

Train Your Brain

Cutting-edge therapies can reshape the body's most complex organ.

BY TOM VALEO

Not so long ago, scientists viewed the brain as something like organic concrete—soft and pliable in youth but gradually hardening over the years into a rigid organ highly resistant to change.

Scientists now recognize that the brain remains malleable throughout life. This neuroplasticity—the ability of neurons to adapt to the demands placed upon them—can produce dramatic improvements in brain function. In fact, repetitive exercises, and sometimes mere thought itself, can transform the brain as effectively as many drugs do.

“Neurology, psychology, speech therapy, education, sports—all of these domains will be improved as we apply the laws of neuroplasticity,” says Norman Doidge, M.D., author of *The Brain That Changes Itself: Stories of Personal Triumph from the Frontiers of Brain Science* (Viking, 2007).

STROKE REHAB

The evidence for neuroplasticity has accumulated steadily in recent decades. In the 1980s, neuroscientist Edward Taub, Ph.D., noticed that when the sensory nerves running to a monkey's arm were cut, causing numbness, the monkey would stop using the limb, even though the nerves controlling the muscles were in perfect working order. When Dr. Taub put the undamaged arm in a sling, the monkey used the numb arm again.

This led to a form of stroke rehabilitation known as constraint-induced movement therapy, widely used today. Like Dr. Taub's monkeys, people will start using a paralyzed arm if their good arm is constrained for several hours a day. An undamaged part of the brain handles signals to and from the paralyzed arm, and these



signals get stronger with practice.

In a similar way, deaf children can learn to decipher sounds transmitted to the brain through a cochlear implant, developed by Michael Merzenich, Ph.D., a neuroscientist at the University of California at San Francisco. The device, a microphone mounted discreetly behind one ear, transforms sounds into electrical signals that are delivered through wires directly into the auditory center of the brain, which learns to interpret human speech and other sounds.

DYSLEXIA, COGNITIVE IMPAIRMENT

Dr. Merzenich also developed an effective treatment for dyslexia that exploits brain plasticity. According to Dr. Merzenich, dyslexic children don't have a problem seeing words, as commonly believed; rather, they have trouble hearing short, rapid sounds, such as “bap” and “cap.” So it's difficult for them to sound out words when they read. Dr. Merzenich created a computer game

that slows down those sounds enough so the children can recognize the differences among them. The game gradually increases the speed as the children improve. Eventually they can hear the sounds as clearly as anyone, and their ability to read rapidly improves.

The success of the computer game prompted Dr. Merzenich, along with Paula Tallal of Rutgers University, to create the Scientific Learning Company that markets the games under the name Fast ForWord. He also created Posit Science to market the Brain Fitness Program, another series of computer games designed to help older people exercise parts of the brain that grow weaker with age. One unpublished study by John Gabrieli, Ph.D., at Massachu-

setts Institute of Technology, found that people with mild cognitive impairment who used the Brain Fitness Program had greater blood flow in their hippocampus, the brain structure essential for forming short-term memories. More studies are planned.

AUTISM, SCHIZOPHRENIA, OCD

Now Dr. Merzenich is trying to use brain plasticity to shore up the brain dysfunctions of schizophrenia and autism.

“They're inherited weaknesses, but you can drive the brain in a corrective direction by intensively training it,” Dr. Merzenich says. “With these disorders, brain development progresses for a while, and then there's a catastrophic failure. By understanding the fundamental neural bases of that failure and then driving the brain in a positive direction, we can get big corrections.”

Controlled trials of his training strategy for schizophrenia, which takes about 120 hours to complete, are underway at

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UCSF and at Yale. The training uses the computer to challenge patients in ways that sharpen perception, visual and auditory response, and movement. The results so far are very promising, Dr. Merzenich says.

Jeffrey Schwartz, M.D., a professor of psychiatry at the UCLA School of Medicine, has used neuroplasticity to counteract the “brain lock” that produces obsessive-compulsive disorder.

Borrowing techniques from Buddhist meditation, which develops the ability to view one’s experiences dispassionately, Schwartz taught his patients to “relabel” their obsessions and compulsions as mere brain malfunctions rather than as character defects. (“It’s not me, it’s my OCD,” as one patient puts it.) When they sense the onset of their compulsion, they “refocus” their mind toward a constructive behavior—tending houseplants, for example—so the OCD circuit is interrupted. They also “revalue” their compulsions, reminding themselves that the urges have no inherent value.

These simple steps have freed many patients of their compulsions, according to Dr. Schwartz, and PET scans have backed up that claim by revealing decreased activity in the left and right caudate, brain regions behind the eyes that flare with activity in people who have OCD. Cells in the orbital frontal cortex light up when we detect that something is wrong, and normally they calm down again right away. In patients with OCD, this function persists, generating a chronic sense that something is wrong and must be fixed. Projections from the orbital frontal cortex extend into the striatum, which includes two information-integrating centers—the caudate nucleus and the putamen. The striatum also receives input from the limbic system, which generates an emotional charge that lends a

sense of urgency to thoughts. This combination of cognitive and emotional input makes the striatum crucial for the forming of habits, something that people with OCD do with ferocious intensity. Once a habit is formed (washing hands in response to a feeling of being contaminated with germs, for example), any violation of the habit alerts the OFC that something is wrong, which reinforces the circuit. Dr. Schwartz’s techniques are designed to interrupt this feedback mechanism.

“I had been doing mindfulness meditation myself since about 1975,” Dr. Schwartz says. “I realized that mindful awareness could help OCD patients rec-

ognize that their brain was sending them a false message. The results turned out to be reproducible and testable.”

In 1913 the great Spanish neuroanatomist Ramon y Cajal wrote that in the adult brain, “the nerve paths are something fixed, ended, immutable. Everything may die, nothing may be regenerated. It is for the science of the future to change, if possible, this harsh decree.”

It looks as though the future he envisioned is now. NN

Tom Valeo is a science and medical writer whose articles have appeared on WebMD and in Scientific American, BrainWork, the Dana Foundation’s 2007 Progress Report on Brain Research, Heart Insight, and other publications.

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