

BLAINE GRETEMAN | MARCH 2009 ISSUE

Improve mental health with neurofeedback



Photo: Susanne Björkman

As Vicki Wyatt attaches electrodes to my scalp with a generous glop of slimy goo, I'll admit I'm a little skeptical about the calming effects of the treatment I'm about to experience. With newborn twins at home, I usually have enough slime in my life and on my clothes to push anyone over the abyss. But that, says Wyatt, is precisely why I could benefit from neurofeedback, a therapeutic tool that advocates claim can reshape our brains—and our lives.

To learn more about the procedure, I've come to The Wyatt Clinic in downtown Oklahoma City. Just blocks from the memorial that marks the site of the 1995 federal building bombing, the location is aptly associated, in my mind, with both psychic trauma and healing. This is a gentrifying but hardscrabble neighborhood where Wyatt treats patients, from overstressed professionals to addicts trying to get back on their feet. Wyatt has been a therapist for 22 years, with a research background at the University of Oklahoma Health Sciences Center, but she has only recently embraced neurofeedback as part of her treatment regimen. "My formal education didn't really provide any alternative treatments," she says. "It was traditional psychotherapy and talk therapy. When I look back, I think this would have benefited a lot of the children and families earlier in my career."

The equipment looks fairly unexceptional, including the electrodes, which could pass for iPod headphones and are glued strategically to my head and temples. Wyatt clips a "ground wire" to my ear. The wires run from the electrodes to a black amplifier box the size of a small paperback. This deceptively simple-looking piece of machinery, which can cost several thousand dollars, processes electrical signals from my brain and sends them to a laptop, where they're represented graphically on the screen. Wyatt boots the laptop, opens a neurofeedback training software program and settles me into one of the comfy chairs that make her cozy, carpeted office look more like my mother's living room than the white-tiled clinic I'd expected.

After Wyatt hooks me up, I'll use my brain waves to control a video game. When I achieve the desired mental state, a small red bug will move around the screen eating flowers and emitting a happy chirping sound. To succeed at the game,

I must eliminate brain waves that interfere with relaxed concentration—those associated with hyperactivity, depression and that all-too-familiar feeling of "zoning out."

I'm coming off a sleepless night of diaper-changing, rocking and feeding, so focus isn't exactly my forte right now. But after watching the bug languish sadly for a few minutes, I begin to practice some deep, yogic breathing and try to stop my racing thoughts about work, home and deadlines. Sure enough, the band representing my desired brain activity jumps and the red bug begins to rouse himself from his stupor, eat a few flowers and chirp with approval.

After years on the outskirts of medical respectability, neurofeedback has been vindicated by a growing body of evidence showing its potentially remarkable benefits to everyone from elite athletes and musicians to violent criminals and children with Attention Deficit Hyperactivity Disorder (ADHD). The U.S. National Library of Medicine's database of scholarly articles, for example, contains dozens of positive scientific studies on neurofeedback published in the last two years. The results, from some of the world's top universities and research hospitals, suggest that neurofeedback is a promising treatment for a range of cognitive health issues: seizures, low IQ in kids with learning difficulties, vertigo and tinnitus in the elderly, and substance abuse, even with notoriously addictive, destructive drugs like crack cocaine.

Advocates say neurofeedback has emotional benefits as well. "You feel very good on this," says John Gruzelier, a professor of psychology at the University of London's Goldsmiths College. And all these effects are generated by the patient's brain, not by drugs. No wonder some proponents describe neurofeedback's effects in spiritual, as well as physical, terms.

It all starts with those slimy electrodes attached to the scalp, which pick up a small part of the electrical symphony produced continually in our brains. Neurons, the billions of cells that make up our cerebral cortex and nervous system, transmit information by firing electrical and chemical signals across synapses, the junctions where they meet. These tiny electrical pulses are central to our consciousness and bodily lives: Each time our hearts beat, we blink at a bright light or smile at a bit of good news, that action requires a flurry of electrical activity.

The brain's electrical impulses take the form of waves that researchers categorize by frequency—the number of times they repeat each second (see "Making waves" box). The slowest are the delta waves, which the brain typically produces during deep sleep. Next are theta waves, another slow undulation at four to eight cycles per second, often associated with creative and subconscious thought, which we produce when we're sleepy or daydreaming. We make alpha waves of eight to 12 cycles per second when we're alert and relaxed, and still-faster beta waves when we engage in active problem-solving or become alert or anxious. The fastest patterns, above 30 cycles per second, are made by gamma waves—usually faint and difficult to detect, but associated with high-level thought.

