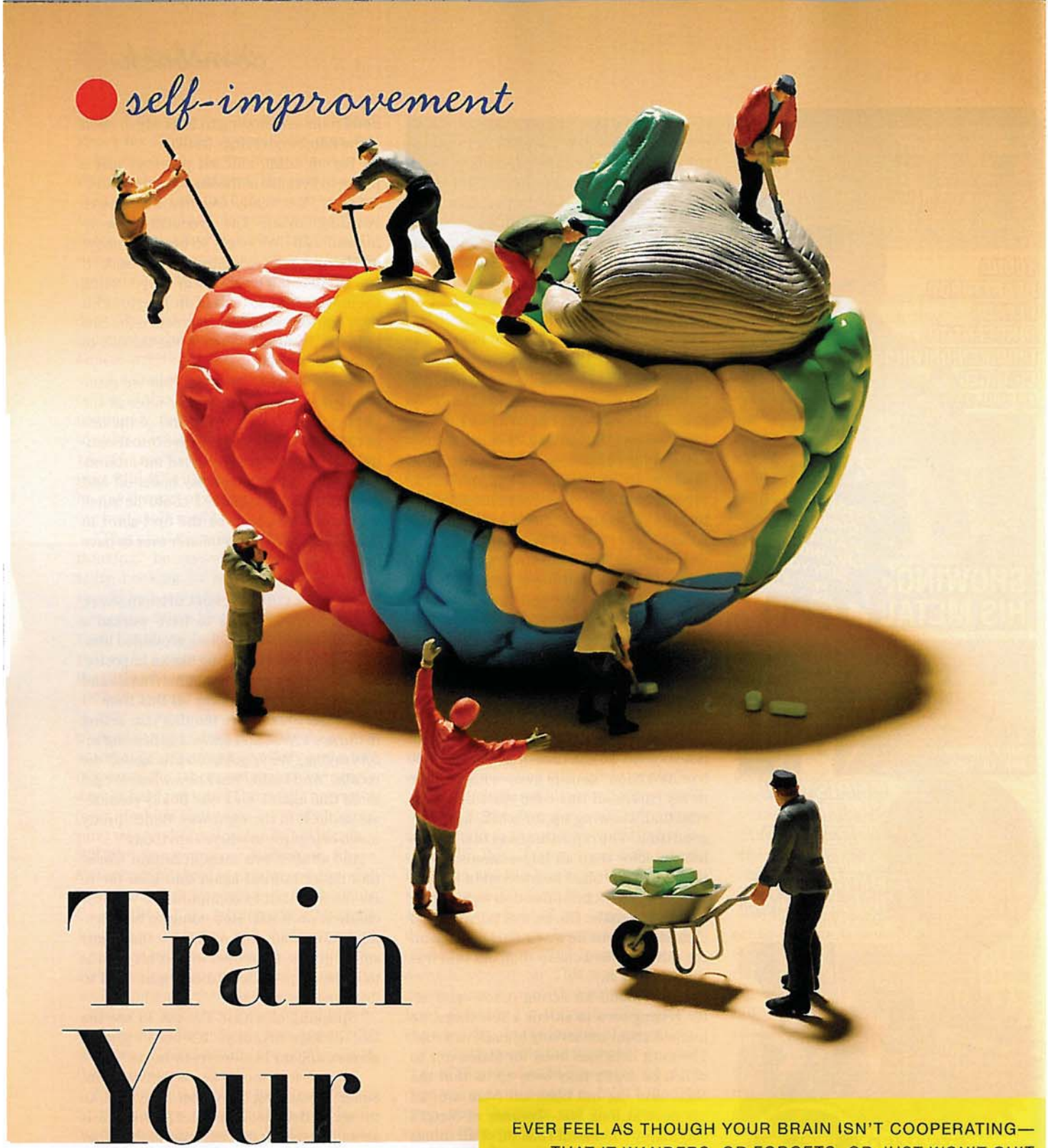


Train Your Brain

EVER FEEL AS THOUGH YOUR BRAIN ISN'T COOPERATING—THAT IT WANDERS, OR FORGETS, OR JUST WON'T QUIT PROCRASTINATING? THE SCIENCE OF NEUROTHERAPY AIMS TO FIX ALL THAT BY TEACHING YOU TO MANIPULATE THE ELECTRICAL FREQUENCIES IN YOUR MIND. KEVIN CONLEY TAKES HIS BRAIN OUT FOR A TEST-DRIVE

