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McLean Study

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Magnetism and the brain

By Marianne Szegedy-Maszak

It began as just another research project, in this case to examine the effects of various drugs on patients with a severe mood disorder. Using an advanced brain scanning technology--the clumsily named echo-planar magnetic resonance spectroscopic imaging procedure, or EP-MRSI--researchers at Boston's McLean Hospital scanned the medicated and unmedicated brains of 30 people with bipolar disorder in order to detect possible new treatments for the more than 2 million American adults who suffer from the disease.

But something unexpected happened. A patient who had been so depressed she could barely speak became ebullient after the 45-minute brain scan. Then a second patient, who seemed incapable of even a wan smile, emerged actually telling jokes. Then another and another. Was this some bizarre coincidence? Aimee Parow, the technician who made these observations (she is now a medical student in New York) didn't think so. She mentioned the patients' striking mood shifts to her boss, and together they completely refocused the study: to see if the electromagnetic fields might actually have a curative effect on debilitating melancholy.

As it turns out, they did. As reported last month in the American Journal of Psychiatry, 23 of the 30 people who were part of the study reported feeling significantly less depressed after the scan. The most dramatic improvements were among those who were taking no medication. The researchers are cautious. Says Bruce Cohen, McLean's president and psychiatrist in chief: "I want to emphasize that we are not saying this is the answer. . . . but this is a completely different approach in trying to help the brain than anything that was done before."

Looking back. It's a completely different approach because of the way the magnetism is applied to the brain. But it's an example of burgeoning new research on an old idea: that the brain is an electromagnetic organ and that brain disorders might result from disarray in magnetic function. The idea has huge appeal to psychiatrists and patients alike, since for many people the side effects of psychiatric drugs are almost as difficult to manage as the disease itself. And 30 percent of the nearly 18.8 million people who suffer from depression do not respond to any of the antidepressants available now. People with other severe mental disorders--schizophrenia, obsessive-compulsive disorder--might benefit as well. And while no one fully understands exactly why or how the brain

responds as it does to electrical currents and magnetic waves, intriguing new research is offering some possible explanations.

This area of psychiatric research and treatment has a grisly history to overcome. "Shock treatment," technically known as electroconvulsive therapy, or ECT, has been around since the 1930s, but its unsavory public image comes mostly from movies like One Flew Over the Cuckoo's Nest and The Snake Pit. And from fact: It was in the early days a brutal procedure. But research on the magnetic brain has led to improvements in such treatments, and their use is on the rise. In 1980 30,000 people received ECT; in 2001, nearly 100,000. Although there are still side effects--headaches and memory problems primarily--the days of seizures, bitten tongues, and broken bones are largely a thing of the past. And the response rate, especially for treatment of drug-resistant depression, is as high as 70 percent.

A related treatment, called rapid transcranial magnetic stimulation or RTMS, creates a current in the brain by using a magnetic field that crosses the exterior of the skull. It has also proved successful in treating depression. Much like the way a defibrillator works in the heart, RTMS uses a powerful magnet to deliver an electric jolt to the brain. In clinical trials, many patients who failed to respond to several other treatments improved within a week, and the vast majority were significantly better after two weeks of daily 20-minute sessions. "Transcranial magnetic stimulation is, in a way, a misnomer," says Alvaro Pascual-Leone, a neurologist at Beth Israel Deaconess Medical Center in Boston. "The main effect is not because of the exposure to the actual magnetic field but because of the way that a rapidly changing magnetic field pulse may be generating a current."

Other electromagnetic treatments are more invasive. With vagus nerve stimulation, a stimulator is slipped into the chest wall, much like a pacemaker, and electrodes are attached to the left vagus nerve in the neck. Stimulation occurs constantly; again, some with chronic, treatment-resistant depression have responded well to the procedure. Deep brain stimulation is the most invasive treatment of all. It involves an electrode implanted directly into a particular part of the brain. It was originally used to treat movement disorders like Parkinson's disease by targeting one area of the brain, but researchers found--again by serendipity--that if the electrode was slightly misplaced, it could either cause or alleviate the symptoms of depression, including hopelessness and suicidal thinking.

The notion that the brain might respond to magnets and electricity actually goes way back before the era of ECT. Franz Anton Mesmer, an 18th-century Swiss physician, developed a theory that the human nervous system was magnetized, just like the Earth. So he developed a variety of treatments using magnets and claimed to have restored sight to a blind musician and relieved the back pains of a hypochondriac. (Mesmer's most enduring contribution is actually not medical

but linguistic, since his name is the source of the word "mesmerized" and he coined the expression "animal magnetism.")

What is it about the brain that makes it especially receptive to electromagnetic stimulation? A partial answer can be found in the neuron, the electrically and chemically excitable nerve cell that receives, processes, and transmits information in the brain. When neurons are activated by magnets or electricity, the nature of their signals changes--affecting everything from mood to cognition and memory.

Networks. Complex brain functions such as these are impossible to completely localize because the brain is composed of complicated, intertwined networks of cells. Much of what we do and think and feel requires the coordinated functioning of several regions in the brain; one small change in one region can cascade into dramatic changes in the whole circuit. "Electrically induced seizures actually cause turnovers of brain neurotransmitters and receptors," says Stuart Yudofsky, chairman of the department of psychiatry and behavioral sciences at Baylor College of Medicine. "We know that this is not like kicking the TV and hoping for better reception, because magnets and electricity do affect neurotransmission."

In psychiatric illnesses, the functioning of the neurons may be compromised so that circuits are disrupted. In a recent article about the neurobiology of bipolar disorder in the American Journal of Medical Genetics, authors Gregory Berns and Charles Nemeroff point out that "changes are evident at virtually all levels of the central nervous system in bipolar patients." Particularly intriguing about the research at McLean Hospital is that most patients in the normal control group were unaffected by the brain scans; their moods neither improved nor worsened. No one really knows why, but Berns, who was not involved in the study, is intrigued. "Part of the neurobiology of bipolar disorder is that there seem to be biochemical alterations at the cellular level within neurons that make them more sensitive to anything coming in," he says. Magnetic stimulation, he speculates, may be tapping into the hypersensitivity of the neurons.

Most fascinating, perhaps, and most complicating, is the fact that the brain is dynamic, always in physiological flux. What these recent experiments most vividly illustrate is the complexity of the brain's pathways, the intricacy of its connections, and the concrete hope that may be offered to those suffering from the anguish of mental illness by the evanescent power of a magnet.