CLARITY DIRECT NEUROFEEDBACK: WHAT IT IS AND HOW IT WORKS

The EEG (electroencephalogram) and Traditional Neurofeedback

The most complex entity in the universe is that grey and white electrochemical organ, the brain. The brain functions at a cellular level by sending an electrical charge from one end of a neuron to the other, with chemical neurotransmitters relaying information from one neuron to another. These neurotransmitters are responsible for much of the communication between nerves.

An electroencephalogram, or EEG, is a device whose sensors are placed on the scalp in order to measure the electrical activity of the brain. This electrical pattern is seen as waves, like the waves you see after dropping pebbles in a pond. Brainwaves, as with any other type of periodic activity, can be described in terms of **frequency** and **amplitude.**

➔ *For more information, see the* **BRAINWAVE** *section, below*

In traditional neurofeedback, the initial qEEG (quantitative EEG) of a client's brain functioning may reveal generalized problems that influence many aspects of the individual's experience. However, people usually seek assistance for particular complaints - the neurofeedback practitioner then looks for connections between the troubling symptoms and related brain patterns.

On the basis of the brain pattern profile, the psychologist will write a computer program to support the operant conditioning process, enhancing strengths or ameliorating weaknesses. For example, if an individual has too much slow activity (**theta**) and not enough fast activity (**beta**) at the front of the brain, and if that person complains of attentional difficulties which the psychologist relates to frontal slowing, training will consist of inhibiting theta activity and enhancing faster, beta activity in the frontal lobes. '

➔ *For more information, see the* **BRAINWAVE** *section, below*

Individuals receiving traditional neurofeedback training wear a clip on each ear, one sensor on the forehead, and one sensor on the target site - this is the "active sensor." The brainwave activity recorded by the active sensor is displayed on the computer monitor. For example, in the case of the client trying to encourage faster brainwave activity in the frontal lobes, a colored bar might represent the amount of beta wave activity, fluctuating up and down in real time. A threshold, or "high jump bar" gives the client a visual representation of their goal, and the computer program emits a pleasant chime when it is achieved. After repeated exposure to this visual and auditory

feedback, the brain begins to recognize a relationship between its own activity and what it is observing on the computer monitor. In other words, the brain begins to recognize itself. This is when learning takes place. Although patients may experience anxiety, frustration, or even competitiveness when trying to meet their goals, most can learn to modulate their brain activity after multiple sessions.

Once the brain "catches on" to what it needs to do in order to make the high jump successfully and to hear the pleasant tone, it begins to do so more consistently.

Clarity Direct Neurofeedback

With Direct Neural Feedback like CDN, the conscious step on the part of the recipient is removed. Because there is no goal to meet, the client doesn't have to *do* anything but relax and tell the practitioner how they are feeling and what they are experiencing. CDN works by signaling the brain to reorganize its fixed patterns, choosing *new* neural pathways which may work better for the body and mind as a whole.

In CDN, weak neurostimulation is sent from an FDA-approved EEG device to your brain. The ultra-low-intensity signal causes a fluctuation in brain patterns, allowing the brain to reorganize itself for optimal functioning. The signal sent is highly specific for each person, and complete customized depending on their current dominant frequency. The device's algorithm adapts for different variables throughout the session.

DNF affects the autonomic nervous system, the part of the nervous system that sends signals to the body's internal organs and glands. The effects of the autonomic nervous system are global, spreading across multiple organ systems and locations simultaneously. Altering the function of the autonomic nervous system affects multiple symptoms at multiple foci - so while a patient may be seeking anxiety relief, they may find that their lower back pain has lessened as well.

