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HEALING YOUNG BRAINS

DRUG-FREE TREATMENT FOR CHILDHOOD DISORDERS—INCLUDING AUTISM, ADHD, DEPRESSION, AND ANXIETY

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The Healing Power of Neurofeedback

Neurofeedback, often known as brainwave biofeedback or EEG biofeedback, is a sophisticated form of biofeedback. Biofeedback is one of these terms that most people have heard but may not understand what it actually means.

Eavesdropping on Events inside Your Body

Biological systems in the human body are constantly sending us messages. We don't usually pay attention to them until they become so loud we can't avoid them. For example, if we run up three flights of stairs, we notice we are breathing hard and sweating, and our hearts are pounding. We hear the message loud and clear, and we slow down, rest, and recover.

The internal messages are always there, but unless we exaggerate them or specifically go looking for them, they generally go unnoticed. When your doctor checks your pulse, she is listening in on biological information; hence, what she gets is biofeedback. If your doctor uses a stethoscope to listen to your heart and lungs, she is using a simple biofeedback instrument.

It is only in the past few decades, however, that technology has provided us with machines sophisticated enough to detect,

amplify, and record the more subtle biological signals. Being able to do this started a revolution in medicine. We soon learned that by getting feedback on internal processes, we could change internal activity.

Biofeedback is like eavesdropping on our body's internal conversations. When these inside-the-skin events are detected and fed back to us through electrical signals using sight, sound, or touch, we can learn to use this information to change unwanted patterns that are contributing to poor physical and/or mental health. That's because our bodies are a sea of information and communication. Every organ is talking and listening to every other organ. This seems to be important for the health of the whole. We are a complexity of many organ systems and trillions of cells that are completely dependent on one another for life itself. If communication breaks down, or a system becomes dysregulated, it affects all other systems.

The idea that there is such a strong mind-body connection in healing has produced an entirely new field of medical study, psychoneuroimmunology (PNI). The term "psychoneuroimmunology" connects the mind *(psycho),* the nervous system *(neuro),* and the body's natural defenses *(immuno).* We know that these three systems carry on a constant dialogue, particularly the brain and nervous system, and this is where neurofeedback plays a major role.

Inside-the-skin events have often been ignored because they are subtle and often difficult to detect. Now, with the development of small, affordable computers, we are more capable than ever of listening in, amplifying, recording, and getting feedback information on biological events. This is revolutionizing the way we look at the whole body as a functioning system. The feedback may be in the form of sight, sound, or physical stimulation. With the latest advances in technology, the feedback can come in the form of sophisticated computer games. With practice, we can begin to change inside-the-body events to make us healthier.

The quieter messages that otherwise go unnoticed until we have a medical or emotional problem are now available for study. With biofeedback, it is a relatively simple process to teach a person

to change inside-the-skin activities. We can change things such as temperature, heart rate, blood pressure, muscle tension, chemical responses, and even brainwaves.

To illustrate the effectiveness of biofeedback, we will share with you a wonderful story that Dr. Elmer Green tells. Dr. Green is one of the early pioneers in biofeedback and has contributed as much to the field as anyone in its history. Dr. Green would bring individuals with unusual talents for self-regulation to the Menninger Clinic in Topeka, Kansas, where they would be studied. On one of his trips to Menninger, the Swami Rama demonstrated that he could create a ten-degree temperature differential just two inches apart on the palm of his hand. This, in anyone's opinion, would be extraordinary. Swami Rama said it took thirteen years to learn this. His biofeedback was the skin color of his hand. The swami would watch the palm of his hand to get his biological feedback. When a part of the body heats up, the area turns red. This is easily seen when a person is embarrassed and the skin flushes. The face, ears, and upper chest turn deep pink to bright red.

So Swami Rama would observe his hand and focus on making one spot red and the cooler spot a grey color. When the one spot turned red, he knew that it was hotter than the surrounding area. This was obviously a result of changes in blood flow. A graduate student working with two temperature biofeedback machines was able to accomplish this task in two weeks. So with appropriate biofeedback technology, the graduate student was able to learn the task more than three hundred times faster than Swami Rama. This reinforces the notion that we can change any organ system quickly if we provide it with appropriate information.

Biofeedback is simple and painless. The therapist attaches small sensory monitors to the scalp or skin, like placing tiny stethoscopes to listen to inside-the-skin events. The patient then sits back, usually in a comfortable chair, and begins to relax. The machines then show how a particular body system is functioning and feeds back information as the patient works to change that system. The patient may be trying to relax a group of muscles for back pain or increase skin temperature of a finger to help in Raynaud's disease.