An overabundance or deficiency at one of these frequencies often correlates to conditions such as depression and other emotional disturbances and learning disabilities. Children with ADHD, for example, often have too many slow brain waves (delta or theta) and not enough of the faster waves that allow them to focus, engage and think productively.

Neurofeedback reads these waves, feeds them into a computer and translates them into visual form—in my case, the ladybug's states of lethargy correlate to levels of electrical activity in my brain. The underlying principle is that by seeing your brain waves you can gain control over them, training your brain to produce desired levels of activity, much like you train your voice to produce certain musical notes. And once those brain waves are in play, the desired brain state comes with them. If, for example, you've got too much anxiety-producing beta, try inducing some theta to calm down.

That might sound like trippy science fiction, but it's based on technology that's been around since the German

psychiatrist Hans Berger began using electrodes to measure and categorize human brain waves in the 1920s. The recordings of the human brain-wave activity produced by this technology—electroencephalography, or EEG—are the cornerstone of neurofeedback. By the 1970s, it was possible to feed that information back to patients who heard a rewarding tone when they produced a pre-selected frequency of brain waves. What's new is both the sophistication of the feedback display and the precision with which therapists can target different parts of the brain wave spectrum. On top of that, neurofeedback has become cheaper, more efficient and more readily applicable to a vast array of brain disorders.

"When I was doing quantified EEG back in the 1970s, computers were the size of filing cabinets," says James R. Evans, a former University of South Carolina psychology professor and current clinician at the Sterlingworth Center in Greenville, South Carolina. Evans, who has written and edited dozens of articles and books on neurofeedback and is a consulting editor to one of the field's flagship publications, *The Journal of Neurotherapy*, says those technological hurdles limited neurofeedback's therapeutic reach in the early years: "You had to have a large-scale grant to afford the equipment and electrical engineering people to keep it going."

By the early 1990s, the same technology that brought us personal computers and Xboxes had changed all that, and without huge research investments therapists could focus specifically on brain waves that correlate to mental states. A quantified EEG could show that a patient's brain contained waves outside the normal range, and new software made it easier to create training protocols or use existing ones to boost or reduce activity across a frequency or region of the brain. Neurofeedback began to gain a devoted following of patients and clinicians who swore by its effects. Martin Wuttke is one of those clinicians, a neurofeedback pioneer known for getting remarkable results—starting with himself.

A former heroin addict, Wuttke discovered meditation could help him beat the drugs, and soon he was running meditation and counseling sessions for other addicts. "I found that the key to recovering from addiction was a spiritual experience," Wuttke says. "That's what the Twelve Steps [of Alcoholics and Narcotics Anonymous] are all about, but I felt like that had gotten lost." To facilitate that experience and give it credibility by grounding it in science, Wuttke turned to neurofeedback.



Practitioner Martin Wuttke found that neurofeedback helped his son overcome major developmental problems.

Photo: Fernando Decillis

Alcoholics and drug addicts often have too many fast brain waves—which is perhaps why they seek a chemical fix to

calm and soothe overactive brains, he says. With the right technology, neurofeedback practitioners believe they can wake up parts of the brain that are too sleepy and calm down regions that are spinning out of control.

For Wuttke, the results were life-changing. As people moved through his program, he says, "Their depressions went away, their pains went away, their anxieties went away." Wuttke believes patients become less likely to backslide once they realize they have access to inner calm without drugs or alcohol, an insight he describes in terms of "awakening."

Neurofeedback's potential hit home when Wuttke's son, Jacob, was born with brain injuries and major developmental problems. "At age 2, he had no muscle tone and some severe difficulties," says Wuttke, "but the pediatric neurologist couldn't give us any answer about why or how to treat him." Wuttke and his wife at the time, Amy O'Dell, took matters into their own hands, developing a comprehensive treatment regime incorporating neurofeedback. Facing the difficulties of asking a child so young to control his brain waves, Wuttke and O'Dell observed the feedback screen and stimulated their son when his brain produced the desired patterns. "We would be very quiet when his brain wasn't within parameters, and then when it was, we would squeeze him and say, 'Good work!' and orient his brain to those moments."

At the beginning of the process, Wuttke describes his toddler son as "hypotonic": unable to sit on his own or hold his head upright. But "within 60 days, his brain started to come alive," Wuttke says, and this cognitive awakening was the first step in a process that soon had his son crawling, walking and running. After witnessing the results, Wuttke and O'Dell established Jacob's Ladder, a school for developmentally challenged children in Atlanta, Georgia, run by O'Dell. Although Jacob couldn't retain five letters of the alphabet at age 6, by age 14 he was reading at a 12th grade level, and the school had achieved national recognition.

