Researcher Controls Colleague’s Motions in First Human Brain-to-Brain Interface

Doree Armstrong and Michelle Ma, University of Washington

Researchers have performed what they believe is the first noninvasive human-to-human brain interface [1], with one researcher able to send a brain signal via the Internet to control the hand motions of a fellow researcher. Using electrical brain recordings and a form of magnetic stimulation, Rajesh Rao [2] sent a brain signal to Andrea Stocco [3] on the other side of the University of Washington campus, causing Stocco’s finger to move on a keyboard.

While researchers at Duke University have demonstrated brain-to-brain communication between two rats, and Harvard researchers have demonstrated it between a human and a rat, Rao and Stocco believe this is the first demonstration of human-to-human brain interfacing.

“The Internet was a way to connect computers, and now it can be a way to connect brains,” Stocco said. “We want to take the knowledge of a brain and transmit it directly from brain to brain.”

The researchers captured the full demonstration on video recorded in both labs. The following version has been edited for length.

Rao, a UW professor of computer science and engineering, has been working on brain-computer interfacing in his lab for more than 10 years and just published a textbook [4] on the subject. In 2011, spurred by the rapid advances in technology, he believed he could demonstrate the concept of human brain-to-brain interfacing. So he partnered with Stocco, a UW research assistant professor in psychology at the UW’s Institute for Learning & Brain Sciences [5].

On August 12, 2013, Rao sat in his lab wearing a cap with electrodes hooked up to an electroencephalography [6] machine, which reads electrical activity in the brain. Stocco was in his lab across campus wearing a purple swim cap marked with the stimulation site for the transcranial magnetic stimulation [7] coil that was placed directly over his left motor cortex, which controls hand movement.

The team had a Skype connection set up so the two labs could coordinate, though neither Rao nor Stocco could see the Skype screens.

Rao looked at a computer screen and played a simple video game with his mind. When he was supposed to fire a cannon at a target, he imagined moving his right hand (being careful not to actually move his hand), causing a cursor to hit the "fire" button. Almost instantaneously, Stocco, who wore noise-canceling earbuds and wasn't looking at a computer screen, involuntarily moved his right index finger to push the space bar on the keyboard in front of him, as if firing the cannon. Stocco compared the feeling of his hand moving involuntarily to that of a nervous tic.

"It was both exciting and eerie to watch an imagined action from my brain get translated into actual action by another brain," Rao said. "This was basically a one-way flow of information from my brain to his. The next step is having a more equitable two-way conversation directly between the two brains."

The technologies used by the researchers for recording and stimulating the brain are both well-known. Electroencephalography, or EEG, is routinely used by clinicians and researchers to record brain activity noninvasively from the scalp. Transcranial magnetic stimulation is a noninvasive way of delivering stimulation to the brain to elicit a response. Its effect depends on where the coil is placed; in this case, it was placed directly over the brain region that controls a person's right hand. By activating these neurons, the stimulation convinced the brain that it needed to move the right hand.

Computer science and engineering undergraduates Matthew Bryan, Bryan Djunaedi, Joseph Wu and Alex Dadgar, along with bioengineering graduate student Dev Sarma, wrote the computer code for the project, translating Rao's brain signals into a command for Stocco's brain.

"Brain-computer interface is something people have been talking about for a long, long time," said Chantel Prat [8], assistant professor in psychology at the UW's Institute for Learning & Brain Sciences, and Stocco's wife and research partner who helped conduct the experiment. "We plugged a brain into the most complex computer anyone has ever studied, and that is another brain."

At first blush, this breakthrough brings to mind all kinds of science fiction scenarios. Stocco jokingly referred to it as a "Vulcan mind meld." But Rao cautioned this technology only reads certain kinds of simple brain signals, not a person's thoughts. And it doesn't give anyone the ability to control your actions against your will.

Both researchers were in the lab wearing highly specialized equipment and under

ideal conditions. They also had to obtain and follow a stringent set of international human-subject testing rules to conduct the demonstration.

"I think some people will be unnerved by this because they will overestimate the technology," Prat said. "There's no possible way the technology that we have could be used on a person unknowingly or without their willing participation."

Stocco said years from now the technology could be used, for example, by someone on the ground to help a flight attendant or passenger land an airplane if the pilot becomes incapacitated. Or a person with disabilities could communicate his or her wish, say, for food or water. The brain signals from one person to another would work even if they didn't speak the same language.

Rao and Stocco next plan to conduct an experiment that would transmit more complex information from one brain to the other. If that works, they then will conduct the experiment on a larger pool of subjects.

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