I CAN'T RETURN MY BRAIN, even though it seems to malfunction all the time. I'm not being facetious: My mind is volatile, easily distracted. I can't keep track of my keys, my billfold, my glasses; when faced with a deadline, I can waste hours writing comments on a new Facebook video posted by a guy I knew for three days on a trip to... Did I mention I frequently space out? Flabby, pallid, out of shape—my brain can sometimes feel like the mental equivalent of a fat gut. »

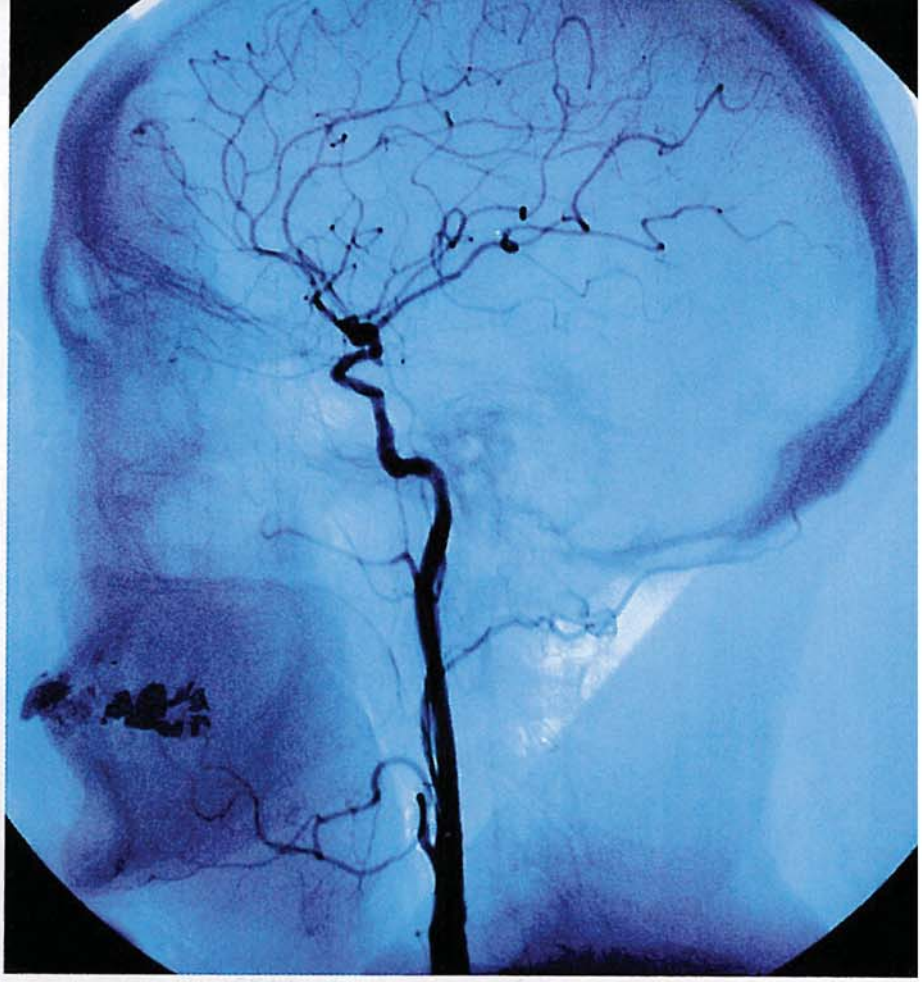
The thing about a fat gut, though, is that I know how to fix it: sit-ups and starvation. But a bloated, ineffectual mind? What goes on inside one's head seems about the same as what's going on inside one's pancreas—sure, there's stuff happening in there, but you'd be hard-pressed to figure out how to get it under control.

