GETTING RID of RITALIN

How Neurofeedback Can Successfully Treat Attention Deficit Disorder without Drugs

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Neurofeedback—The Healing Potentials of Brainwave Biofeedback

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 before but they do not necessarily understand what it actually means.

Biofeedback—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, 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, he is listening in on biological information—hence, what he gets is

biofeedback. If your doctor uses a stethoscope to listen to your heart and lungs, he is using a simple biofeedback instrument.

However, it is only in the past few decades that technology has provided us with machines sophisticated enough to detect, amplify, and record these 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 own 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 if we are to remain healthy. 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, 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, Swami Rama demonstrated that he could create a ten-degree temperature differential on the palm of his hand just two inches apart. 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 our 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 own hand and would focus on making one spot red. 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 300 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, routinely in biofeedback practices all over the world, we train people to change those "involuntary" processes, bringing them under voluntary control. Once the patient learns to regulate a system, he no longer needs the biofeedback equipment. While training, he develops a sensory image. This is not a visual image, but a feeling that physical things are changing inside him. For example, he 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.

Neurofeedback—The Newest Innovation in Biofeedback

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. This groundbreaking

research was done by Barry Sterman and colleagues at the Sepulveda, California V. A. Medical Center Research Center.[6] There are many people who have seizure after seizure with little help from medication. By giving the patients feedback on their EEG rhythms, they 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.[7,8] EEG biofeedback's effectiveness was also demonstrated by Tansy and Bruen.[9] 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 per-

Conditions Neurofeedback Can Help

Disorders that have been successfully treated with EEG biofeedback in clinical settings include:

- Attention deficit disorder (ADD)
- Attention deficit/hyperactive disorder (ADHD)
- Migraines
- Tension headaches
- PMS
- Alcohol and drug addiction
- Sleep disorders
- Depression
- Panic attacks
- Chronic pain
- Bruxism
- Mild closed head injury
- Oppositional and conduct disorders
- Epilepsy
- Chronic fatigue syndrome
- Stroke
- Multiple chemical sensitivities
- Autoimmune dysfunction
- Tinnitus
- Glucose metabolism dysregulation: Type II diabetes, hypoglycemia
- Specific learning disabilities/dyslexia
- Silicone related disease (breast implantation problems)

formance training. There is a growing interest in peak performance, so many practitioners of neurofeedback practice 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.

The Neurofeedback Training Model

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.

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In contrast, the unhealthy brain may be under-aroused and sluggish or over-aroused 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 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, the ADD brain tends to produce more 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. The individual being trained can move their own brain to different physiological states, depending upon what the immediate situation requires.

We have been training people for many years to change their physiological state by altering their temperature or muscle tension. With neurofeedback, we are using a more sophisticated system that trains a more central process allowing direct access to the central processing system of the brain, rather than the peripheral systems of skin and muscle. Hence the new name—*neuro*feedback.

Neurofeedback makes the brain more flexible, and seems to have a generalizing effect on the full nervous system. The implications of this are profound. Training the brain to correct its dysregulated state seems to have a positive effect on neurological functioning as well as the cardiovascular, gastrointestinal, immune, and endocrine systems. Self-regulation not only enhances the brain's ability to improve cognitive/intellectual functioning, but it aids in the process of helping the body to heal itself.

Self-healing is what biofeedback is all about—it brings these involuntary processes under voluntary control. Self-regulation is exciting because it gives the patient some control over his own health and well-being. He is no longer at the mercy of a dysregulated brain and no longer completely dependent upon the pharmaceutical industry to provide him with the "magic pill."

What Is Neurofeedback Training?

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 com-

paring behavior with the brainwave frequency, conclusions can be drawn about the relationship of the two. As a result of research in this area, we have been able to determine different subjective/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. (See table, pages 78-79)

By using feedback instruments, the therapist can feed back information to the patient on their level of consciousness at any given moment. The patient can subjectively evaluate what that conscious state feels like. With practice, the patient can begin to voluntarily approximate and reproduce that level of consciousness. Over time the patient will get closer and closer to that state until the desired rhythmic activity of the brain can be voluntarily produced. Once the patient has developed a level of sophistication in identifying the desired state, they no longer need the neurofeedback equipment to accomplish the task. They are now self-regulating.