Raynaud's disease is a painful phenomenon in which the small arteries in the finger go into spasm, cutting off the blood flow. The fingers turn white and/or purple due to loss of blood flow.

As the patient becomes more proficient in the use of a biofeedback instrument, he becomes more aware of how a particular body system is functioning. This helps the patient bring that system under more voluntary control. Until recent decades, Western medicine believed that systems under the control of the autonomic nervous system functioned involuntarily, that we had no control over them. Yet yogis in the East had demonstrated for millennia that they could control such processes. It was only through biofeedback that we were able to change the belief system of Western medicine.

Now, in biofeedback practices all over the world, we routinely train people to change those "involuntary" processes, bringing them under voluntary control. Once patients learn to regulate a system, they no longer need the biofeedback equipment. While training, they develop a sensory image. This is not a visual image, but a feeling that physical things are changing inside the body. For example, patients can sense when the hands are beginning to warm, the blood pressure is going down, the muscles are relaxing, and the brain is alert.

Imagine having voluntary control over your autonomic reflexes. A few decades ago physicians would have dismissed the idea as crazy. Now, informed physicians use and prescribe biofeedback daily to patients with disorders ranging from high blood pressure to urinary incontinence to stress-related disorders.

Neurofeedback, the Next Step Up

Neurofeedback is a sophisticated form of biofeedback that has been demonstrated to be highly effective in treating dozens of physical and psychological disorders. It has also been used for individuals who want to perform at peak efficiency. This is usually called "peak performance training."

Early in the history of neurofeedback, it was used successfully to help individuals with uncontrollable epilepsy. Barry Sterman

and colleagues at the Sepulveda, California, Veterans Administration Medical Center conducted their groundbreaking research.[1-5] There are many people who have seizure after seizure with little help from medication. By giving the patients feedback on their EEG rhythms, the patients were able to change the rhythms, thereby bringing the seizure activity under control.

Following closely on that work, Joel Lubar and his associates found EEG biofeedback to be a successful treatment for attention-deficit disorder and hyperactivity.[6-7] EEG biofeedback's effectiveness was also demonstrated by Tansy and Bruen.[8] From there, the modality has demonstrated efficiency with disorders from alcoholism to depression, anxiety to migraines.

Neurofeedback is not a cure-all, end-all treatment. It is, however, an exciting treatment that offers hope to some of the hopeless by teaching them to regulate their own inside-the-skin events. The field is growing and changing rapidly, offering hope to larger and larger populations as research in neurofeedback continues in many universities and private settings.

Significant among the expanding fields of application is performance training. There is a growing interest in peak performance, so many practitioners of neurofeedback offer peak performance training. Many governmental and industrial clients have their management teams go through neurofeedback training because it sharpens the brain, improves creativity, and enhances critical thinking. Japanese companies send management personnel to the United States for neurofeedback training because staying competitive is important and they know neurofeedback makes sharper, quicker thinkers.

Neurofeedback: Training or Treatment or Both

Most neurofeedback training clinics have their roots in client-centered psychotherapy and self-regulation, so there is a lot of personal attention when a patient receives neurofeedback. The neurofeedback therapist understands that a healthy brain has the ability and versatility to change states of arousal and attention. As each new situation in a person's life demands a specific level of

arousal and awareness, the healthy brain can quickly move to the appropriate level of alertness.

By contrast, the unhealthy brain may be underaroused and sluggish or overaroused and anxious. Either way, the dysregulated brain has a diminished ability to respond to specific demands. The immature, injured, or disordered brain lacks the normal elasticity of the healthy brain. Scientifically speaking, there appears to be discontinuity in the brain and nervous system processing or breakdowns in the way the brain and nervous system communicate. In other words, the brain is not processing information or repsonding at the right speed. It is either too slow or too fast. Also, the brain is not communicating information correctly to itself, so it is out of sync with itself.

The disordered brain seems to be stuck, or "parked," at the wrong place. It produces brainwaves that are inappropriate for the immediate situation. For example, in most of the childhood disorders we have been discussing, the brain tends to produce more lazy daydreaming-type brainwaves than it does thinking, concentrating-type brainwaves.

Neurofeedback training teaches the person what specific brainwave states feel like and how to turn those states on voluntarily. Individuals being trained can move their own brains to different physiological states, depending on what the immediate situation requires.

We have been training people for many years to change their physiological state through biofeedback. With the aid of biofeedback machines, we can alter practically any physiological process. Neurofeedback is the next step up; we are actually training the central processing system, the brain. Most of the early work in biofeedback focused on the peripheral systems of skin and muscle. Now we can go directly to the brain, hence the new name—neurofeedback.