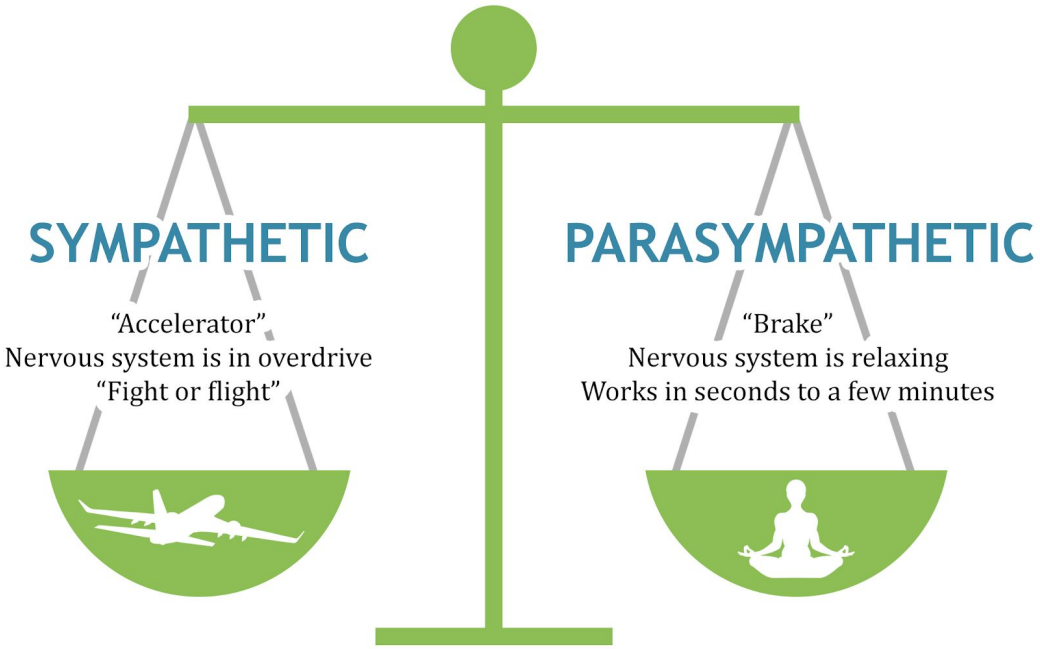
Modern life has left too many of us in a chronic "fight-or-flight" state in which we experience anxiety and stress. When our bodies fail to regulate the interplay of the **sympathetic** and **parasympathetic** nervous system, we cannot adequately recover from chronic stress, and suffer from disorders including anxiety, panic, depression, obsessive-compulsive disorder, panic disorders, fibromyalgia, and chronic fatigue.

➔ *For more information, see the* SYMPATHETIC & PARASYMPATHETIC *section, below*

SYMPATHETIC AND PARASYMPATHETIC: SCIENTIFIC BACKGROUND

To understand the science of CDN, it is necessary to have a clear picture of the control systems which it affects. The nervous system is divided into a **central** portion (the brain and spinal cord), and the many **peripheral** nerves which connect it to the body. The peripheral nerves are further divided into two systems: the **voluntary** nervous system, which consists of nerves that direct muscles and movement, and the **autonomic** nervous system, which innervates the internal organs. Regulated by the hypothalamus and limbic system above, the autonomic nervous system regulates global physiological responses that spread across multiple organ systems and locations (e.g breathing, heart rate, digestion, emotional state, vasodilation).

CDN works is at the level of the autonomic nervous system, which has two basic modes. The **sympathetic** mode swiftly engages when the brain decides it needs to be highly aroused, alert, and full of energy. The **parasympathetic mode**, which engages more slowly, is activated to relax and return to a state of calm. Both parts, the "fight or flight" sympathetic accelerator, and the "rest, relax, and recover" parasympathetic break are needed to maintain homeostasis. However, when a client comes in on sympathetic "overdrive", CDN treatment can promote relaxation and calm by triggering the brain to switch modes.



The parasympathetic stimulation of DNF can result in positive effects very quickly, generally from seconds to a few minutes. The brain's changed activation pattern involves the entire autonomic nervous system, not just a few specific areas - leading to a generalized feeling of calm and relaxation in the nervous system as a whole. Clients often experience sharper vision, increase in

output of salivary glands, and other physical manifestations of parasympathetic function after treatment.

Enhancing parasympathetic "tone" explains many effects of DNF, but not all. For example, some studies suggest that microstimulation of the brain through CES can lead to cognitive improvements involving working memory, language, and visual tasks.[1] It is unknown whether these effects are secondary effects of the changes in the peripheral nervous system, or are mediated by a different mechanism such as small changes in cortical excitability or stimulation of neurotransmitter release. The dramatic changes seen with DNF are associated with **neuroplasticity**. Neuroplasticity is a very flexible (pun intended) term that can encompass almost anything related to change in the nervous system. In the brain, anything that affects electrical activity must influence the neurotransmitters and other chemical interactions.

Finally, any discussion of the mechanism of CDN should include a mention of stochastic phase resetting theory.[2] Based in the field of electronics, this theory suggests that there are "pacemaker"-like neurons that send signals to keep the nervous system regulated. In situations of chronic stress, inflammation, or anxiety, the signals of these pacemakers are overwhelmed by the electronic noise, and the proper desynchronization and synchronization of neural activity is disrupted. CDN's ultra-low-power signal is believed to raise the amplitude of the pacemaker's signal, correcting the signal-to-noise ratio and returning that functional area back to equilibrium.

