News Center

Brain-computer interface advance allows fast, accurate typing by paralysis

In a Stanford-led research report, three participants with movement impairment controlled an c imagining their own hand movements.

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A clinical research publication led by Stanford University investigators has demonstrated that a brain-to-com with paralysis to type via direct brain control at the highest speeds and accuracy levels reported to date.

The report involved three study participants with severe limb weakness — two from amyotrophic lateral scler disease, and one from a spinal cord injury. They each had one or two baby-aspirin-sized electrode arrays plac from the motor cortex, a region controlling muscle movement. These signals were transmitted to a computer algorithms into point-and-click commands guiding a cursor to characters on an onscreen keyboard.

Stanford researchers develop brain-controlled typing for people with paralysis

Each participant, after minimal training, mastered the technique sufficiently to outperform the results of any previous test c
for enhancing communication by people with similarly impaired movement. Notably, the study participants achieved these
automatic word-completion assistance common in electronic keyboarding applications nowadays, which likely would have

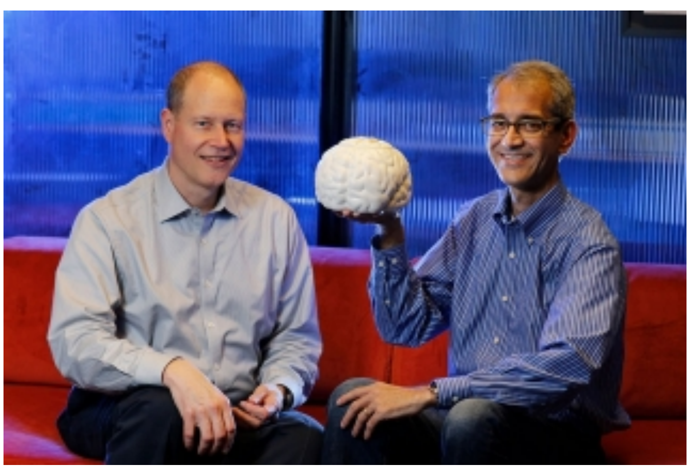
One participant, Dennis Degray of Menlo Park, California, was able to type 39 correct characters per minute, equivalent to a

'A major milestone'

This point-and-click approach could be applied to a variety of computing devices, including smartphones and tablets, witho
Stanford researchers said.

"Our study's success marks a major milestone on the road to improving quality of life for people with paralysis," said Jaimie
neurosurgery, who performed two of the three device-implantation procedures at Stanford Hospital. The third took place a

Henderson and Krishna Shenoy, PhD, professor of electrical engineering, are co-senior authors of the study, which was pub
lead authors are former postdoctoral scholar Chethan Pandarinath, PhD, and postdoctoral scholar Paul Nuyujukian, MD, Ph
two years working full time on the project at Stanford.



Stanford's Jaimie Henderson and Krishna Shenoy are part of a consortium working on an investigational brain-to-computer hookup.
Paul Sakuma

"This study reports the highest speed and
what's been shown before," said Shenoy,
investigator who's been pursuing BCI dev
with Henderson since 2009. "We're appro
type text on your cellphone."

"The performance is really exciting," said
appointment at Emory University and the
an assistant professor of biomedical engi
communication rates that many people w
find useful. That's a critical step for makin
real-world use."

Shenoy's lab pioneered the algorithms us
electrical signals fired by nerve cells in th
command center for movement, and con
ordinarily executed by spinal cord and m

“These high-performing BCI algorithms’ use in human clinical trials demonstrates the potential for this class of technology with paralysis,” said Nuyujukian.

Life-changing accident

Millions of people with paralysis reside in the United States. Sometimes their paralysis comes gradually, as occurs in ALS. So Degray’s case.

Now 64, Degray became quadriplegic on Oct. 10, 2007, when he fell and sustained a life-changing spinal-cord injury. “I was said. Holding the garbage in one hand and the recycling in the other, he slipped on the grass and landed on his chin. The im injured his spine, cutting off all communication between his brain and musculature from the head down.

“I’ve got nothing going on below the collarbones,” he said.

Degray received two device implants at Henderson’s hands in August 2016. In several ensuing research sessions, he and the underwent similar surgeries, were encouraged to attempt or visualize patterns of desired arm, hand and finger movements motor cortex were electronically extracted by the embedded recording devices, transmitted to a computer and translated b commands directing a cursor on an onscreen keyboard to participant-specified characters.

The researchers gauged the speeds at which the patients were able to correctly copy phrases and sentences — for example, the lazy dog.” Average rates were 7.8 words per minute for Degray and 6.3 and 2.7 words per minute, respectively, for the ot

A tiny silicon chip

The investigational system used in the study, an intracortical brain-computer interface called the BrainGate Neural Interface generation of BCIs. Previous generations picked up signals first via electrical leads placed on the scalp, then by being surgic beneath the skull.

An intracortical BCI uses a tiny silicon chip, just over one-sixth of an inch square, from which protrude 100 electrodes that p thickness of a quarter and tap into the electrical activity of individual nerve cells in the motor cortex.

> *“This is like one of the coolest video games I’ve ever gotten to play with.”*

Henderson likened the resulting improved resoluti that of older-generation BCIs, to that of handing ou members of a studio audience rather than just stati can tell just how hard and how fast each person in t

Shenoy said the day will come — closer to five than when a self-calibrating, fully implanted wireless system can be used without caregiver assistance, has no cosmetic impact a

“I don’t see any insurmountable challenges.” he said. “We know the steps we have to take to get there.”

Degray, who continues to participate actively in the research, knew how to type before his accident but was no expert at it. prowess in the language of a video game aficionado.

“This is like one of the coolest video games I’ve ever gotten to play with,” he said. “And I don’t even have to put a quarter in

The study's results are the culmination of a long-running collaboration between Henderson and Shenoy and a multi-institu Leigh Hochberg, MD, PhD, a neurologist and neuroscientist at Massachusetts General Hospital, Brown University and the VA Development Center for Neurorestoration and Neurotechnology in Providence, Rhode Island, directs the pilot clinical trial c study co-author.

"This incredible collaboration continues to break new ground in developing powerful, intuitive, flexible neural interfaces th communication, mobility and independence for people with neurologic disease or injury," said Hochberg.

Stanford research assistant Christine Blabe was also a study co-author, as were BrainGate researchers from Massachusetts University.

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Stanford's Office of Technology Licensing holds intellectual property on the intercortical BCI-related engineering advances r

Stanford's departments of Neurosurgery and of Electrical Engineering also supported the work. Shenoy and Henderson are Neuroscience Institute.

*CAUTION: Investigational Device. Limited by Federal Law to Investigational Use.

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