Until lately, that is. Professional athletes—who count among their ranks some impressive head cases—have recently turned to brain scientists to help them conquer the final frontier of athletic performance: the mind. By sticking electrodes on their skulls and learning to control their own brain waves, in real time, on computer screens, these athletes are gaining a mental edge over the competition. The Austrian skier and four-time World Cup winner Hermann Maier has profited from treatment, as has the Italian soccer team AC Milan, which went so far as to put a "mind room" into the team's training complex. After practice the players undergo a twenty-minute neurofeedback session designed to promote execution under pressure: They watch footage of their worst moments and train themselves to produce the same brain waves under these adverse conditions that they do at their calmest and most relaxed. (The room was installed after an epic choke in the 2005 Champions League final; in 2007, AC Milan returned to the final and beat the same opponent 2–1.)

Last year, neurofeedback jumped Stateside with the California-based company Elite Sports Performance, which trains a host of unnamed athletes, including an entire professional hockey team (pro athletes tend to clam up when it comes to disclosing their relationship with neurotherapy). Elite offered to let me try out their treatment. I had no preexisting mental pathologies or sports-related hang-ups that I knew of, but I had a fairly keen sense that I could stand a tune-up in any number of cognitive areas. I'd read that neurofeedback could help me hone my focus, tone down my distractibility—even, ideally, add a high gear to the upper reaches of my cognitive powers or help me finish the Saturday *New York Times* crossword.

Here were the tools for me to pry open the black box of my mind.

When I arrived at Elite Sports Performance's Los Angeles office, it certainly looked like the sort of place accustomed to pampering professional athletes: There were ergonomic chairs, sixty-inch flat-panel computer monitors, and control rooms manned by technical observation teams. The day I got there, an NCAA Division 1 kicker with NFL-level distance (he could consistently hit field goals of fifty yards and more in practice) was wired up, practicing concentration routines aimed at helping him hang on to the perfect form that often deserted him in critical moments.



NEUROTHERAPY COULD HELP ME HONE MY FOCUS, TONE DOWN MY DISTRACTIBILITY—EVEN ADD A HIGH GEAR TO THE UPPER REACHES OF MY COGNITIVE POWERS. HERE WERE THE TOOLS FOR ME TO PRY OPEN THE BLACK BOX OF MY MIND.

ESP chief partner James Thompson, a Canadian who'd helped perfect the Thought Tech brain-analysis setup the company uses, and founder Michael Mark, a sports agent turned neurofeedback specialist, ran the scan of my brain. The mind-reading procedure began with Thompson sticking nineteen electrodes to my head, which would produce colorful representations of the hot spots and dead zones in my mental landscape. The mathematics behind this procedure are complex, but the images it produces, called low-resolution electromagnetic brain-tomography (or LORETA) scans, resemble MRIs—they're straightforward, almost *USA Today*–like graphics of the mind that show the places where my brain activity dips below or rises above the statistical average.

One of the first things Mark pointed out was a bruised-looking area, persistent neurological evidence of a concussion I'd sustained at some point. (Sure enough: thirty years ago, high school football.) Other data showed that I was three standard deviations above normal in the calming alpha range, which suggested that despite my easy distractibility to outside stimuli, I possessed an above-average ability to be internally focused. "Did you say you've ever meditated?" Thompson asked. (Guilty again.)

"Hey," Mark said, pointing Thompson to a reading from a location on the left side of my head. "Did you see this?"

"That's weird," Thompson agreed. "Not what I would expect from a journalist."

"Nope."

"This shows very low beta activity—that's processing activity—in the verbal area."

This was how I learned that the close-up view of the brain is not always pretty. As the readings came in, I tended to gloss over the positives in my LORETA scan—a peak frequency somewhere near the crown of my head that suggested strong social skills—and focus on the defects: that verbal-deficiency thing, for example, or that little dead zone in the reading, which can be associated with "absence seizures." In other words, I space out (like I said!)—a fact that I, until then, had never known might be attributed to low-level epilepsy.

After the procedure (known as a quantitative electroencephalogram, or QEEG), Mark rewired me, sat me in front of the flat-screen, and ran me through a further battery of tests: a muscular-tension test, a breathing test, a test where I counted down

from 400 by sevens and they checked my galvanic skin response, and so on. Once again, positives (I had the breath control of a Zen monk) seemed outweighed by negatives, such as a tendency during stress tests to increase the production of the dreamier brain waves. (My mental reaction to crisis was to get *loopier*.)