Neurofeedback makes the brain more flexible, and seems to have a generalizing effect on the whole nervous system. The implications of this are profound. Training the brain to correct its dysregulated state has a positive effect on neurological functioning as well as on the cardiovascular, gastrointestinal, immune, and

endocrine systems. Self-regulation not only enhances the brain's ability to improve cognitive/intellectual functioning, but it also aids the body in healing itself.

Self-healing is what biofeedback is all about. It brings what used to be termed involuntary processes under voluntary control. Self-regulation is exciting because it gives patients some control over their own health and well-being. They are no longer at the mercy of a dysregulated brain and no longer completely dependent on the pharmaceutical industry to provide them with the "magic pill."

Changing Inside Out

A neurofeedback machine monitors the electrical activity produced by the brain, and the neurotherapist (neurofeedback professional) can correlate this activity with human behavior. The brain's electrical activity is measured in cycles per second, or hertz. A neurotherapist can examine the activity of a single frequency or a group of frequencies together, called a frequency band. By comparing behavior with the brainwave frequency, conclusions can be drawn about the relationship between the two. As a result of research in this area, we have been able to determine different behavioral states and how they relate to rhythmic activity of the brain. In other words, we know what state of consciousness a person is in when the brain is producing a dominance of a single frequency or frequency band.

By using feedback instruments, the therapist can feed back information to patients on their level of consciousness at any given moment. Patients can subjectively evaluate what that conscious state feels like and, with practice, can begin to reproduce that level of consciousness voluntarily. It takes training time, but patients gradually learn to move the brain out of "park," giving it the power and flexibility to meet life tasks. Once trained, patients developed a level of sophistication in identifying the desired state; they no longer need the neurofeedback equipment to accomplish the task at hand. They are now self-regulating.

Once trained, patients no longer need the neurofeedback equipment to relax, feel calmer, concentrate better, or be more focused.

Therefore the student shows fewer and fewer symptoms of any disorder they have been dealing with. The businessman is much more efficient on the job; the migraine sufferer can dramatically reduce the frequency, duration, and intensity of her headaches. Neurofeedback teaches the fine and profound art of self-mastery. It can make any person less dependent on medical personnel, drugs, machines, or medical technology. It produces strong self-reliance, independence, and self-esteem, and provides patients with some control over their physical and mental states of health.

The Neurofeedback Learning Process

All biofeedback, including neurofeedback, is a learning process. It involves physical learning and mental skills. It is a process of learning how to change your body by listening to its functioning. When you can control your own mental state, you have real power. Neurofeedback is like any other learning process: The more you learn through practice, the more confidence you develop. So we suppose you could say that a side effect of neurofeedback is greater self-confidence.

Neurofeedback is not complicated. In our office practice, children of four, five, and six years learn to change their brainwave patterns. A number of neurotherapists have trained infants; a parent holds the infant during the session. Anyone except the very mentally deficient can learn self-regulation, so neurofeedback is not just for the elite. It is for all humans who want self-control and self-determination. Although patients cannot explain what they have learned and how they have learned it, they know they have changed.

For example, in temperature training, we have many patients who can quickly learn to increase a hand temperature of seventy-two degrees to ninety-five degrees. They know they can do it, but they cannot tell you how they do it because the learning is at a subconscious level.

In neurofeedback, the brain learns what it needs to do to accomplish the task. You want it, you tell the brain to do it, and it does it, leaving you never knowing exactly what you've learned.

Truly, if there is any magic left in the world, it is the magic inside each of us.

Some biofeedback processes, like hand temperature training, may only take a few training sessions to achieve. The more complex the system, the longer training takes. Brainwave training takes longer than temperature training because you are dealing with a more complex system. In brainwave biofeedback, the patient learns the "feel" of a particular brainwave. The more training patients have, the more easily they perfect the skill of producing a particular rhythmic state in the brain. Learning to modify a brainwave state in the direction of a desired mental state is a "discovery" process, a process of gaining more and more control over your thoughts, feelings, and behavior.

Global Dysregulation

We have talked about clusters of disorders, but now we want to delve deeper into why people have multiple symptoms that seem to emerge at the same time. Because of the wide variety of disorders that have been helped with neurofeedback, the idea of a global dysregulation effect emerged. This is a simple concept that means that if the brain is dysregulated, it can have a global, or body-wide, effect. Seldom does a patient present to a health professional with a single symptom, and the symptoms usually involve more than one body system.

For example, patients may present with the chief complaint of depression, but after a thorough intake evaluation, they acknowledge trouble sleeping, poor attention span, irritable-bowel-type problems, low-back pain, sugar cravings, weight gain, alcohol use, irritability, and chronic anxiety. So the symptoms are not just in one system; they tend to be global, or body-wide. Once neurofeedback treatment begins, symptoms from several systems begin to respond, and the response generally has lasting benefits.