Using the neurofeedback equipment to *train* voluntary control, patients are able to use this information on their own to relax, concentrate better, or feel calmer and be more focused. Therefore, the student shows fewer and fewer symptoms of attention deficit/hyperactivity disorder. The businessman is much more efficient on the job, the migraine sufferer can dramatically reduce the frequency, duration, and intensity of her headaches. Neurofeedback uses this information about very subtle inside-the-brain events to change the levels of alertness and awareness. This is the fine and profound art of self-mastery. It makes the human much less dependent on any other person, drug, machine, or medical technology. It produces strong self-reliance, independence, self-esteem, and provides some control over one's physical and mental state 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. Soon the patient learns control and can change mental states. Like any other learning process, the more one learns, the more confidence one develops. So not only does the

Behavioral States and Brainwave Activity

Band Name	Frequency Band	Alertness Level
High Beta	19 Hz and above	Hyper-alert to intensely alert. Can range from fear, panic, rage, or anxiety to being super alert.
Beta	15 to 18 Hz	Active alert.
Sensory Motor Rhythm (SMR), Low Beta	12 to 15 Hz	Calm alert.
Alpha	8 to 12 Hz	Relaxed focus.
Theta	4 to 8 Hz	Drowsy, lethargic, dreamy.
Delta	1 to 4 Hz	Deep sleep.

Focusing Ability	When Appropriate	Efficiency
Can vary from super-focus to unfocused and confused. May be very intense to very scattered with fragmented thinking.	Appropriate for learning very difficult material when intensity is required. Inappropriate for normal daily activity.	Very efficient to very poor efficiency, depending on the situation.
Can focus very well and can respond quickly. Good selective attention; can shift focus easily; good anticipation.	Appropriate for learning, doing a task, staying focused. Inappropriate for relaxing.	Efficient for learning, working, reading difficult material, or being in school. Inefficient for leisure activity.
A calm focus. Ability to concentrate without a sense of urgency.	Appropriate for learning quietly without high intensity. Inappropriate for high-intensity learning.	Efficient for calm, focused learning. Good for reading light material.
Able to focus in a relaxed, meditative way.	Appropriate for relaxation and creativity. Inappropriate for intense learning.	Efficient for creative endeavors. Good for breaking away from obvious views. Inefficient for work or classroom learning.
Reduced awareness, poor focus, dreamlike, near sleep.	Appropriate for deep meditation, some creative work. Good for bedtime. Inappropriate for work or classroom.	Efficient for sleep preparation. Has some implications for creative inspiration. Very inefficient for work or classroom.
Loss of ability to focus. Loss of awareness.	Appropriate for deep sleep. Very inappropriate for thought processes.	No efficiency except sleep.

patient learn the neurofeedback skill, but her self-confidence improves.

Neurofeedback is not complicated. In our office practice we have four-, five-, and six-year-olds learn to change their brainwave patterns. 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, they *know* they have changed.

For example, in temperature training, we have many patients who can quickly learn to take a seventy-nine-degree hand temperature and increase it 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 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 the patient has, the more easily he perfects 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.

The Emerging Theory of Global Dysregulation

Because of the wide variety of disorders that have been helped with neurofeedback, the idea of a global dysregulation effect is emerging. This is a simple concept that means 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; usually the symptoms involve more than one body system.

For example, a patient 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 may 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 other systems. Therefore, to regulate 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 has a systemic effect. When we treat people for ADD with neurofeedback, other systems begin to improve because the brainwaves become regulated. For example, in treating ADD, not only does attention improve, but oppositional behavior, sleep, irritability, depression, anxiety, antisocial behavior, tics, and many other problems also improve.

It appears that neurofeedback not only affects such problems as attention and concentration, but has a systemic effect. When we treat people for ADD with neurofeedback, other systems begin to improve because the brainwaves become regulated.

To give you an unusual example, several years ago we were treating a ten-year-old male for ADD, and 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, his "lazy eye" had suddenly got much better. We all concluded that focusing on the neurofeedback monitor must have helped train the eye to focus more normally.

Neurofeedback seems to have the ability to reduce or correct global dysregulation. The future implications of this are exciting; if such turns out to be the case, it could preclude taking multiple medications for different 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 appears to produce global body-wide changes.

7

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 you more energy, give you greater sexual prowess, or help you lose weight? Most products with broadly based claims just do not hold up to close inspection. They may help with one thing or reduce one symptom, but they seldom meet our expectations. When they don't, we find our optimism has turned 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 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.