I was, as a more verbal person might put it, nonplussed. Getting to know my brain reminded me of house hunting, where the repair costs of shitty plumbing could cancel out the benefits of a great view. The closer I got, the less I saw to admire. My mind, it seemed, was a teardown.

NEUROFEEDBACK has long been regarded as the tie-dyed shirt of medicine: way too trippy and embarrassing to trot out in serious company. When the field first came to prominence back in the late '60s, it was largely made up of moonlighting defense contractors and rocket scientists looking to apply their math acumen to the problem of the mind. But just as it began to attract mainstream interest—"The children of the future may look back on us as little more than Neanderthal men, crude creatures who were unable to control our feelings, our psychology—and unable to play upon the instrument of the brain," *The New York Times Magazine* gushed—things took a turn toward the wacky. In 1969 a conference for neurofeedback researchers was opened to the public, and it attracted all sorts of long-haired aficionados of altered states of consciousness. This group of spacey newcomers, not the mild-mannered science types, set the far-out tone for press coverage thereafter.

But eventually, when the press got bored with quoting hippies and the funding dried up, it was the lab coats who kept the serious research going. Joel Lubar, a retired professor at the University of Tennessee, has spent nearly forty years producing studies on the suppression of certain brain waves; his research has led to successful treatment of ADD and seizure disorders. Roy John, a professor of psychiatry at NYU, has devoted the past thirty years to assembling a database of brain scans—now 20,000 strong—that forms the statistical average that each individual brain is measured against when creating readouts like the one I had done in Los Angeles.

"What neurofeedback begins with," John told me, "is valid neurobiological measurement. How it's used is a function of the individual practitioner. Some of it, frankly, is pretty questionable—and some of it is extremely interesting."

John warned me away from untrained therapists who'd simply bought a neurofeedback kit and taught themselves to use it; he suggested that practitioners should be judged by their qualifications and credentials. Then he cited a number of studies showing how neurofeedback therapy can relieve the need for medication in children with ADD, help stroke victims regain mental function, and treat moderate depression, alcoholism, and sleep disorders.

"I think twenty years from now," he said, "it'll be a widely used branch of medicine."

As further proof, John pointed to some research from 2003: a British double-blind study undertaken by John Gruzelier, of London's Goldsmiths University. In Gruzelier's study, students from the Royal College of Music were judged by a panel of experts on creativity, technique, and ability. He then divided the group: All students continued rehearsing and performing as before, but only some received neurofeedback training designed to increase internal focus and creativity. At the end of the study, new performance tapes were submitted to the panel—and those students who'd successfully raised their levels of certain brain waves consistently received higher scores on the artistic qualities of their work.

"Now, that's amazing," John said. "Because what the neurofeedback group experienced had nothing to do with their music. It had to do with EEG training."

The treatment that Gruzelier gave the music students involved altering their alpha and theta waves (see "Know Your Brain Waves," page 196) to tap creative reservoirs inside the brain; a variation of that same technique has had clinical success here in the U.S. helping alcoholics, drug addicts, prisoners, and veterans suffering from post-traumatic stress disorder. Both approaches can induce dreamy edge-of-sleep states that cause memories, often vivid or even traumatic ones, to reach the conscious level. In the British study, this tapping of a creative wellspring helped performers access new levels of emotional strength and artistic interpretation; with alcoholics and PTSD patients, the traumatic memories were reprocessed in ways that helped eliminate their persistent destructive effects.

Beyond just helping athletes improve performance, neurofeedback has led to important diagnostic breakthroughs. This is especially true in the world of football, where teams, faced with mounting evidence of the risks players run by returning to the game too soon after a concussion, have grown more receptive to new treatments. One such advance is an experimental instrument called the BrainScope, designed by John; it's a PDA-like portable EEG able to detect and quantify concussive brain injury on the field. (The Department of Defense has also shown interest, since so much mild traumatic brain injury—for example, blast concussions from improvised explosive devices—turns out to be invisible to a CAT scan or an MRI.)