The brain is such an extraordinarily complex organ that it seems counter-intuitive to believe that the ultra-low-power signals used in CDN can have effects that can be both immediate and profound. But the results are clear: CDN is a simple, extremely low-risk modality that can have many beneficial, long-term enduring effects.

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[1] Zaghi, S., Acar, M., Hultgren, B., Boggio, P. S., & Fregni, F. (2009). Noninvasive Brain Stimulation with Low-Intensity Electrical Currents: Putative Mechanisms of Action for Direct and Alternating Current Stimulation. *The Neuroscientist*, 16(3), 285–307. doi:10.1177/1073858409336227

[2] Tass, P. A. (2000). Stochastic phase resetting: a theory for deep brain stimulation. *Progress of Theoretical Physics Supplement*, *139*, 301-313.

BRAINWAVES: SCIENTIFIC BACKGROUND

To understand the science behind Direct Neurofeedback, it is important to understand the patterns of electrical activity known colloquially as "brainwaves," and how we describe them. All waves repeat (or **oscillate**) regularly, with a certain speed of oscillation (**frequency**) and maximum height or voltage (**amplitude**). When considering the specific context of waves of electrical activity in the brain, we must also consider **symmetry**, **coherence**, **offset**, **complexity**, and **duration** of different signals.

Terms To Know

Frequency refers to the rate at which a brainwave repeats its cycle. It is measured in cycles per second, or **hertz** (Hz). A "faster" brainwave, colloquially, is one that repeats itself more times in one second. Some practitioners divide the frequency of brainwaves into categories:

0-4 Hz	**Delta waves** are slow waves which occur primarily during sleep. They are also present to various degrees throughout normal brains when awake.
4-8 Hz	**Theta waves** are also slow waves, and are often associated with twilight states between sleep and wakefulness. Theta activity has also been shown to be important in memory consolidation.[3]
8-12 Hz	**Alpha waves** are an "idling" rhythm associated with relaxation, meditation or multi-tasking. Alpha is produced by large groups of neurons that are not engaged in any particular task, but rather, are standing at the ready.
12 Hz +	**Beta waves** are the fastest form of brainwave, and are associated with focus, concentration, and active attention. Excessive levels of beta activity are associated with anxiety, possibly due to their relationship to exaggerated focus and hyperalertness.[4]

All sites of the brain show all frequencies of activity; however, different amounts of each frequency are desirable at different brain locations. In general, concentrations of alpha are found

[3] Buzsáki, G. (2005). Theta rhythm of navigation: link between path integration and landmark navigation, episodic and semantic memory. *Hippocampus*, *15*(7), 827-840.

[4] Kiloh, L., McComas, A., Osselton, J., Upton, A., 1981. Clinical Electroencephalography. Butterworths, London

at the back of the head, and faster waves are more prominent at the front of the head. No brainwave is good or bad - they are just more or less adaptive.

Amplitude is defined as the voltage in microVolts of the EEG machine. This is the amount of energy put into a particular brainwave; which you can think of as the "volume" of that brainwave. A high-amplitude theta signal at a particular site means a lot of energy generating theta rhythms at that site.

Symmetry is a measure of the similarity of brain activity on the left and right sides. Activity at a particular site one one side of the brain is compared to the corresponding side, allowing a person's brain to serve as its own reference point. For most people, the activity should be symmetrical at opposing sites, and hemispheric asymmetries are associated with disorders such as anxiety.[5]

Offset measures how well (or poorly) two waves match up to each other. A small offset means waves are closer to being in sync - when combined, they will sum to a more powerful wave. A large offset indicates the waves are **out of phase**, and the high points in one wave will cancel out the low points in the other wave.

Coherence is a measure of how closely each brain site communicates with each other site. This is calculated by measuring how similar the brainwaves are in different areas - if they track the same relative amplitude and phase offset over time, they are likely to be functionally connected. Coherence may be different in each frequency band, and there is an optimal amount of connection for the brain to efficiently function.

