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A Bright Approach to Brain Implants

New light-based brain implants could help stimulate individual cells and offer more targeted therapies

So far, sending messages inward via man-made technologies has been an inexact science. *PHOTO: ISTOCK*

By **KARA PLATONI**

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The brain was once considered a "black box," a device so mysterious that you could only guess what it was doing by observing human behavior. You might log its output and glitches, but you'd never parse its code. Scientists are now much closer to engaging the brain in electrochemical conversation—and that could lead to a new generation of high-tech treatments for ailments like stroke, blindness and diseases of aging.

This conversation with the brain has two sides. Neuroscientists call the first “writing in” (sending information to the brain) and the second “reading out” (understanding instructions coming from the brain.) Our senses normally write in—they collect information from the world and convey it to the brain, which interprets it.

So far, sending messages inward via man-made technologies has been an inexact science.

Researchers sometimes compare the brain to a forest, with its neurons clustered together as tightly as trees. Each neuron has an axon that extends from its body like a root. Neurons communicate by forming and breaking electrochemical connections called synapses, passing information from one cell’s axon to the next cell’s dendrites, which are a bit like tiny branches.

Some of the earliest brain implants used an electrode to stimulate the brain; the FDA approved such a device in 2002 for the tremor associated with Parkinson’s disease. But Krishna Shenoy, a pioneering neuroprosthetics researcher at Stanford University, likens electrical current to a river: You can’t control the water’s flow, or which kind of trees it reaches or which roots absorb the most. Stimulating so many neuron types haphazardly can produce some fuzziness in the effect of the treatment. A similar problem arises with medication: You can’t precisely control which cells it reaches.

But light could more precisely stimulate individual cells. This nascent technology is called optogenetics, and scientists are eager to explore it. The idea: Light-sensitive proteins are inserted into cells using gene therapy. Then neurons can be delicately activated or quieted using light patterns conveyed through implanted fiber optics. These patterns more accurately mimic the electrochemical pulses of the brain’s language.

Today, as part of the federally funded BrainGate research team, Dr. Shenoy’s lab is working on developing thought-controlled prosthetic limbs. This is an example of a “read out” technology: These tiny brain implants would read a person’s intent to move a prosthetic limb, and a person would only have to think for the limb to respond. Similar implants could help people paralyzed by a stroke or Lou Gehrig’s disease to move a computer cursor to communicate their thoughts. But to develop even more complex “write in” touch technology, so that a person could know how tightly their prosthetic hand is gripping an object or feel the warmth of another’s hand, researchers will need a more exact way to speak to the brain—with light.