Meanwhile, brain science has taken some curious turns over the past few decades. Medical science started out trying to understand the brain as a functional system. By looking at specific disorders, we hoped to see how the systems had failed. For example, when we first started looking at the ADD phenomena, we had the intuitive understanding that it was a functional problem, that it had to do with how the brain functions as a whole unit. This mindset is seen in the terminology of "Minimal Brain Dysfunction." Then, brain science went in a different direction.

Scientists began an attempt to understand the brain from a molecular level. They broke the brain down into the smallest bits, rather than seeing it as a whole, precluding the functional model of the brain.

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 the patient's disorder 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 issue of gross motor, gross thought, and gross emotional behavior is not the primary focus. Most of our patients are not concerned with their molecules, but they are concerned about balance and

strength, quality and quantity of thought, and of being overwhelmed by their emotions. As a result, in the past few years, many brain scientists have returned to examining the brain as a functional system rather than as trillions of molecules. This has translated into practical therapeutic treatments for clusters of disorders. Not only are we concerned with the idea of global dysregulation, where the brain causes body-wide problems, but we are concerned about clusters of disorders.

For example, accompanying depression, the person may also have tiredness, loss of interest, irritability, loss of sleep, or a decreased sense of humor. The cluster of symptoms relates 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 clusters of symptoms, but also on global symptoms.

Let's consider the brain. The 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.

For example, if you smoke cigarettes long enough, the body begins to act as though they are as necessary to you as oxygen, water, or food. When you try to quit, the body rebels, making quitting very difficult. Brainwaves are much the same. If a brain receives a head injury during birth, it may produce the wrong brainwave for the task at hand. After long enough a time, the brain doesn't try to correct the dysfunction.

Neurofeedback works by challenging the dysfunction and nudging the brain's firing patterns in the direction of a healthier balance. This nudging seems to awaken the brain's self-regulating system. A process then begins to take place which appears to be the brain teaching itself to normalize. Because the brain is trying to maintain a balance, 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 insures 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 *fast*. 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 we have not previously worked with.

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. Not only does it assist in regulating the dysrhythmic activity of ADD (when the brain's rhythms are not appropriate to the task), but also the dysrhythmic activity of epilepsy, chronic migraines, head injury, stroke, sleep disorders, PMS, depression, and anxiety.[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 will 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 the Brain's Rhythmic Activities—by Ourselves

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 our 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 problem, the brain will frequently 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. Frequently, these types of head injuries do not show up on conventional imaging such as MRIs or CT scans.

In other types of problems, such as ADD, we do not generally see spikes, but we see a single brainwave or band of brainwaves that are inappropriately dominant, expressed when they should not be. If sleep waves are dominant when one is trying to read, they are inappropriate, and he has a problem. Occasionally, we see ADD children who also have spikes in the one to four hertz range. 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 an important term. 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 will be higher than others. That wave or band of waves will be dominant. 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 boys with ADD show a dominance of slower EEG waves and a deficit of faster-frequency waves.[3] If the patient is asleep, it is appropriate to have a dominance of slow waves, but if he is producing excessive slow waves in math class, there is a problem. He would appear to be in a fog; short-term memory is compromised and lethargy is common (i.e., he probably has ADD).

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 types of 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 some generalities. Think of brainwaves on a continuum from very slow to very frantic, in terms of what they mean about brainwave activity. Our behavioral functioning varies according to where we are dominant (or "parked") on the continuum.

In deep sleep, we are producing more of the very high-amplitude, low-frequency delta waves, less than four cycles per second (see figure 7-1), 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.

cps = cycles per second, or Hertz

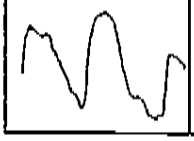
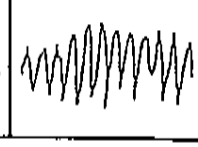
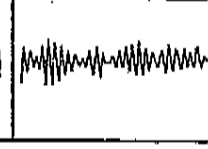
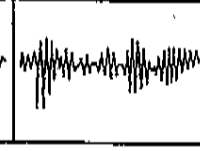
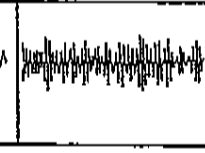
DELTA Less than 4 cps	THETA 4–8 cps	ALPHA 8–12 cps	SMR 12–15 cps	BETA 15–18 cps	HIGH BETA more than 19 cps
Sleep	Drowsy	Relaxed Focus	Relaxed Thought	Active Thinking	Excited
					

Figure 7-1. The Range of Brainwaves in the Human Brain

The next frequency band on our continuum is alpha. They 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 meditation or yoga.