That experience helped Wuttke formulate his "neurodevelopmental" approach, in which he uses exercise, dietary supplements and neurofeedback in concert to establish and rewire broken pathways in the brain. Since then, Wuttke has trained thousands of neurofeedback practitioners and garnered a cadre of patients who describe neurofeedback in transformative terms.

Beth Black, for example, fairly raves about the way Wuttke's neurofeedback regimen impacted her 7-year-old son. "Ethan's a completely different kid now," she says. When Black adopted Ethan at 5 months old, he'd already endured severe neglect and suspected pre-natal drug use by his mother, so it wasn't entirely surprising that the boy faced challenges. Still, by the time he entered first grade at age 6 it was clear to Black, director of the Family Art Therapy Center in Clayton, Georgia, that Ethan's problems were cause for serious concern. "We first noticed that when you teased him, he wouldn't understand or react normally, but would have these explosive tantrums," she explains.

Failing socially and academically, Ethan hated school despite the efforts of his teachers and his mother to implement a program of special instruction and behavioral therapy. "He said no one liked him and he wanted to die, and when he would get really upset he would have to exhaust himself before he could get control," Black recalls. A child psychologist labeled Ethan with ADHD and prescribed medication, but Black was desperate to avoid drugs and turned to Wuttke instead. Using an evaluative brain-wave scan, Wuttke determined that Ethan lacked normal levels of beta, the relatively fast waves associated with attention and concentrated thought.

They implemented a training program of neurofeedback and listening therapy to boost this band and improve the boy's concentration, and within two weeks Black was a believer. "For the first time ever, he could tell me a story in sequence; within three weeks, he was scoring 100s on his spelling tests and just blowing us and his teachers away." After seven weeks, Ethan was able to calm himself, and the explosive anger was a thing of the past.

Black was so impressed that she applied for a grant to use neurofeedback with the juvenile offenders sent to her clinic regularly for court-assigned behavioral therapy. Counseling these young offenders had been "a waste of money," according to Black, but the seven juvenile offenders who entered the program of intensive neurofeedback therapy flourished.

"The judge came to us at the end of this program," Wuttke remembers, "and said, 'What did you do to these kids?'" Within weeks those who'd dropped out were back in school, performing so well on standardized tests that their learning disabilities seemed to have disappeared.

Such stories abound. "Our whole family was in trouble because of my daughter's depression and discipline problems," says Joann Bullard, whose daughter received treatment at Wuttke's clinic in the Netherlands. "She was going to have to go on medication because there just weren't any other options," Bullard says, but after 60 sessions of neurotherapy, there was a total turnaround, and we're grateful every day." Another father, Ben Odukwe, says he visited specialists round the world after his son Onura was diagnosed with mild autism, but saw no real results until the boy entered Jacob's Ladder school and began a neurofeedback program under Wuttke's supervision. Onura's father notes that the boy's "communication, his confidence, his handwriting and dexterity all transformed," and at age 16, he's entering mainstream school for the first time.

Neurofeedback doesn't cure conditions like ADHD, depression or addiction. Instead, it enables people to produce the appropriate brain waves, which helps provide the attention, rest or contemplative awareness needed to deal with underlying issues. You can't manufacture these brain waves by force of will. I quickly discovered that success comes from letting go. "It's not a conscious thing," Wuttke emphasizes. You have to "surrender to the process [and] let your brain take over. You are going to deep parts of the brain and neutralizing disruptive brain waves, and often in this extreme state of quietude, key memories and patterns come up, almost like you're in a half dream state, and there's sort of a rewiring that occurs."

Wuttke likes to say our brain tends to follow certain "scripts," patterns of thought that take us to the same place over and over. Neurofeedback, as it forges new pathways in the brain, helps us devise new scripts.

Even as the technology has advanced and the success stories have grown into a rich anecdotal lore, however, neurofeedback continues to face skepticism and resistance from parts of the medical establishment. It has only begun to gain widespread acceptance as a therapeutic tool recently. "It was an up-and-coming treatment modality in the 1970s," says Evans, who has worked with the technology in academic and clinical settings. But he says neurofeedback lost scientific credibility when the early, simple equipment was adopted by and became associated with "hippies" in pursuit of "instant Zen."

Neurofeedback still has its skeptics among consumers too, especially since it remains unregulated; anyone who can afford the equipment can rent an office, hang a shingle and treat patients (see "How to choose a neurofeedback practitioner" box on page 51). Today, however, Evans says, "We've reached a tipping point where there are hardcore science people working in neurofeedback and articles being published in good journals, and it's becoming much more difficult for mainstream medicine to ignore. No one can say any longer that there is no science behind it."