It appears that once the brain becomes dysregulated, it can have a global effect on the body. After all, the rhythmic activity of the brain affects all functional systems of the body, and this rhythmic activity is central to all systems. Therefore, regulating the

central rhythmic activity of the brain improves body-wide functioning. It appears that neurofeedback not only affects such problems as attention and concentration, but also has a systemic effect. When we treat people for ADHD with neurofeedback, other systems begin to improve because the brainwaves become regulated. For example, in treating ADHD, not only does attention improve, but oppositional behavior, sleep, irritability, depression, anxiety, antisocial behavior, tics, and many other problems also improve.

To give you an unusual example, several years ago we were treating a ten-year-old for ADHD. During the treatment period, he started having visual problems. His mother took him to his ophthalmologist who told her, and us, that after years of following this child's visual problems, the child's "lazy eye" had suddenly gotten much better. We all concluded that focusing on the neurofeedback monitor must have helped train the eye to focus more normally.

Early on, we noticed that while treating women for depression, anxiety, or other disorders, their PMS or menopausal symptoms improved dramatically. At first we thought it was just a coincidence, but it happened again and again. We now realize that if you regulate the brain, you affect all systems, even the endocrine system.

Neurofeedback has the ability to reduce or correct global dysregulation. The future implications of this are profound. Neurofeedback training could preclude taking multiple medications for multiple problems, or seeing several different specialists, each treating a different problem. Neurofeedback treats problems at the core—the brain—and when the functioning of the brain improves, it produces global body-wide changes.

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How Neurofeedback Works

When you make claims that a particular treatment is highly effective for a number of different diagnoses, professionals and laypersons alike tend to become suspicious. And we think they should. Snake-oil salesmen have long pervaded the arena of medical treatment. How many times have we all heard that this pill or that herb will heal, give us more energy, give us greater sexual prowess, or help us lose weight? Most products with broadly based claims just do not hold up under close inspection. They may help with one thing or reduce one symptom, but they seldom meet our expectations. When they don't, our optimism turns sour.

Brainwave Researchers Take Advantage of Modern Computers

When we first ventured into the field of neurofeedback, we kept waiting for the bottom to fall out. After all, we remembered with vivid disappointment the "alpha craze" in the 1960s and 1970s. The promoters of alpha brainwaves promised that if we could make more alpha brainwaves through meditation, drugs, and primitive neurofeedback machines, we could achieve a life of bliss. In the 1960s, some people were even turning on their TVs and adjusting the picture until it was a snowy fuzz. They sat staring at it because it was supposed to help them produce more

alpha waves. Transcendental meditation was the craze, acid was the party drug, and companies made alpha machines. Those who promised nirvana could not deliver on the promise. The machines were too primitive and research too scarce. The alpha phenomena hurt the science of neurofeedback; it did not produce all the promises we were told to expect. In retrospect, there is nothing wrong with meditation, biofeedback, and learning to produce more alpha waves, but there were lots of reasons for the failures: The equipment was not as sophisticated; the science was too new to make such exaggerated claims; and it was too entangled with the metaphysics of the 1960s and 1970s.

Over time, brain science has taken some curious turns. We have vacillated between looking at the brain in small components versus the notion of understanding the brain as a complete functional system. Neurotherapists have always looked at the brain as a functioning system and so, with any disorder, we hoped to see how the systems had failed. For example, when we first started looking at the ADHD phenomenon, we had the intuitive understanding that it was a functional problem and not some minute component. As we discussed earlier, this idea is reflected in the terminology of "minimal brain dysfunction."

Brain scientists are still in conflict. Many scientists are attempting to understand the brain from a molecular level and that is a positive thing to do. They break the brain down into the smallest bits, rather than seeing it as a whole. In treating the disorders we are discussing, we want to understand the brain as an entire functional system.

Often our patients come in with normal CT scans, normal EEGs, and/or normal MRIs, but functionally they are a mess. So, structurally, and perhaps molecularly, they appear normal, but it is their routine brain function that seems disturbed. We frequently describe patients' disorders to them by giving this example: "You are like a car with faulty timing. Your brain is okay—it just needs a tune-up."

By examining the brain at a molecular level, the issues of gross motor, gross thought, and gross emotional behavior are not the

primary focuses. Most of our patients are not concerned with their molecules, but they are concerned about balance and strength, quality and quantity of thought, and being overwhelmed by their emotions. Neurotherapists are not concerned on a daily basis with the trillions of molecules that make up the brain; we are concerned with the global functioning of that system we call the brain and nervous system. This has translated into practical therapeutic treatments for clusters of disorders.

