

Wired for miracles?

By: Jim Robbins

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Epilepsy. ADD. Depression. PMS. Insomnia. What do all these conditions have in common? They're being treated with a new form of high-tech brain biofeedback. So open your radical science horizons. Here, a report on the cresting edge of the brainwave.

JAKE'S BIRTH WAS A LONG SHOT. Three months premature, he weighed just a pound, and his early birth took a heavy neurological toll. When he was four, he entered his parents' room one evening, drooling and unable to speak. As they watched, horrified, one side of his body went into seizure and he lost consciousness. Jake's seizures often happened at night, and his parents kept an overnight bag packed for trips to the hospital emergency room, where he received injections of Valium. He often had petit mal seizures during the day. He was also diagnosed with cerebral palsy, which diminished his fine and gross motor skills. His learning disabilities included attention deficit disorder and hyperactivity. He had speech problems and ground his teeth constantly. His sleep was troubled and he often woke up ten or eleven times in a night.

Like many children with epilepsy, Jake took two heavy-duty anti-seizure medications: Depakote and Tegretol. Both are depressants, and both have serious side effects. As a result, the boy was logy and often tired. "We felt that Jake was losing his personality," says his mother. "He was zoned out."

I had known Jake since his birth; the incredible story of his survival had made him something of a celebrity in our town of Helena, Montana. Two years ago, I was in Santa Fe doing a piece on the use of different technologies to enhance brain performance; while I was there, I heard about a new technique for the treatment of epilepsy--a natural treatment called electroencephalographic (EEG) biofeedback, or neurofeedback, that often reduced or eliminated the need for drugs. I was skeptical, but I mentioned it to Jake's mother at a Christmas party. They drove three hundred miles to Jackson, Wyoming; for a week at the local hospital, Jake underwent two hour-long sessions a day on a computerized biofeedback program.

Within just a few days, Jake's condition had improved. "His teeth-grinding and sleep problems disappeared," says his mother. "We could carry on a conversation for the first time ever. He wanted to cut and draw and zip and button. He could never do any of that." Unprompted, friends and relatives remarked that Jake seemed more centered.

Later, Jake repeated the protocol for another week. The results were similar. Jake's pediatric neurologist, Don Wight--who had been extremely skeptical--examined the boy. When he was done, he concluded that he had found a new and exciting way to supplement his practice: "There was a qualitative and quantitative improvement in the way he was functioning," says Wight. "It was very real."

Jake's parents bought one of the machines and donated it to the local hospital, where Wight is using it in his practice. "For most people, taking one kind of medication to control seizures is a pretty

good deal," he says. "I would like to use neurofeedback with people who are on two medicines, on high doses, or whose seizures are not being controlled." And Jake? Though he may need to continue neurofeedback training for the rest of his life, the quality of that life will most likely be forever changed.

Neurofeedback is a new type of computerized biofeedback that has begun to wend its way into the health care system with dramatic effects. It's a far cry from the old kind of biofeedback that was developed in the 1960s and used primarily for relaxation and to treat stress, incontinence, and pain. For some applications--epilepsy, attention deficit disorder, and closed head injuries--a number of studies and much anecdotal evidence suggest neurofeedback is effective. Other research suggests it may help treat chronic substance abuse and post-traumatic stress disorder. For other conditions, such as Tourette's syndrome, sleep disorders, depression, and autism, individual case studies are glowing, but few, if any, controlled studies have been conducted. "The phenomenon is robust," insists Siegfried Othmer, Ph.D., physicist and founder of EEG Spectrum, one of a handful of companies in the U.S. that sell biofeedback equipment. Othmer and his wife Sue fell into the biofeedback business in 1987, when treatment caused a miraculous change in their son, who, like Jake, suffered from life-threatening epileptic seizures.

After seeing Jake's transformation up close, and talking to others who had used neurofeedback, my curiosity was piqued. What could it do for a relatively healthy 42-year-old with the usual assortment of mid-life problems: occasional fatigue, a little mild depression, intermittent problems with sleep? When I started work on this article, I also started a series of training sessions. The results were surprising. But first, a look at just what neurofeedback is--a potential method for changing what drugs and therapy sometimes can't--and at the window it may provide on the greatest mystery of all, the human brain.