The studies that have generated the most enthusiasm are the ones suggesting that the treatment offers a drug-free alternative for children with ADHD. A review of the scientific literature in 2005, for example, noted that 75 percent of kids with ADHD treated with neurofeedback improved—compared to about 70 percent treated with drugs—and no

study has reported negative effects. A 2007 study from the University Hospital of Tübingen in Germany showed that after a treatment regime lasting several months, children diagnosed with ADHD not only improved their behavior and increased their ability to concentrate "significantly," but added nearly 10 points to their IQs—a result maintained six months after the study ended.

Skeptics have long argued that the benefits of neurofeedback to children with ADHD could be attributed to the placebo effect—or that the children could achieve similar improvement if they spent the same amount of time working with parents on focused tasks like assembling puzzles. By this logic, it isn't the technology of neurofeedback that helps children with ADHD, but the attention and effort of parents and therapists working in concert to support learning and concentration. To find out the truth, Swiss researchers at the University of Zurich created a controlled study to isolate neurofeedback from other factors. One group of children with ADHD was given neurofeedback, while another entered an intensive behavioral therapy program that used traditional techniques to teach them to focus. The results were dramatic: Children in the neurofeedback trial improved markedly on indices of attention and "metacognition" (the awareness of one's mental processes), whereas children in the behavioral therapy group showed no significant improvement.

But there was just one caveat. The researchers noted that the results seemed "mediated by unspecific factors, such as parental support or certain properties of the therapeutic setting and content." So, while neurofeedback works, it isn't a magic bullet—parental support and the right clinical setting, which might include other therapies, are key to realizing its potential.

Importantly, however, that potential goes beyond the treatment of disorders. Indeed, neurofeedback seems remarkably effective at improving mental focus and concentration, even for apparently "normal" individuals. "We've just done a study training eye surgeons," says Gruzelier of Goldsmiths College in London, "and we found that the rhythm that's very effective in reducing hyperactivity in ADHD children also helped enhance surgical performance by 20 percent." The aim was to do the surgery as quickly and accurately as possible, and neurofeedback training, which enhanced beta waves while relaxing the cerebral cortex to reduce hyperactive movements, seemed to enhance surgeons' ability to modulate their performance. "Instead of just charging at the target," Gruzelier says, "they were actually slightly longer and more methodical in their preparatory time, then faster and more accurate on task."

Athletes and performers often associate such success with being "in the zone." Many athletes believe neurofeedback allows them to pause racing thoughts and live wholly in the moment of the game. Prominent among them is Chris Kamen, the center for the Los Angeles Clippers basketball team, who was diagnosed with ADHD as a child and struggled in his early career, despite his imposing seven-foot height. In 2007, he discovered neurofeedback and soon improved his scoring and rebounding by more than 50 percent. As important, Kamen says, his life off the court improved as he stopped making impulsive decisions.

Kamen not only attributed the success to neurofeedback, but became a spokesperson for Hope139, a Michigan company dedicated to bringing neurofeedback technology into schools and businesses to improve performance. Neurofeedback has gained such a lustrous reputation that the Italian professional soccer team A.C. Milan has created a glassed-in "mind room," where the team gathers for mental tune-ups. In the mind room, players watch their brain waves play out across a computer screen while a team of sports psychologists monitors their progress.

Gruzelier emphasizes that neurofeedback's performance-enhancing results go beyond relaxation or the relief of anxiety—effects that might be achieved with sedatives or more conventional relaxation techniques. "We've compared this to

other techniques that have reduced anxiety but have not enhanced performance in the same way," says Gruzelier, citing his studies of professional dancers and musicians who did neurofeedback training to quiet the brain's fast-wave activity and produce more slow theta waves. These studies showed remarkable improvements "not only in artistry, but communication, the way people expressed themselves, the presence they have on stage."

Elite students at the Royal College of Music in London improved their performance an average 17 percent, according to a panel of independent judges, and competitive ballroom dancers achieved "professionally significant" improvement in just five weeks. Moreover, Gruzelier notes his recent research hasn't only replicated these results, but shown they extend to novice performers. "There are dramatic improvements," he says. "Breath and pitch improve. Where they didn't sing in tune to begin with, they did afterwards."

Gruzelier attributes such results to the technology's ability to allow slow waves to travel farther, uninterrupted, across the brain. That facilitates interaction between areas of the brain that don't typically connect, he says. Normally, such a process is disrupted by the fast waves that characterize our waking life—a kind of mental static. "It's been known for centuries that the hypnagogic experience, the border between waking and sleeping, is the source of remarkable insights," Gruzelier says.