For example, accompanying depression, the person may also have tiredness, loss of interest, irritability, loss of sleep, and/or a decreased sense of humor. This cluster of symptoms all relate to the same problem. Global symptoms may reflect problems from several systems. Therefore a practical therapeutic approach focuses on a treatment such as neurofeedback that not only has a positive effect on a cluster of symptoms, but also on global dysregualtion.

Think for a minute about that brain inside your skull. Your brain is a large, complex, self-organizing system. Occasionally, the functioning of that system becomes dysregulated. As we explained earlier, it is likely a result of genetics or some type of injury. When the brain is dysregulated for a period of time without restoration of its normal functioning, it interprets the new functioning as normal. That dysregulation produces a cluster of unwanted symptoms.

To use an example from the area of dependence, if you smoke cigarettes long enough, the body begins to act as though cigarettes are as necessary to you as oxygen, water, or food. Therefore, if you try to quit smoking, your body rebels, making you uncomfortable and quitting very difficult. Brainwaves are much the same. If a brain received a head injury during birth, that injury may cause the brain to produce the wrong brainwave for any given task. After a long enough time, the brain doesn't try to correct the dysfunction because it thinks the current waves are normal.

Neurofeedback works by challenging the brain to make different waves. It is this challenging of the brain that seems to awaken the brain's self-regulating mechanism. We nudge the brain's firing

patterns in the direction of a healthier balance. A process then begins to take place that appears to be the brain teaching itself to normalize. Because the brain is trying to maintain a balance, we push and it pushes back, resisting a rapid change in one direction or another. This is why progress is not rapid with neurofeedback. This slow learning process ensures that the brain does not rush to a new firing pattern that could be in a more dysfunctional, opposite direction. The fact is, we can change any functional system of the body, including the brain and nervous system, if we give it appropriate feedback and enough time.

It took the newer, faster, more compact computers to make neurofeedback a practical therapeutic treatment that could be made available to the general public. If you are going to give the brain information about its own rhythmic activity, and give it fast enough for it to recognize and change the pattern, it has to be real-time fast (not delayed information). It has only been in the past decade or so that we could even begin to formulate treatment protocols and to experiment on what types of disorders would respond positively to the training. We don't apologize for being a new science, but we still eagerly await the next research paper or treatment protocol for some disorder with which we have not previously worked.

Neurofeedback offers hope to so many people who feel hopeless because it is able to provide the brain with information about its own rhythmic activity. It assists in regulating not only the dysrhythmic activity of emotional problems such as depression and anxiety, but also the dysrhythmic activity of physical and neurological disorders such as autism, epilepsy, migraines, head injury, stroke, and PMS.[1-2]

The brain communicates to all systems, including itself, through electrical activity. As odd as it may sound, it appears that the brain has generators that produce the brainwave activity, which are actually low-frequency electrical rhythms. It is this electrical activity that gives the information about what and how to do everything. This low-frequency rhythmic activity is central to life and the second-to-second functioning of every organ system in the body. If this rhythmic activity becomes dysregulated, it leads to dysfunction.

We could end up sleeping rather than reading, anxious rather than calm, dull rather than alert.

We know now that the brain responds to many forms of intervention, including classical and operant conditioning, which we discuss later. Neurofeedback directly affects the brain, so its impact is on the central processes of the entire person. Since the brain is intimately involved with every organ and system in the body, neurofeedback affects us at the core. You cannot change the brain without it having some effect on every functioning system. Because neurofeedback directly affects the brain, it has the opportunity to elicit a faster, more comprehensive, longer-lasting resolution to functional problems.

Adjusting Our Own Brain Rhythms

To be more specific about how neurofeedback works, the brain controls our physiological state of arousal. This is done by the rhythmic activity of the brain, expressed through brainwaves. If brainwaves become dysregulated for whatever reason, they may not return to a healthy functional state after the event has passed.

Earlier we discussed the notion that the brain may assume dysfunctional rhythmic activity to be normal and work to maintain it. When the brain is producing a steady state, regardless of the activity level, we say it is "parked," to use a term coined by brain researcher Dr. Michael Tansy. For example, if the brain is consistently showing a dominance of seven hertz, regardless of the human's functional activity, we say the brain is parked at seven hertz.

There are certain brainwaves that are characteristically seen as a result of a specific event. For example, when there is a blow to the head or a seizure, the brain will emit a high burst of a single brainwave or a band of brainwaves. These are referred to as spikes. In closed head injuries, we may see spikes in the very low delta range (one to four hertz). In epilepsy, we see high spikes in the area of seven hertz. When there is trauma to the brain, these injuries usually show up on conventional imaging, such as MRIs or CT scans. We can see the inappropriate burst and also determine the focal point.