MUSIC of the Brain

Neurofeedback is part hero and part orphan these days. Despite some powerful research that testifies to its impact, it is only peripherally concerned with what has become the hot topic in neuroscience: neurotransmitters. Far less fashionable than Prozac or Paxil, neurofeedback seems to work by intervening in the realm of frequency. Frequency is the rate at which electrical charges move through brain cells. The human brain is measured by four basic frequency ranges. In delta, the sleep state, signals are moving through clusters of neurons very slowly, just 4 cycles per second, or hertz (Hz). Just above that is theta, around 4 to 8 Hz, a deeply relaxed state. Next is alpha, a slightly less relaxed state, at 8 to 13 Hz. The most rapid brain waves are beta, and they reflect normal waking consciousness. However, there's a range of beta, from low beta, which is a relaxed but alert state of 12 to 15 Hz, to mid-range beta, around 15 to 19 Hz, up to an excited, hyper state of high-beta--as high as 35 Hz.

Even though our measures of frequency (through EEG) are relatively crude, they seem to provide a window into excitability within the brain. Researchers believe that problems crop up when the operating speed of someone's brain is either too low (underarousal) or too high (overarousal). As Othmer puts it, "some people can't find the gas pedal while some people can't take their foot off it." There is speculation that arousal levels may be a major component in a whole host of disorder--and their prevalence may be the key to neurofeedback's sometimes miraculous effect. The goal? To stabilize the brain, to render it more robust, so that it does not tip easily into overarousal or underarousal.

Viewing the human mind this way, through the prism of neurofeedback, harkens back to a theory of arousal that was popular in the 1950s. This approach essentially cuts across the spectrum of psychological diagnostic categories with just two physiological measures: stability and arousal. According to this theory, optimal idling speed for the human brain is about 14 Hz. If the brain's major activity is a speed lower than that--8 to 13 Hz--a person can feel tired and might seek stimulation through coffee or stimulating behavior. They might suffer from depression, ADD, and mild dissociative disorder. Overarousal, on the other hand, means a person has trouble unwinding and might seek out several glasses of wine at the end of the day to modulate their arousal level. Or they might need Valium. Anxiety attacks, hypervigilance, stress, and obsessive behavior are all symptoms of overarousal.

HOOKED UP to Happiness

Neurofeedback sessions are surprisingly fun and simple: they're like playing computer games where every move is made by the mind. The technology utilized in neurofeedback, however, is fairly sophisticated, and unit prices can run from \$3,000 to \$9,000. Brain waves must be mapped and analyzed for deviations from the norm. If there is, for instance, too much theta--which often occurs in brain trauma, as well as in depression--and not enough beta, the practitioner will set parameters for a slightly healthier brain wave map. A session may consist of playing some kind of computer game--in which a smiling Pacman gobbles up enemy blobs or a balloon tries to float up to the sky--while the patient's brain waves are continuously monitored. Each time the brain waves find their way into the optimal state set by the practitioner, the patient is rewarded with positive feedback: Pacman eats his enemy or a pleasant tone sounds. After anywhere from five to fifty sessions, the brain seems able to find the optimal state on its own.

One of the ingenious aspects of neurofeedback is that it is perfectly tailored to each individual. Training is always set to be challenging and exciting but not too difficult, so that patients can move slowly and steadily into their optimal brain states.

BIOFEEDBACK'S Bold Beginnings

In the 1960s, neurofeedback was a revolutionary way to look at the mind and its capabilities, and it coincided with other, more dubiously regarded revolutions. Neurofeedback was adopted by people interested in mind expansion, often in the forms of LSD and meditation, and its association with Eastern mystics and parapsychology earned it a crackpot reputation with the mainstream scientific community. But when I actually went and looked at the early research, I was astonished at some of the remarkable studies. One of the crucial pioneers of neurofeedback was Barry Sterman, Ph.D., professor of neurobiology and biobehavioral psychiatry at the UCLA School of Medicine, who was the first to experiment with a kind of beta wave called sensory motor rhythm (SMR), in the 12 to 15 Hz range of beta, and was able to actually treat epilepsy.