Next, we find a low beta that was identified and named sensory motor rhythm (SMR) by the brain scientist, Barry Sterman, Ph.D.[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, up to or beyond forty hertz.

If the brain moves toward the slower frequency brainwaves, a person becomes decreasingly aroused, until they finally achieve sleep or an unconscious state. If the brain moves to higher and higher frequencies, the person becomes increasingly 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 that 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. It is generally dominant in the mid-frequency range, focused but relaxed. Unfortunately, most people with ADD are parked in the lower frequencies, and we see dominant theta patterns in most individuals with ADD. They are often parked somewhere around seven hertz.

Neurofeedback treats the patient's central processing mechanisms, 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 gets better results than stimulant medications overall.

It is surprising to most parents to find out that their wild, hyperactive child actually is in a state of under-arousal. 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 semi-awake. There are other children, primarily females, who do not use the hyper movement. They are the dull, listless, often irritable ones.

Another consequence of the slow rhythmic activity is sleep disturbance. A large number of individuals with ADD and other ADD-type problems also suffer from sleep problems. These may be delayed-onset insomnia, frequent awakening, early awakening, and/or restless sleep. This list would also include restless-leg syndrome, bed-wetting, encopresis (fecal incontinence), nightmares, and other nocturnal problems. Parents of ADD patients frequently tell us how their child's 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 ADD 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 also makes the collateral symptoms worse.

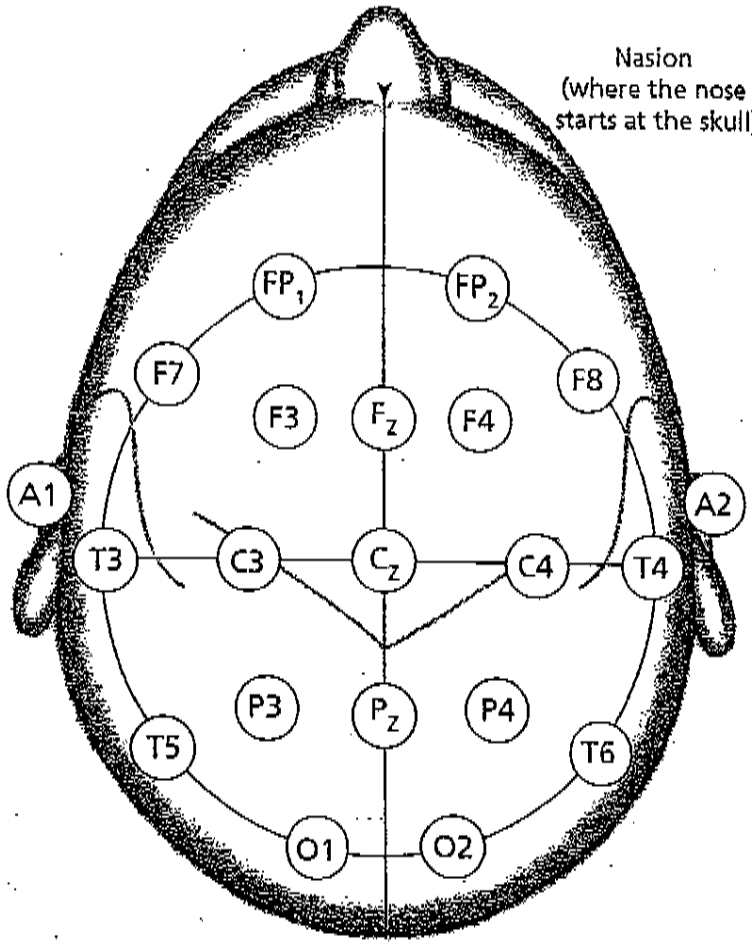


Figure 7-2. International Ten-Twenty System of Electrode Placement

The ten-twenty head chart is internationally recognized. It tells clinicians and researchers exactly where to place the sensors on the head. The *nasion* is located where the nose starts at the skull, and the *inion* is located at the two knots on either side of the back of the skull. A1 and A2 represent the left and right ears. Sensors are placed at the various sites on the head to record the EEG or to train the site with neurofeedback.

For example, parents often report school grades improve when the child is on Ritalin, but that their sleep is awful, their irritability more prevalent, and their tic behavior much worse. In contrast with stimulant medications, neurofeedback treats the patient's central processing mechanisms, 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 gets better results than stimulant medications overall.