In other types of problems, such as ADHD and depression, we do not generally see spikes, but we see single brainwave frequencies or frequency bands that are inappropriately dominant. For example, if sleep waves are dominant when you are trying to read, they are inappropriate. We have seen ADHD children exhibit large inappropriate spiking. In such cases, we suspect these children have suffered some type of closed head injury: a fall, a sharp bang or hit, or some other trauma.

Dominance is a key term to remember when thinking about appropriate and inappropriate functioning. Brains produce all of the various brainwaves all of the time, but depending on our level of arousal, a single brainwave or a band of several brainwaves will be higher than others. That wave or band of waves will be the dominant wave or frequency band. To function at peak efficiency, we want the dominant wave to reflect the activity we are engaged in at the time. For example, if we are sleeping, we want slow "sleep" brainwaves; if we are doing a complicated math problem, we want the faster, "alerting" brainwaves to be dominant.

Children and adults who have attentional disorders demonstrate a dominance of low-frequency waves. In fact, both epileptics and children with ADHD show a dominance of slower EEG waves and a deficit of faster-frequency waves.[3] If a person is asleep, it is appropriate to have a dominance of slow waves. But if the person is producing excessive slow waves in math class, there is a problem. This person appears to be in a fog, short-term memory is compromised, and either lethargy or hyperactivity is common.

A multitude of symptoms may be present when we see a dominance of low-frequency waves. If the brainwave states are not normalized, all other areas of the patient's life may be affected. If the rhythmic activity is normalized, normal functioning is restored. The normalization of the brain generally produces the following positive changes: improved executive functioning, restful sleep, improved memory, improved concentration, reduced hyperactivity, and elimination of depression and anxiety.

To better understand how brainwaves are related to functioning, let's look at brainwaves in generalities. Think of brainwaves

on a continuum from very slow to very frantic; each band of brainwave activity reflects a level of arousal or consciousness. Our behavioral functioning varies according to the dominant frequency on the continuum. What we would like is a highly flexible brain where the brainwaves go up and down according to what we are doing. We definitely do not want the brain to get "parked" at any one frequency.

In deep sleep, we are producing more of the very high-amplitude, low-frequency delta waves, four or fewer cycles per second, so delta is dominant. Moving along the continuum, next we have theta waves. They are slightly lower in amplitude, and there is an increase in frequency. We will see four to eight cycles per second. In other words, they are not quite as "loud," but there are more of them. Theta is characterized by a drowsy, partial awareness or an unconscious state nearing sleep.

The next frequency band on our continuum is alpha. These brainwaves are lower in amplitude than theta, and, again, there are more of them. Their frequency increases and we see eight to twelve cycles per second. Alpha is characterized by a relaxed, focused awareness, somewhat like in meditation or yoga.

Next, we find a low beta identified and named sensorimotor rhythm (SMR) by the brain scientist Barry Sterman, PhD.[4] Dr. Sterman first observed this process in physically relaxed cats. SMR is from twelve to fifteen hertz followed by the beta frequency band, which is a higher-frequency band from fifteen to eighteen hertz. Beta is characterized by low amplitude, higher frequency. It is very focused, but busier, and not as relaxed as the rhythm of alpha.

Last, we have a low-amplitude, very high-frequency band labeled high beta or gamma. This high beta wave is characterized by an excited, super focused, anxious, fearful, or angry mental state, and ranges from more than nineteen hertz to forty hertz and beyond.

If the brain moves toward the slower frequency brainwaves, a person becomes less aroused, until they finally achieve sleep or an unconscious state. If the brain moves to higher and higher

frequencies, the person becomes increasingly more aroused until they are finally out of control due to excitation. Some people are able to sustain a state of super focus in the higher frequencies. There is some controversy about the exact labeling of such terms as alpha and theta, and about the exact frequencies that should be included in the bands, but we will leave such issues to academia. It is important, however (and generally agreed upon), that the lower the frequency, the more lethargic we become, and the higher the frequency, the more agitated we become.

You can easily see how brainwaves affect our state of arousal. If we are underaroused, we don't function at full capacity because we are dull, lazy, or sleepy. It is okay to sleep in the low waves, but we don't want to be parked there all the time. It is okay to become excited over something, but no one would want to stay there. The normally functioning brain is very flexible, and can move easily up or down the frequency range, depending on the level of arousal needed for the task at hand. Unfortunately, most people with dysregulation disorders are parked in the lower frequencies.

In the case of ADHD, it is surprising to most parents to find out that their wild, hyperactive child is actually in a state of underarousal. The child is using hyper movement to wake up and stay focused in his surroundings. Otherwise, the child is in a dull, lethargic state. Hyper movement then becomes a very functional behavior for keeping the brain awake. There are other children, primarily females, who do not use the hyper movement. When these children do not use movement, they tend to be dull, listless, and often irritable.