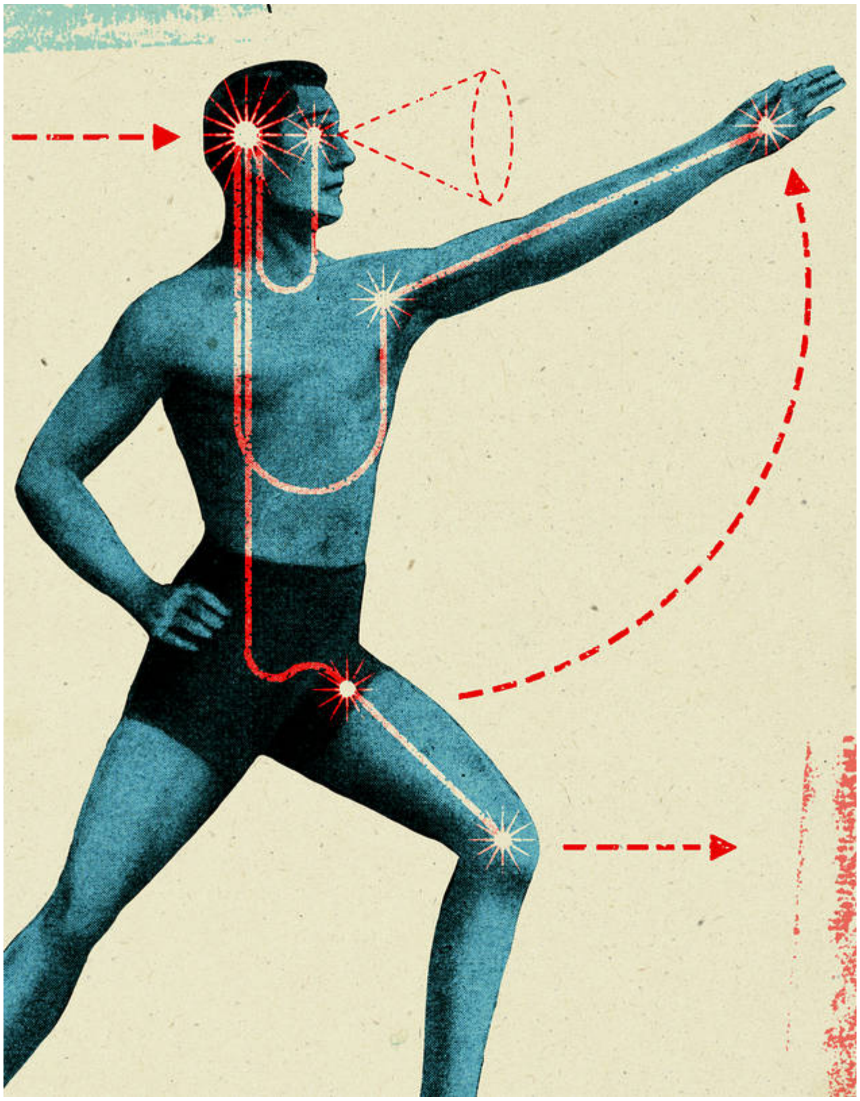
Next-generation implants may someday treat diseases of the brain itself, particularly those of aging. Such ailments are increasingly common as people live longer but devilishly hard to treat. One day, brain implants might “patch over” areas damaged by stroke or neurodegenerative illnesses, allowing healthy parts of the brain to communicate.

Optogenetics is also being considered for a new generation of sensory devices, like retinal implants to help people who have lost their vision regain some degree of sight. Today, the Argus II, a retinal implant made by Second Sight, works by transforming a camera feed into electrical impulses. These travel to an implant inside a person’s eye, where they stimulate surviving photoreceptors and pass visual information to the brain.

This produces a low-resolution form of vision, a mainly black-and-white universe lighted by flashes indicating contrast points between dark and light. Some researchers imagine future implants that would stimulate retinal cells using light rather than electricity, creating an even finer visual experience.

ILLUSTRATION: PEP MONTSERRAT

Another approach to learning the brain’s language is a technology called “stimulus reconstruction,” otherwise known as “brain reading.” At the University of California, Berkeley (where I teach journalism), several labs are exploring the



use of mathematical models to read out and interpret brain activity.

The first generation of these experiments involved building a model that could accurately identify and re-create images or sounds a person had seen or heard as they lay inside an fMRI scanner, which recorded their brain activity. Now the researchers are working on applying that technique to reconstructing the imaginary—images seen by the mind's eye or the internal speech that narrates your thoughts. These scientists too envision helping people with locked-in syndrome or ALS communicate, perhaps by using a device that would speak their thoughts aloud.

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For now, there may be other ways to find a shortcut around neurodegenerative damage—at least temporarily. I visited a hospital in Paris where volunteers from Cosmetic Executive Women were experimenting with "olfactotherapy," or using scents to help people with Alzheimer's disease recall and share memories.

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Trouble smelling is often one of the first clinically observable symptoms of Alzheimer's. (Don't worry if you don't smell as well as you used to: Olfaction always fades a bit with age.) Alzheimer's doesn't create an inability to smell anything; it just makes it increasingly difficult to differentiate between smells. Yet because the brain's olfactory center is deeply connected to the areas that process emotion and memory, scents have tremendous nostalgic power, even if you misidentify which one you're smelling.

The olfactotherapy testers found that even summoning the wrong scent-associated memory can offer people a moment of pleasure. That can be a boon for Alzheimer's patients, who often withdraw socially as they find it harder to recall words. For their family members, it is a poignant reminder that their loved one is still the same person.

This workaround isn't a cure, and its effect is fleeting. But until scientists can fluently communicate in the brain's own code, we can still try a few clever hacks.

—Ms. Platoni is the author of "We Have the Technology," recently published by Basic Books.