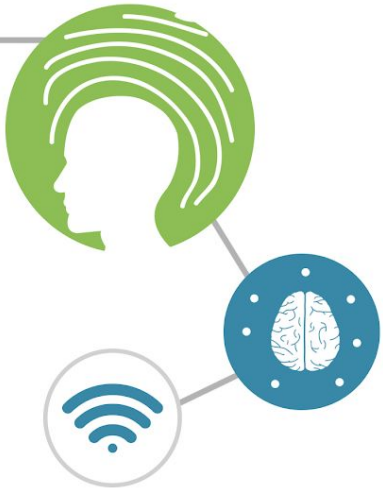
Complexity in this context, refers to how many times there is a change (such as an offset) in the signal. A more complex signal will have more changes, a less complex signal will have fewer changes. For example, the offset in a particular protocol may change once every 2 seconds . The pattern in another protocol is 1/sec. The latter signal is more complex because it changes more frequently.

Duration refers to the length of time over which a signal is being transmitted. When using Clarity Direct Neurofeedback, the duration of stimulation will be short bursts (<0.03 sec), rather than the extended stimulation in other types of electrical stimulation.

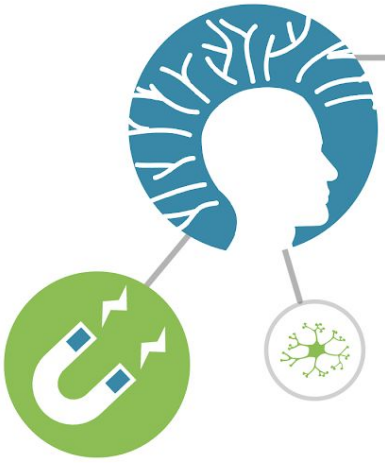
[5] Heller, W., Nitschke, J. B., Etienne, M. A., & Miller, G. A. (1997). Patterns of regional brain activity differentiate types of anxiety. *Journal of Abnormal Psychology*, *106*(3), 376.

OVERVIEW OF THE DIFFERENT TYPES OF ELECTRICAL STIMULATION

ECT



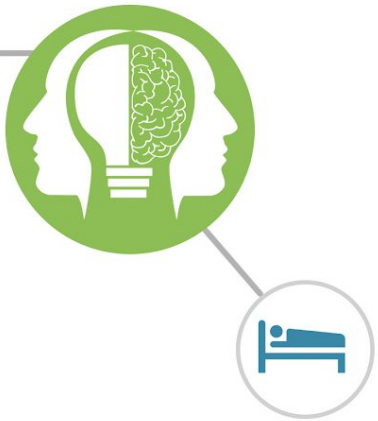
By far the strongest electrical stimulation, Electroconvulsive Therapy (ECT) sends an electrochemical force hundreds of thousands of times stronger than those technologies at the other end of the spectrum, particularly Direct Neurofeedback (see chart). The ECT signal is strong enough to cause a seizure in the brain and allows the brain to restart itself. It is similar to applying a cardio shock to the heart, the organ is temporarily "paralyzed", and then restarts itself when it's internal pacemakers start up on their own. ECT is primarily used for severe depression, either monopolar or bipolar. *The duration of most side effects, particularly cognitive dysfunction, are almost always temporary. Treatment is typically 15-18 sessions over a few weeks.*



TMS

Second in strength to ECT, Transcranial Magnetic Stimulation, or TMS sends magnetic waves into the brain. These electromagnetic impulses, while much weaker than ECT, still sends signals that are strong enough to stimulate or inhibit neurons from firing. THis treatment typically consists of half hour sessions five days a week for four to six weeks. While not as successful in alleviating depression as ECT, it is a common practice to see how effective TMS is before going to ECT. Both are FDA approved for the treatment of depression. The downsides to using TMS are that the machines are expensive (so it's hard to scale up), the amount of time put in by the patient, the technician and even the physician is quite high, and the treatment is not reliably effective in treating depression.

CES



Cranio-electric (CES) stimulation is also an electromagnetic signal sent directly to the brain, but whose strength is much less than TMS. It is often felt as a mild vibration on the skin. These devices are purchased by home users. They tend to help a fairly mild range of symptoms, including insomnia, mild depression, chronic pain and anxiety and can even temporarily improve learning. The effects are typically temporary and need to be used daily. They are frequently not effective for the more severely symptomatic cases, and their overall rate of success rate is mild to moderate. The Fisher Wallace Device is a popular CES. It is a portable medical device that comfortably stimulates brain regions responsible for healthy mood and sleep. The device is cleared by the FDA and approved for sale over-the-counter in Europe for the treatment of depression, anxiety and insomnia.

COMPARISON OF ECT, TMS, tCES, AND CLARITY