Sterman's original work in the 1970s was on cats. Using implants and EEG equipment in a study funded by the National Institutes of Health, he found that cats could be trained to control their brain waves. He then discovered that when he exposed those trained cats to toxic vapors that usually induce epileptic seizures, they had far fewer seizures than untrained cats. The experiment was replicated with monkeys. In both cases deep probes showed that the training produced physiological changes in the brain's neurons.

Moving on to humans with refractory epilepsy--the most severe kind--Serman achieved a 60% reduction of seizures in 60% of his patients. Numerous other experiments at more than a dozen other institutions have demonstrated even higher success rates, and the treatment of epilepsy is the most established of the protocols for neurofeedback. Serman, who is now research director at EEG Spectrum, has theorized that training may activate healthy adjacent neurons to take the place of damaged ones. We are still a long way from a real understanding of why neurofeedback does what it seems to, but Serman maintains that "if the neural substrate is intact, the neurons can be trained."

One of Serman's researchers, Joel Lubar, Ph.D., of the University of Tennessee at Knoxville, took their work even further and in a different direction. He had noticed that hyperactivity decreased in patients treated for epilepsy and, based on this, created the protocol now used for treatment of ADD.

WIRED in the Schools

One place where the treatment of ADD has been put to the test is the Enrico Fermi Center for the Performing Arts in Yonkers, New York. Three years ago, Linda Vergara, assistant at the school, was faced with taking her son from a private school because he was hyperactive. Within several sessions, she says, her son began to change. Profoundly "He started sitting through dinner," she says, "and finishing his homework."

Her experience convinced her to bring an EEG neurofeedback machine into the inner-city school of about one thousand minority students. Three years and sixty kids later, the program has worked. "It has fumed people's lives around," says Vergara. The program is being expanded to two other schools in Yonkers, and eventually, school board members say, to all twenty-two schools in the district. So far, neurofeedback has kept twenty students out of expensive special-education classrooms and thereby saved the district an estimated \$500,000. When I visited the school recently, parents, teachers, and children raved about this alternative to Ritalin. "If it works here," says psychologist Mary Jo Sabo, Ph.D., who helped Vergara bring the technique to Fermi, "it will work anywhere."

And here's fascinating news: even when treating ADD, therapists and teachers see other positive changes in behavior. Serman saw ADD diminish with treatment for epilepsy, and he saw sleep improve. Rachel Campanella, a fourth-grade teacher at Fermi, told me a story about a boy in her class named Nelson. "His parents were worried about him. He would come into class and put his head down on the desk," says Campanella. "He had no self-esteem, there was no social interaction. If I spoke to him, he would nod his head. For months I never knew if he had teeth, because he never smiled. He was like an infant in a big guy's body."

Nelson started EEG training in March of 1997. "In June," Campanella says, "he raised his hand for the first time ever. He started to speak, to smile. He spoke in complete sentences. Now he comes by with a grin and says 'Hello, Mrs. Campanella.'" Though case-by-case examples, such as that of Nelson, do not offer proof of this or any treatment's efficacy, they do make an impression.

Another area where neurofeedback has proven successful is in the treatment of closed head injury. Symptoms of head injury can range from mood swings and irritability to short-term memory loss, confusion, headaches, nausea, and blurred vision. There are no drugs to treat closed head injury; any recovery usually occurs on its own within two years. Psychologist Steven Stockdale, Ph.D., director of the Neuro-Health Center in Colorado Springs, is one of several practitioners using neurofeedback

for mild closed head injury. In an ongoing three-year study of sixty patients already past the two-year recovery mark yet still suffering from symptoms, he has found that "about 80% of the people we work with learn to do the feedback. In those patients, there is a 75% reduction in symptoms. They just clear up."