And lately, neurotherapy has been branching out not just to people concerned with top-level athletic or creative performance but also to those with problems more generally within the purview of traditional psychotherapy. When I met James Thompson at his New York office, he told me about a hedge-fund manager who'd been coming to see him.

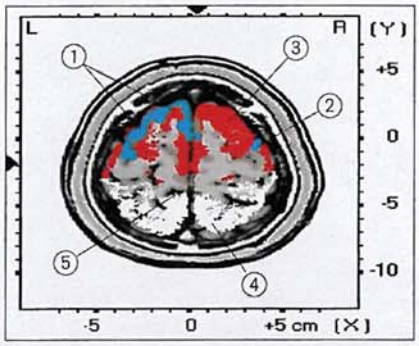
"Look at this guy," Thompson said, opening up a brain scan on his computer screen. "Makes *millions*. But he can't put down his BlackBerry. He has a deficit of slow activity in his emotional side. That's why it's blue over here." Thompson indicated a spot on the left side of the brain that showed very little activity in the slower calming frequencies. "His fast activity is dead center in the cingulate gyrus," said Thompson, pointing to a part of the brain associated with heart rate, blood pressure, and attention. "He can't let anything go. He sleeps terribly; he's superanxious. He's *super*productive—but that's not saving his marriage."

In his first neurotherapy session, the hedge-fund manager (who later described his treatment to me in detail; to protect his identity, let's call him Bill Steele) told Thompson what he hoped to accomplish: stay married, sleep at night, cut down on his tendency to "go off." To help him meet these goals, Thompson designed a series of exercises that involved learning to control brain waves. He put a few electrodes in strategic sites on Steele's scalp, and a precise readout of the brain's oscillating electrical activity showed up on the monitor. Steele could watch real-time images of his own changing mental state, which appeared either as no-nonsense data or in friendlier video-game formats: sailboats racing across the screen, a pair of mice marching along to some jazzy riffs.

Ideally, once you can see your brain waves on-screen, you can learn to exercise control over them. Reach certain goals—for Steele, lowering activity in his anxious brain waves

WHAT'S GOING ON IN THERE?

LORETA scans produce intricate structural pictures of your brain. What can you learn from them? Our intrepid writer agreed to show us what's going on inside his head. – HILARY ELKINS



KEY: Red area – ALPHA Blue area – THETA

+ KNOW YOUR BRAIN WAVES

Brain waves are divided into Greek-letter-named subranges that roughly correspond to the following mental states

- **Delta** (0–3.5 hertz): deep sleep and/or brain damage
- **Theta** (3.5–8 hertz): drowsiness on the low end and internal focus at the upper end
- **Alpha** (8–13 hertz): meditative states on the low end; intellectual awareness at the upper end
- **Sensory-motor rhythm** (13–15 hertz): stillness, mental focus
- **Low beta** (15–20 hertz): active problem-solving and cognitive activity
- **High beta** (20–30 hertz): anxious thought, emotional intensity, and at the upper end, neuroses

ONE: Kevin's left frontal lobe shows an excess of the slower, spacier theta and alpha frequencies—not exactly what you want in the part of the brain that organizes, strategizes, and pays attention to detail.

TWO: This blip of excess theta in the inferior frontal gyrus can mean that Kevin is sometimes a wee bit irritable.

THREE: Kevin can be a pretty introspective guy, and high alpha levels on his right frontal lobe mean he can truly get in the zone and meditate. Kevin would also like you to know that high alpha levels in this location are often found in professional athletes, an indication of their ability to tap into the Zen-like state associated with, yes, athletic greatness.

FOUR: The occipital lobe houses visual faculties; white and gray here indicates Kevin is A-OK. And if he weren't? Frequency abnormalities could indicate damage to the optic nerve or problems with visual processing.

FIVE: One thing Kevin doesn't have to worry about: turning it off. Excesses in higher, such as beta, frequencies located at the crown of the head in the anterior cingulate are characteristic of "chatter brain." Think type A personality.