Another consequence of the slow rhythmic activity is sleep disturbance. A large number of individuals with dysregulation disorders suffer from sleep problems. These may be delayed-onset insomnia, frequent awakening, early awakening, and/or restless sleep. This list could include restless-leg syndrome, bed-wetting, encopresis (fecal incontinence), nightmares, and other nocturnal problems. It is not uncommon for people with dysregulation disorders to report that their bed is torn apart every morning.

From a practical standpoint, it is hard to sleep at night if the brain has been semi-asleep all day. As practitioners, we often end

up training the brain to wake up so that it will be able to sleep later.

When we treat any dysregulation disorder with neurofeedback, we see dramatic improvement in the other symptoms that manifest as a result of too much low-frequency brainwave activity. Low-frequency brainwave activity is directly or indirectly responsible for a host of problems. While neurofeedback cannot fix everything, it can improve dysfunctional rhythmic activity, which can alleviate many different symptoms. A treatment such as stimulant medications may make the child alert, but it frequently causes collateral damage and makes other symptoms worse.

Take the case of Ritalin. Parents often report school grades improve when the child is on the medication, but sleep is awful, irritability more prevalent, and tic behavior much worse. In contrast to stimulant medications, neurofeedback treats the patient's central processing mechanism, the brain. It doesn't merely chase one symptom with one drug and another symptom with a second or third drug. Neurofeedback treats the cause and not the symptoms, which is why it is the preferred treatment for many people.

One technique to determine if the brain is functioning within "normal" parameters is to look at the ratio between the low frequencies and the mid-range frequencies. We generally compare the ratio of theta averages to beta averages, measured with electrodes placed at different locations on the head.

To do this, neurotherapists use what is known as the international ten-twenty system of electrode placement. This system indicates the exact placement sites of the sensors. Research protocol and clinical treatments are standardized by placing the electrode sensors at specific head sites. Correct sensor placement is critical to success, so neurotherapists take great care to place the sensors at specific locations on the head. To train the wrong area prolongs or increases the existence of the dysregulation.

The theta-to-beta ratio in adults generally ranges from one-to-one to one-and-a-half-to-one. With younger children, the ratio is somewhat higher, but we still want a ratio near that range. Frequently, patients with dysregulation disorders have excessive ratios,

often two-, three-, and four-to-one. In the case of severe injury, the ratio can climb much higher. The job of neurotherapists is to train down the high ratio.

When treating patients with these high ratios, we do not always see the ratios change dramatically, but there is always some change somewhere in the brainwave patterns. It is surprising to see how a little change in brainwave activity can make a huge change in behavior. If we don't see anything else, there is almost always a reduction in amplitudes. Not every dysregulation disorder looks the same. In anxiety disorders, we may see excessive high-frequency waves. They may even have a V-type pattern, with elevated low-frequency and elevated high-frequency waves and the nice mid-range frequencies in the basement. The objective, in this case, would be to train up the mid-range waves and reduce the high amplitudes of the waves on the ends of the continuum.

Operant Conditioning, the Secret to Training

The process of training the brain to make appropriate adjustments in rhythmic firing is as simple, in theory, as the way Dr. Ivan Pavlov conditioned his dogs to salivate at the sound of a bell. Dr. Pavlov's training paradigm is known as classical conditioning. Operant conditioning is about rewarding behavior that approximates a desired behavior. In education, we give an A to students who more closely approximate the learning behavior we want to see; we give Bs to those who are close, but not quite as close; and we give Fs to those who miss the mark.

An example of operant conditioning is if we wanted a child to play in the sandbox, we rewarded the child every time she went to the sandbox and ignored her when she played elsewhere. Soon she would play in the sandbox because it is the most rewarding place to be. Giving Fido a treat when he sits for us is also operant conditioning.

Brainwave training works the same way. If the brain's dominant frequency is low frequency, we reward the trainee with points or a tone each time he makes the more desirable, higher-frequency brainwaves. Unfortunately, this is not as direct and as quick as

training Fido to sit because the brain is "parked." It takes time to nudge it back to a more functional, flexible position.

With neurofeedback, we eavesdrop on complex inside-the-brain events, run the information through a computer, and feed back the information through the eyes, ears, and/or skin of the trainee. Each time trainees improve their brainwaves, we reward them. If the brainwaves stay the same, there is no reward. The most stubborn child will eventually get involved in the "game."

