Robotic Arm Fueled by Brain Power

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A woman paralyzed from the neck down for 13 years was able to move a prosthetic arm and hand just by thinking after only about 2 days of training, researchers reported.

After 13 weeks with the brain-machine interface, she could reach out and perform tasks 7-dimensionally with the prosthesis successfully 92% of the time, Andrew B. Schwartz, PhD, of the University of Pittsburgh, and colleagues reported online in The Lancet.

Her scores on the action research arm test (ARAT) typically used to assess arm function in activities of daily living after a stroke rose from 0 to 15 to 17 out of a possible 27, which far exceeded the 5.7-point improvement needed to be considered clinically significant.

"With continued development of neuroprosthetic limbs, individuals with long-term paralysis could recover the natural and intuitive command signals for hand placement, orientation, and reaching, allowing them to perform activities of daily living," the group predicted.

The device interface is a remarkable achievement, Grégoire Courtine, PhD, of the Center for Neuroprosthetics and Brain Mind Institute at the Swiss Federal Institute of Technology in Lausanne, and colleagues declared in an accompanying commentary.

Animal studies had been promising with the technology, but this is the first time a person has performed better than a monkey in such experiments, they explained.

They chalked the success up to a control architecture mimicking the central nervous system itself, which is thought to feed an abstraction of desired motion from the motor cortex to the brainstem and spinal cord, where smart circuits do the rest.

"The participant reported that she was only focusing on the goal of the action, as opposed to the details of the kinematic trajectory or other precise control parameters," Courtine's group noted.

The woman, who had become quadriplegic 13 years prior due to spinocerebellar degeneration, had two silicon-substrate microelectrode arrays surgically implanted in her motor cortex that recorded ensemble neuronal activity.

An algorithm then translated brain waves into intended movement commands and fed them to a shared controller that integrated the desired movement with robotic position feedback and task-dependent constraints to guide the prosthetic limb.

The patient's success rate in reaching and grasping at computer-generated targets in seven dimensions (translation, orientation, and grasp) was 76% initially compared with a median chance success rate of 37% due to computer assistance in some regards.

During the final two weeks without any computer assistance, her mean success rate reached 92% compared with a median chance success rate of 6%.

"The participant did the maneuvers with coordination, skill, and speed almost similar to that of an able-bodied person," the group reported.

Further developments in the technology are expected soon, the researchers pointed out.

Adding hand shape will allow the prosthesis to do a wider range of tasks, tactile feedback can be transmitted to the sensory cortex, telemetry will remove the need for transcutaneous leads and connectors, and individual's own muscles will be reanimated with the technology, they predicted.

"Our results and the very rapid developments in this specialty show the potential to restore much of the function lost in individuals with tetraplegia or upper limb amputation, allowing them to regain natural behaviors to interact with the world around them," they wrote.

However, there are still plenty of challenges ahead to getting the brain-controlled prosthesis into real-world use, Courtine's group pointed out.

"These issues include safe, low-power, and wireless microsystems for neuronal recordings that remain operational for decades, and stable decoders that give robust performance without daily retraining," they wrote, all nontrivial hurdles.

Other avenues being explored are interfacing prosthetic hands with peripheral nerves for amputees and non-invasive electroencephalographic and electrocorticographic brain-machine interfaces for paralyzed people.

"Although many obstacles remain, neural prosthetic systems are rapidly approaching clinical fruition," Courtine and colleagues agreed.