METHODS FOR RESTORING FUNCTION

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All of our skills, from walking and talking to the most sophisticated athletic and intellectual capacities, depend on activity-dependent plasticity in the nervous system. This plasticity continues throughout life, has many different mechanisms, and occurs at many different neuronal and synaptic sites from the cortex to the spinal cord. New methods are needed to induce and guide this plasticity to improve motor function in people with severe disabilities due to spinal cord injury, cerebral palsy, stroke, amyotrophic lateral sclerosis (ALS), or other chronic neuromuscular disorders. We are developing two new therapeutic strategies.

One new strategy creates new skills that substitute for important skills that have been lost. People who are paralyzed often need assistive communication and control technology. Brain-computer interfaces (BCIs) allow people to use brain signals, rather than muscles, for communication and control. We have shown that people can learn to use scalp-recorded EEG signals to operate a virtual keyboard or to move a computer cursor in one, two, or three dimensions, and that a BCI system can function reliably in the homes of patients with severe disabilities, can provide them with useful communication (word-processing, environmental control, Internet access, e-mail, etc.), and can do so without excessive technical support. We hope to make BCI technology widely available to people who need it through a non-profit foundation.

The other new strategy improves impaired skills such as walking by teaching simple skills that use the same neuronal circuitry. The neuronal circuits of the spinal cord are the final common pathway for motor skills. By operantly conditioning spinal cord reflexes, we can change these circuits and can thereby affect skills such as locomotion that use the same circuits. Appropriate reflex conditioning can help to reduce locomotor abnormalities caused by spinal cord injury in animals. Human studies are now underway and their initial results are promising. Furthermore, when spinal cord regeneration becomes possible, reflex conditioning methods that can induce and guide spinal cord plasticity may be essential for re-educating the newly regenerated spinal cord so that it supports effective motor function.