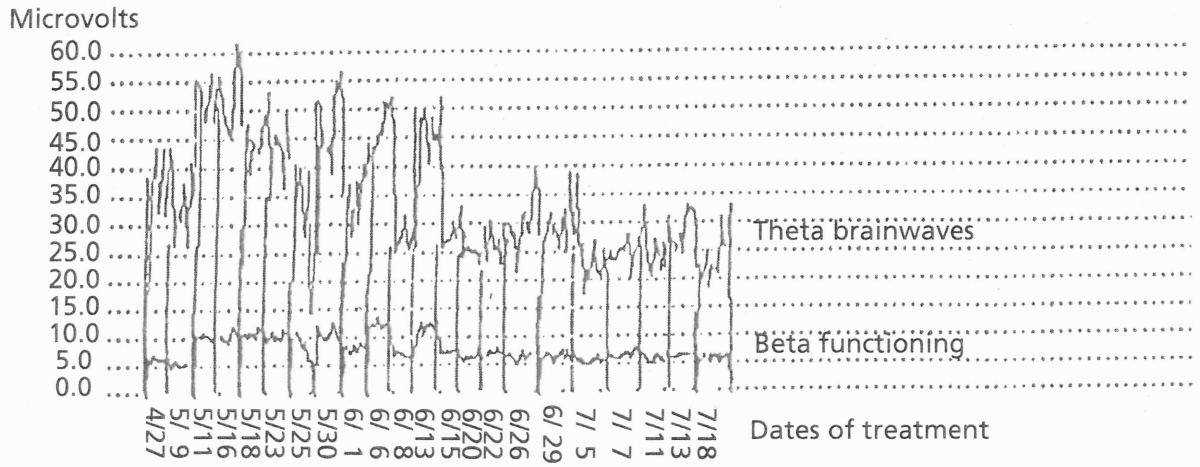
One of our standard training screens is a "video game" in which the patient directs a large dot along a path, eating smaller dots. If the brain is functioning better, the big dot eats more of the small dots faster, and the patient scores more points. There are a variety of games used to stimulate the brain to wake up, but they are specialized games programmed to reflect EEG functioning. Traditional video games lull the brain into producing the wrong brainwaves. These traditional video games drive the patient deeper into dysregulation. In addition, we are very skeptical of EEG games that can be bought through magazines and such. When dealing with the brain, make sure you seek professional help from qualified individuals with medical-grade equipment.

Balancing the Brain

Figure 16.1 illustrates how the brainwaves normalized and the ratio balance was improved in the case of Otis, an eleven-year-old with ADHD. The figure shows Otis's progress at his twenty-second neurofeedback session. During the first treatment, the theta-beta ratio was in the range of eight-to-one. This means that Otis was making eight times more slow sleep waves than the faster alert waves. By the time Otis completed twenty-two training sessions, his beta ratio was in the range of 4.6-to-one. Otis required many more sessions to normalize the dysregulation, but there were dramatic behavioral improvements at session number twenty-two.

You will note in this figure that, in treatment sessions one and two, the ratio looks better, due to what psychologist label "the novelty effect." Otis is experiencing something new and exciting, so he is more awake. After a couple of sessions, however, the task

Figure 16.1. Neurofeedback Summary Chart



The numbers in the left-hand column are microvolts of electrical activity recorded from the brain. The top horizontal line that starts at approximately forty microvolts and wanders up and down, ending the twenty-second session at approximately twenty-three microvolts, is Otis's theta (4–8 Hz) brainwaves. The lower, less jagged line that starts at five microvolts is his beta (15–18 Hz) brainwaves. At session one, Otis's theta-to-beta ratio was slightly over eight-to-one. By the end of his twenty-second session, that ratio had dropped to slightly over 4.6-to-one and declining. The bottom line reflects the dates of training.

becomes boring, as it usually does for ADHD patients. For them, everything new and wonderful soon becomes old and boring.

For Otis, the twenty-two sessions improved his concentration, raised his school grades, and helped him feel "happier," as described by a parent. Otis made significant improvements, as do most patients who are treated with neurofeedback. It took a total of forty training sessions before we discontinued Otis's treatment, and one year later his mother reported he was doing "great."

The proof that we can do this with neurofeedback has been established for more than two decades. It has just taken a long time to get this sophisticated treatment to the general public, and it has taken us some time to understand what we were seeing.

Neurofeedback has now come of age and can be used therapeutically to help individuals with all types of dysregulation disorders.

It is quite possible that, some day, the use of medications for dysregulation disorders will be a thing of the past. At some point in the future, patients will have easy access to neurofeedback for a wide variety of disorders. In the meantime, practitioners are becoming proficient at correcting disorders of brainwave dysregulation and the number of patients seeking this treatment is growing rapidly. Why give any medication if patients and clients can self-correct a problem with neurofeedback training?