Elite Sports Performance's neurofeedback packages start at $5,500 and include blocks of ten or twenty training sessions. Visit www.elitesportsperformancellc.com.

and raising activity in his relaxed ones—and you get the reward: The mice march jauntily across the screen, the sailboat races ahead. Usually, progress was slow, but one day Steele had a breakthrough. For a long stretch, he got his brain under control. Music played. Mice boogied.

"Whoa," Thompson said. "What was that?"

"Oh, I was just thinking about when I sit on the couch at home," Steele said, "and one of my kids puts his head on me and I can feel his breathing. I get into sync with him. It's nice."

It was almost a throwaway moment—just a few easy breaths in the executive pressure chamber. But in that moment's brain scan, Thompson saw exactly what he was looking for.

"Well," he said, "that's the feeling we're going to work on."

FOR MY OWN treatment, I regularly visited Thompson's office, where after the standard delays of applying conductive gel to the tough skin on my bald head, my brain waves would pop up on the monitor. The display looked like a sonar scan of the ocean floor: I watched hot-pink peaks, blue foothills, and gently rolling green-and-white plains—the topographic contours appearing rapidly as a line progressed across the screen.

Thompson's practice is split between people trying to tweak their circuitry for optimal performance—like the hedge-fund guy and me—and people with medical conditions like ADD. The sessions are similar. You sit in a chair, wired to the EEG by three or four electrodes (nineteen are required for the more complex QEEG neuroguide I received in Los Angeles), and perform a series of three-to-six-minute exercises based on operant-conditioning principles: By rewarding desired behaviors and punishing unwanted ones, the program trains you to modify behaviors normally beyond conscious control.

At my first session, after taking a ninety-second reading of my brain, Thompson transferred the data to a spreadsheet. "Based on this," he said, "I can determine what your baseline average is, your slow-wave and fast-wave activity." He pointed out some numbers and then homed in on my theta-beta ratio, which showed three times as much slow-wave as fast-wave activity.

"What does that mean?" I asked. "How do I compare to a gorilla?"

"Your brain-wave pattern, with this ratio, is more like a brain that is, uh..." Thompson was searching for the nicest way to put it. "*Creative*: a hunter-mind style. Some people would look at this and say you have attentional difficulties. Well, potentially. But only in tasks that you're not interested in. A child with this brain-wave pattern might be able to hyperfocus on something he's excited about—like a video game—but he would also have trouble studying or paying attention in school."

In other words, I have ADD. I could just hear my mother: *Where'd you pick that up? Working in magazines?*

Over the next several weeks, I came into Thompson's office to train my "calm focus" on a series of EEG-driven exercises aimed at getting the dreamy theta activity down and the more clear-thinking beta activity up. (Steele, on the other hand, was trying to lower his beta, which in excess can lead to anxiety, and increase his alpha—a combination designed to help him become, in his wife's gingerly description, "less reactive.") Thompson warned me that it was like learning to ride a bike: He couldn't explain what to do; I had to get the hang of it on my own. It wasn't as easy as it sounds. Sensation within the brain is remote, and exerting your will tends to achieve the opposite of what you're aiming for—especially if the goal is relaxation. Whenever I got it right, cool things happened on-screen: A ball bounced across colored tubes, a dart floated into a bull's-eye, the mice boogied across the screen. But every time my hunter mind wandered, the music stopped, the mice backed up, the dart froze.

Effecting any noticeable changes in my brain waves took concentration, and I had to shove aside self-consciousness to do it, which wasn't easy, especially with Thompson watching everything and twiddling with the controls all the time. Overall, the sessions felt like working out with a personal trainer. When I did well on one screen, Thompson adjusted the parameters (without telling me) until it was as difficult as I could stand. But even though I was exerting effort, I wasn't *doing* anything.

Still, when I left Thompson, I often got that sense of lightness, that relaxed goodwill-toward-strangers feeling that accompanies a hard workout. Re-creating this feeling, repeatedly, with confirmation on the video monitor, helped me to recognize the distinct mental feeling of concentration and (after a few sessions) to invoke it more or less at will, just the way I could decide to run or stomp or cha-cha-cha. Joel Lubar confirmed this impression. After initial training—usually somewhere between

twenty to forty sessions—the new mental habits acquired in neurofeedback become more or less permanently available.