Neurofeedback's apparent ability to bring those insights into the light, however, is what seems remarkable, especially since we still don't understand key factors about how it works—how, for example, people control their own brain waves. "It's very much a black box," explains John Kounios, a professor of psychology at Drexel University in Pennsylvania.

Kounios conducted a double-blind study of elderly subjects that showed neurofeedback may help improve cognitive processing speed and "executive function," the mental operations that help us plan and organize our lives, but he admits the cognitive process underlying neurofeedback is still something of a mystery. "Although neurofeedback has been around for 40 years, we still don't have the slightest clue as to how people do this," Kounios says. "It's not as if there aren't any good theories. There are just no theories, not even bad ones—just the observation that this is something animals and humans can do."

That sometimes makes for surprising results, as in the case of Kounios' study, which increased the production of alpha waves in the frontal lobes of elderly people. The frontal lobe often deteriorates as people age, which makes problem-solving, abstract reasoning and all kinds of planning more difficult. And so, as Kounios' subjects boosted their alpha activity in this region of the brain, they demonstrated an improved ability to respond when presented with new information and to make quick decisions in cognitive tests. Such results are preliminary but exciting. Kounios emphasizes that the field needs funding for large-scale studies that can establish the basic science of neurofeedback and determine which training protocols are most effective, "but there's no question in my mind that this has significant potential and the phenomena are real."

This is a common refrain among researchers and practitioners. "It works," agrees Evans. "Almost anybody can get the equipment and get 60 percent good results. The question is, what are those people doing who get 90 percent? Some people give vitamins along with their treatment; others pray with clients or use counseling. In many respects, these people fire a shotgun and we don't know which pellets hit."

That's why Wuttke is creating an institution that will train a core group of people who can replicate his results and methods. His mission is to establish a network of neurofeedback clinics and training facilities in Europe through his work with the LifeWorks Foundation.

"One of the biggest risks right now is that this becomes a novelty, where people can buy some software and hook into it at home and play a game," says Wuttke. "That's going to happen, but it takes away from the profound clinical applications, which have to be part of a more comprehensive approach."

Wyatt agrees. "For most patients, whether they're suffering from depression or post-traumatic stress syndrome, I don't believe that neurofeedback offers a complete solution any more than I believe a doctor can give you a drug that offers a complete solution. Neurofeedback can calm the brain down, but then you still often have to deal with underlying issues."

The desire to get at those underlying issues is why Wuttke, an ordained non-denominational minister, keeps coming back to the notion of spiritual growth. "When you incorporate all these things and straighten out the brain, the ultimate goal is for people's spiritual awareness to start manifesting itself," he says. Indeed, recent studies of Tibetan Buddhist monks by Richard Davidson, director of the Lab for Affective Neuroscience at the University of Wisconsin-Madison, have shown links between spirituality and the processes encouraged by neurofeedback. In particular, monks who are experts in meditation seem capable of generating extraordinary levels of gamma waves as they achieve a state typically associated with "transcendence."

From a materialist perspective, the key seems to be neurofeedback's ability to help us connect memories and sense perceptions that have been laid down in disparate regions of the brain—to achieve the feeling of unified consciousness by unifying the brain's electrical impulses. But if neurofeedback can foster and even enhance such a state, this begs the question of whether the phenomena we typically describe in terms of "spirituality" are just physical by-products of a material mind.

Wuttke turns such skepticism on its head. "The way I look at it," he says, "we may be able to map an experience through physiology, whether it is a profound sense of peace or a religious sense, but that doesn't mean the material brain is the source of those experiences." Instead, he sees the brain as "a transformer, something that conducts energy between metaphysical and physical reality." He admits neurofeedback can't necessarily help any Joe off the street achieve the transcendence of a Tibetan yogi, but adds, "It has been my experience that everybody is enlightened; they just don't know it."

After my first session of neurofeedback therapy, there's little chance I'll be confused with one of the enlightened—something my wife readily confirms. But as I watched the red bug move with increasing dexterity about the screen, it certainly felt empowering to see how much control we can exert over our minds, moods and selves. Over the next few weeks, it's a sensation I'll recall during moments of stress, like the long nights with my ever-wakeful children. Just this recollection seems to have some tangible effect, slowing the quickening pulse and quieting the static I've seen in the graphic representations of my brain waves. As Wuttke would say, we can sometimes be locked into old scripts, reacting to our world in ways we don't understand or seem to control. Neurofeedback's potential is so inspiring, in part, because it can help us rescript our brains and, thus, rewrite our lives.

Blaine Greteman, *who trains the brains of undergraduates as a professor at Oklahoma State University, wrote about micro power generation in the September 2008 issue.*

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