

## Mind Over Matter, With a Machine's Help

By JASON PONTIN

WOULD that thinking made it so, people sometimes wistfully say. But Christopher deCharms, the chief executive of Omneuron, a start-up in Menlo Park, Calif., believes the adage.

The company he founded has created technologies that teach sufferers to think away their pain, and plans to similarly treat addiction, depression and other intractable neurological and psychological conditions.

Omneuron is one of a number of new companies that are commercializing a brain-scanning technology called real-time functional magnetic resonance imaging, or fMRI. Using large scanners to measure blood flow to different parts of the brain, the technology makes the brain's activity visible by revealing which of its parts are busiest when we perform different tasks.

While fMRI dates back to the early 1990s, hitherto it has been used mainly by doctors in hospitals to make diagnoses. The commercialization of brain scanning is a recent development, spurred by the refinement of the technology. Omneuron, which Dr. deCharms founded in 2001 and whose research has been funded by the National Institutes of Health, uses fMRI to teach people how to play with their own heads. Other entrepreneurs are working on ways to deploy fMRI as a lie detector, a tool for conducting marketing research or an instrument to make brain surgeries safer and more precise.

Here's how Omneuron uses fMRI to treat chronic pain: A patient slides into the coffin-like scanner and watches a computer-generated flame projected on the screen of virtual-reality goggles; the flame's intensity reflects the neural activity of regions of the brain involved in the perception of pain. Using a variety of mental techniques — for instance, imagining that a painful area is being flooded with soothing chemicals — most people can, with a little concentration, make the flame wax or wane. As the flame wanes, the patient feels better. Superficially similar to an older technology, electroencephalogram biofeedback, which measures electrical feedback across multiple areas of the brain, fMRI feedback measures the blood flow in precise areas of the brain.

“We believe that people will use real-time fMRI feedback to hone cognitive strategies that will increase activation of brain regions,” Dr. deCharms said.

With practice and repetition, he said, this could lead to “long-term changes in the brain.”

In time, he hopes, a patient could evoke the effect without the machine.

In a 2005 study, Dr. deCharms and Sean Mackey, associate director of the pain management division at Stanford, showed that eight patients with recalcitrant pain felt their discomfort reduced by as much as 64 percent by using Omneuron's technology.

If fMRI proves effective in treating pain, it could be big business. According to the American Chronic Pain Association, one in three Americans will experience chronic pain at some point in life. At any one time, more than 50 million Americans complain of pain. And Dr. deCharms contends that fully one-third find their pain resistant to traditional treatments like narcotics. Omneuron's technologies could offer such patients some relief, and without side effects.

The pain-relief industry is huge: the average American spends as much as \$900 a year on pain medications, whose effects are generally short-lived.

But Dr. deCharms says that controlling pain is just one of many possible uses for fMRI feedback. Today, Omneuron is also researching treatments for addiction, depression and other psychological illnesses. In addition, he said, the company has contemplated “several dozen applications,” including the treatment of stroke and epilepsy. Brain scanning could even be used to improve athletic performance, he speculated.

Doctors and drug-abuse experts are particularly excited about the idea of treating addiction using fMRI. While scientists have talked about such an application since the technology was invented, Omneuron is the first to work on a real therapy. “We might have a tool to help control the inner sensation of craving,” said Nora D. Volkow, director of the National Institute on Drug Abuse, which helped fund Omneuron's research into addiction.

A growing number of ventures hope to turn fMRI into a business. The most well-publicized is No Lie MRI, which wants to sell brain scanning to law firms and governmental bodies like police departments or security and intelligence agencies as a replacement for the notoriously unreliable polygraph test. No Lie MRI has already begun selling what it calls its truth verification technology for about \$10,000 to individuals keen to prove their innocence.

Joel Huizenga, the chief executive of No Lie MRI, said: “A technology gets known by its first product. For fMRI, that application is going to be truth verification.”

Mr. Huizenga says he would also like to sell fMRI to marketers who wish to determine whether consumers are responding to advertising, a commercial application of an emerging field of research called neuro-economics.

Other brain-scanning ventures include Cephos, another lie-detection company, and Imagilys, which sells fMRI to surgeons who want to map the brains of patients before operations.

For its part, Omneuron would make money not by building fMRI centers — which are expensive and fairly common in larger hospitals — but by selling clinical skills, software and equipment.

“I imagine the business model would be akin to Lasik eye surgery,” Dr. deCharms says. “We’d provide the technology to outpatient treatment centers.”

There are challenges to the commercialization of brain scanning, and the most important may be regulatory. Clinical trials can take many years, and federal approval is famously unpredictable. But until clinical data and federal approval are forthcoming, Dr. deCharms says, Omneuron cannot sell its technology as a clinical treatment.

Ed Boyden, an assistant professor at the Media Lab of the Massachusetts Institute of Technology and a researcher in neuroengineering, distinguishes sharply among different brain-scanning ventures. “If you want to commercialize this technology,” he said, “then the use has to approximate real-world situations.”

In his view, tests of fMRI truth verification don’t meet that criterion. For instance, in studies at the University of Pennsylvania in 2002 and 2005, subjects were told to conceal the identity of a card under questioning. FMRI was able to distinguish falsification 77 percent of the time.

Mr. Huizenga was so inspired by this research that he decided to start his company, confident that fMRI would soon identify lies 90 percent of the time.

But Dr. Boyden says he believes that being asked to tell a falsehood that everyone knows is a falsehood is not the same thing as lying to deceive someone. Thus, whatever brain patterns fMRI detects when a person constructs such a requested fiction may be different from whatever happens when we lie.

By contrast, Dr. Boyden says: “What I like about Omneuron is that it’s working with real-world situations. They gave people visualization strategies which they could monitor — and which produced real, measurable results.”

If Dr. deCharms and Omneuron are successful, and can teach us to train our brains to manage neurological and psychological conditions, they will have given us something that has challenged philosophers, psychologists and yogis alike: gaining some reliable control over our own thoughts.