"Once you've learned to produce a certain EEG pattern associated with the resolution of certain clinical problems," he told me, "that pattern is yours."

PROFESSIONAL as Thompson's whole setup seemed, it was hard not to question certain aspects of neurotherapy. I had no reservations about the EEG equipment, or the computer analysis, or the extensive database that provided a three-dimensional neuroanatomical profile of my brain. Those were all objective measurements; it would make more sense to question an ATM.

My concerns focused on the interpretive step. How did therapists move from objective observations (like the comparatively large amount of six-hertz-frequency brain waves in my left frontal region) to character assessment (that I had a hunter mind) and treatment (let's suppress some of that six-hertz activity)? How was it that the theta frequency I possessed such an abundance of had come to be associated with creativity, distractibility, spontaneity, drowsiness, depression? That all sounded much more like the old Robert Downey Jr. than me.

I'd heard a similar line of criticism expressed by Joel Morgenlander, M.D., a Duke University professor of neurology who'd consulted for the NFL on concussion injuries and was doubtful about EEG readings' real-world uses. "So someone's baseline EEG rhythm was ten hertz and now it's nine hertz. Well, does that matter? It doesn't matter to any neurologist I know," he said, voicing fairly standard concern about the paucity of controlled studies supporting many of the claims made by neurotherapy.

Thompson emphasized that the training wasn't designed to eliminate any particular baseline. People tend to have dominant frequencies, mental "parking spaces," he said. Ideally, neurofeedback would give me the option of switching back and forth between them. This sounded like a good strategy: I was diversifying my mental portfolio.

So that I could tinker with my brain on my own time, Thompson had sent me a home EEG kit—a simple training module that can accommodate about eight connections. The machines are small, about the size of a PDA, and relatively affordable, around what you'd pay for a high-end computer. Thompson had suggested certain calm-focus menus for me to train on; using them, I was able to continue lowering my theta thresholds on my own. It was also technically possible to wire up my brain and connect to Thompson's computer through the Internet for a remote training session.

Of course, many of neurotherapy's recommended treatments seem pretty obvious: teach an athlete to relax, force a writer to concentrate, get a stressed-out executive to imagine holding his son. Any conventional therapist would probably suggest the same thing. But the value of the training is that it teaches you what it actually feels like to produce such states. The lights go on when you succeed; succeed enough times and you wind up getting the hang of it. What separates this sort of therapy from other self-improvement schemes is the clear signals that let you know when you're on the right track—the *feedback* part of neurofeedback.

And it was true that ever since my sessions, I'd been uncharacteristically efficient, far less likely to waste an afternoon playing online mah-jongg or compulsively checking blogs. Working with brain waves at first had felt a lot like trying to get my kids into the bathtub: Nobody's listening, everybody's naked and jumping around, somebody's overturning the junk box looking for a tub toy. The training had helped me tune out all that background noise and focus on my strengths—but more generally, it also taught me a new kind of patience and humility, a result of my face-to-face confrontations with my own brain.

As my training went on, I kept encountering extraordinary recommendations from a variety of sources. Roy John, the NYU professor who had seemed immune to overstatement, quietly mentioned a pair of case studies he was writing up. Earlier in his career, he'd been part of a team that created the now standard, FDA-approved depth-of-anesthesia monitor that uses electrodes on the forehead to help an anesthetist determine a patient's level of consciousness. In a recent study, he and his team used an EEG mechanism on two comatose patients, monitoring the patients' levels of consciousness, while researchers treated their brains with neurochemical agents. In the aftermath, both patients, each of whom, according to John, had been declared irreversibly vegetative by experts in two hospitals, regained consciousness. "One of those patients is home with his family, talking to his kids, and learning how to walk again," he said.

Bringing back the dead is a high recommendation for any therapy, but John was hesitant to acknowledge the threshold he had crossed. Instead he offered what felt like a telling assessment of the state of the whole field.

"You can think of all this as brain electrical activity, which gives you a compass," he said simply. "It tells you how far you are from where you want to be—and in what direction you need to go."

KEVIN CONLEY *wrote about Shia LaBeouf in the June issue.*