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 (see figure 7-2). Research protocol and clinical treatments are standardized by placing the electrode sensors at specific head sites. Correct sensor placement is critical to success, so the neurotherapist takes great care to place the sensors at specific locations on the head. To train the wrong area could worsen existing problems.

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, the patient with ADD and the cluster of other disorders like depression, sleep dysfunction, tics, and head injury will have excessive ratios. We have seen two-, three-, four-, five-, and six-to-one ratios in severely dysregulated brains. This indicates that the patient is producing excessive low-frequency waves.

When treating patients with these high ratios, we do not always see the ratios change, but we almost always see the high elevations of theta come down. Individuals with anxiety usually have excessive high-frequency waves. They may even have a V-type pattern of elevated low-frequency waves, often indicative of a patient who is ADD with concomitant anxiety, and elevated high-frequency waves with deficits in the production of mid-range frequencies.

Operant Conditioning—How to Train the Brain

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 would be if we wanted a child to play in the sandbox, we would reward the child every time she would go to the sandbox and ignore her if 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 is making too much low-frequency activity, we reward it with points or a tone each time it makes the more desirable, higher frequency brainwaves. Unfortunately, this is not as direct and as quick as training Fido to sit.

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 the trainee improves his brainwaves, we reward him; if the brainwaves stay the same, there is no reward.

One of our standard techniques 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, which adds to the problems of ADD.

Moving toward Brainwave Balance

Figure 7-3 illustrates how the brainwaves normalized and the ratio balance was improved in the case of Otis, an eleven-year-old male with ADD and hyperactivity. The figure shows Otis' 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 22.

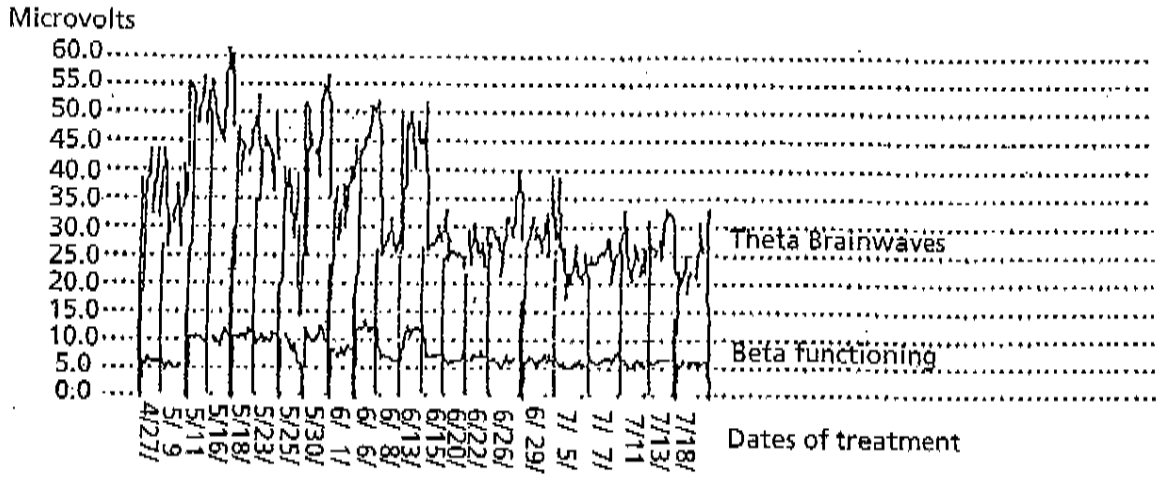


Figure 7-3. Neurofeedback Summary Chart

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' 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' 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.

You will note in this figure that in treatment sessions one and two, the ratio looks better, due to the novelty effect. Otis is experiencing something new and exciting, so he is more awake. However, after a couple of sessions, the task becomes boring, as it usually does for ADD patients. For them, everything new is wonderful and everything old is 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 ADD patients who are treated with neurofeedback. It took a total of forty training sessions before we discontinued Otis' 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 over 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 are seeing and how to use it therapeutically to help individuals like Otis with these truly disruptive disorders of brain regulation.

It is quite possible that some day, the use of medications such as Ritalin for attentional and behavioral disorders will be a thing of the past. Human beings will then have easy access to neurofeedback for a wide variety of disorders. In the meantime, practitioners are becoming proficient at correcting disorders of brainwave dysregulation such as ADD and behavioral problems using neurofeedback. Why give any medication if the individual can self-correct a problem with neurofeedback training?

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