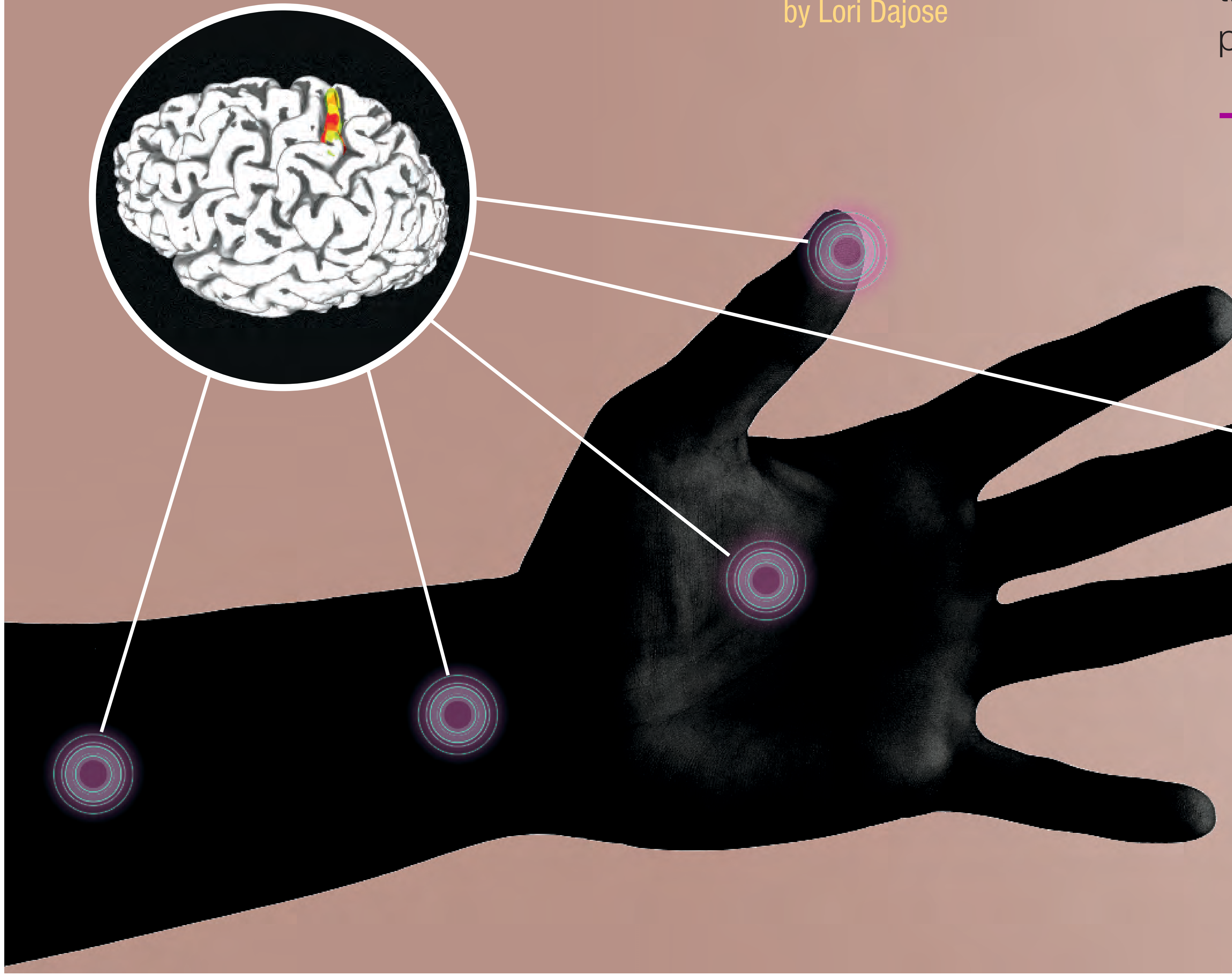
To Feel Again

by Lori Dajose

A tiny brain implant developed at Caltech returns the sensations of touch and movement to a paralyzed man's arms and hands.



Three years ago, a man became paralyzed from the shoulders down after a spinal cord injury; since that time, he had been unable to move or even feel his limbs. Now, however, he is able to experience sensations of touch and movement in his hands and arms when two tiny electrode arrays activate particular neurons. Developed in the laboratory of Caltech neuroscientist Richard Andersen, the electrodes were implanted in the somatosensory cortex of the man's brain.

The somatosensory cortex is a strip of brain tissue that governs the body's proprioceptive sensations (sensations of movement or the body's position in space) and cutaneous sensations (those of pressure, vibration, touch, and the like).

Although previous work by other groups has been able to produce tingling or buzzing sensations in patients' hands, the Andersen lab's implants were the first to create more natural sensations with very small pulses of electricity within the brain's cortex. According to Andersen's patient, the sensations varied in type, intensity, and location, and they felt more closely akin to those he had experienced prior to his injury.

"It was quite interesting," he says. "It was a lot of pinching, squeezing movements, things like that."

In 2015, the Andersen lab developed brain-machine interfaces (also known as BMIs) to connect a prosthetic robotic arm to electrodes implanted in the region of the brain that governs intentions. In this way, a different paralyzed man was able to reach out with a prosthetic arm, grasp a cup, and bring it to his mouth to take a drink. What was missing, however, was the ability to actually *feel* the cup in the prosthetic hand; this new implant could create a bidirectional interface that would make that sort of sensation possible.

"Currently the only feedback that is available for neural prosthetics is visual, meaning that participants can watch the brain-controlled operation of robotic limbs to make corrections," says Andersen. "However, once an object is grasped, it is essential to also have somatosensory information to dexterously manipulate the object. Stimulation-induced somatosensory sensations have the potential added advantage of producing a sense of embodiment; for example, a participant may feel over time that the robotic limb is a part of their body."

A paper describing this work appeared in the April 10 issue of the journal *eLife* and included authors from Caltech, the Keck School of Medicine at USC, and the Rancho Los Amigos National Rehabilitation Center.

Richard Andersen is the James G. Boswell Professor of Neuroscience, T&C Chen Brain-Machine Interface Center Leadership Chair, and director of the T&C Chen Brain-Machine Interface Center. Funding for this research was provided by the U.S. Department of Health and Human Services, the National Institutes of Health, the National Institute of Neurological Disorders and Stroke, the T&C Chen Brain-Machine Interface Center, the Della Martin Foundation, the Boswell Foundation, the National Science Foundation, and the David Geffen Medical Scholarship.