The technique may even help in post-traumatic stress disorder. New York City psychiatrist Daniel Kuhn, M.D., treats veterans of the Israeli war of 1973. Even if PTSD is resolved with standard psychotherapy, there are residual cognitive problems. "You can't talk people out of these. Nothing works as well to clear them up as EEG neurofeedback," says Kuhn.

FEEDING MY HEAD

Beta training was where I started my journey with neurofeedback. I was curious about the technology, especially after I heard talk of the Clean Windshield Effect. Bernadette Pedersen, an EEG technician from the local hospital, came and helped me hook up the first few times. Though the equipment--two computers, a neuroamplifier, and some EEG electrodes--is relatively easy to use, one does need training, and, for therapeutic uses, a trained doctor or psychologist is necessary. For a half hour or so, I watched a game: white lines formed in the middle of the highway and a beep sounded when I produced the right brain waves. About an hour after that, it was as if someone had flipped a switch. The world looked sharp and crystalline, its colors richer. My thinking was sharper and I had a quiet kind of energy. It lasted a couple of hours.

After five or six sessions, the God-just-painted-the-world effect dissipated, but I noticed other changes. I felt calmer and more centered. I felt more secure in social situations. Particularly important to me was that my mornings were much more productive. I always drink coffee and drag my tail until late morning. Lately I've been getting up, ready to go. By the fifteenth session, the change was unmistakable. As of this writing, it has lasted about a month.

I was also interested in trying another kind of training, known as the alpha-theta protocol. The technique is very different from the work in beta. It takes place in the lower registers of the brain's frequencies. The first EEG-produced study of the effectiveness of the alpha-theta protocol on substance abusers was begun in 1982 by Eugene Peniston, a researcher at the Sam Rayburn Memorial Veterans' Center in Bonham, Texas. He treated ten severe alcoholics with traditional counseling only, and ten more with the added element of the alpha-theta training on a neurofeedback instrument. Peniston hypothesized that alcoholics drink because they cannot get into alpha states naturally, and therefore cannot produce self-soothing neurotransmitters on their own. Peniston claims an unheard-of 80% success rate with the group who used the neurofeedback--compared to a ceiling of 20% to 30% for traditional therapies. However, because of his small sample size, more studies are needed to buttress his claims. There have been other impressive small studies since then, but again, the cure rate seems improbably high. We won't know the actual impact of this therapy until larger samples are studied. Alfonso Bermea, M.A., of the Life Sciences Institute in Shawnee, Kansas, who has also used this technique says, "With conventional therapy a lot of people take a white-knuckle approach. They say, 'Dammit, I'm not going to drink.' With neurofeedback, people no longer have the desire to drink. They're no longer fighting the urge."

Alpha-theta training had a pleasant, if not revolutionary, effect on me when I tried it. I laid down on a mattress in my office, and Bernadette hooked me up. Eyes closed, I started to relax. On the EEG Spectrum machine I was using, a stream began to babble as alpha was produced. Then, as I sank

deeper, a series of alpha bings sounded. As theta came into play, I heard a roaring ocean and the deep, resonant bongs of a Tibetan bowl. These sounds held me on the edge of sleep for nearly half an hour. It's an interesting place, that twilight zone between sleep and wakefulness. During that time, my mind produced a host of intriguing, dreamlike images, but none of them, in my few sessions, was revelatory.

FEEDING THE FUTURE

Neurofeedback may be of help in the treatment of a host of problems besides epilepsy, ADD, closed head injuries, and addiction. Its applications are being explored, but all of them have yet to be subjected to controlled studies. EEG Spectrum has treated more than two thousand people clinically in the past ten years--some for such problems as Tourette's syndrome, PMS, depression, teeth grinding, migraines, insomnia, strokes, menopause, and I chronic pain.

Los Angeles writer Margaret Sachs underwent neurofeedback training for symptoms of menopause after she saw its dramatic effect on her daughter's ADD. "I was waking up in the middle of the night totally drenched with sweat," she says. "And then I started waking up at three or four and I couldn't go back to sleep, as if I was on speed." A congenital heart murmur began acting up, causing a rapid and irregular heartbeat. Dramatic mood swings erupted, and her period became irregular.

After twenty sessions, she claims, every single symptom subsided. "I felt grounded in a way I never had before," the 47-year-old says. "When I got in a situation that normally threw me for a loop, I not only stayed calm, but I thought of all the things I should have thought of, instead of thinking of them later. I felt so in control of myself. It was a wonderful feeling." A few months later, her family moved, and the situation was stressful for a while. The good feeling left her. It took a few refresher sessions to bring it back.

Not surprisingly, there are critics of neurofeedback. Joel Lubar questions claims that neurofeedback can be used to treat problems such as PMS or migraine. "That's speculative," he says. "There need to be studies done for those applications." Many practitioners worry that too much sloppy optimism will damage the reputation of EEG neurofeedback in the same way that unproven claims did to biofeedback in the 1960s.

Much of the criticism has come in the arena of ADD. "There's a tremendous placebo effect in a situation like this," says Russell Barkley, director of psychology and professor of psychiatry and neurology at the University of Massachusetts. He is the author of a book about the treatment of ADD, entitled *Defiant Children: Management of Difficult Children*.

He has not studied the use of neurofeedback, but he has reviewed some of the studies, and he points out that the use of "high technology in a medical environment has a high placebo effect. And some children improve with maturation alone."

On the other hand, "we don't have any studies that say it's bad for you. I don't think it will do harm. Basically, it's 'buyer beware.'" Claims that neurofeedback can alter brain physiology, says Dr. Barkley, are "totally unfounded and unethical."

Indeed, all we can definitively say about neurofeedback at this point is that it provides access to our internal processes and, in ways we do not fully understand, sometimes allows us to regulate them.

The claims that some practitioners make about neurofeedback do alarm certain researchers, but Susan and Siegfried Othmer are unrepentant. Fifteen years ago, their son Brian was one of the first to be treated for severe epileptic seizures and behavioral disorders. They saw dramatic positive changes in his personality as well as in his physiological problems, and, says Susan, "we knew right away this was something we had to be involved with. We found out that it's not considered scientific to be enthusiastic. We're sorry, but we're parents. We need to get this out there."

The Othmers now have three hundred or so affiliates who have built a common body of knowledge, sharing information at conferences and over the Internet. There are several other companies that manufacture the equipment, including American Biotec in Ossining, New York.

The word about EEG has spread. Othmer estimates the handful of practitioners ten years ago has grown to fifteen hundred worldwide. Perhaps for good reason. Barry Sterman believes there is no doubt that physiological changes take place, and claims there are several careful studies to prove it. According to Joel Lubar, neurofeedback "increases the blood flow into the brain. Blood flow, metabolism, and high frequency electrical activity all work together." Increased blood flow may help the brain reset itself in a normal range. And Don Wight, Jake's pediatric neurologist, says the impact of neurofeedback is not a placebo effect. "You would know," he says. "If the kids come off medicine, and stay off it, and can function, you would know. It's real."

If neurofeedback works so well, why is it virtually unknown? One reason may be that neurofeedback fits no prevailing medical model. Nearly all research on the brain is in the language of neurotransmitters and psychotropic drugs, and not in that of frequency or of mental exercise. Science likes its medicine to fit within the governing conceptual framework.

Othmer blames "panacea paranoia." Something that works so well can't possibly be real. There are also some real drawbacks: it's expensive, it's time-consuming, and it must be conducted by trained personnel.

But beyond this, there is a problem with the therapeutic potential of neurofeedback that is something of a philosophical riddle. If the brain can be trained to deal with depression physiologically, does a patient short-circuit the important processes of recognizing, comprehending, and coming to grips with a deep psychological problem? And--to pose an entirely new question--does that matter?

For many people who have tried it, any debate about neurofeedback is moot. As Jake's mother puts it: "It's nothing short of a miracle for us."

Jim Robbins is a writer in Helena, Montana, whose work has appeared in The New York Times and Smithsonian. He is the author of A Symphony in the Brain: The Evolution of the New Brain Wave Biofeedback (2001, GroveAtlantic).

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