THE BIRTH OF BIOFEEDBACK

The term “biofeedback” was coined in 1969 at a conference at the Surf Rider Inn in Santa Monica, based on mathematician Norbert Wiener’s cybernetic theory. Cybernetic theory concerns itself with feedback systems, and biofeedback proposed that the human system could be controlled by monitoring its own behavior using technology. Through the simple observation that individuals tend to increase behaviors when positively rewarded and decreased them when not or negatively rewarded, remarkable results can be achieved.

Biofeedback involves measuring a physiological variable such as blood pressure, heart rate, or skin temperature, and relaying that information in real time to the individual. This raises awareness and conscious control of the related physiological processes, allowing a person to enhance or relearn the desired outcome and obtain relaxation.

For example, if I asked you to raise your skin temperature a few degrees you would probably be unable to do so. However, if I put sensors on your skin that measured changes as small as 0.1° F, and presented that information to you in real time, you could learn to control it.[1] The real-time feedback is usually graphically or through sounds, often in the format of a computer game. (For instance, when the brainwave frequencies are going in the desired direction, a spaceship might move or a green bar would get taller.) With this real-time information, most people can learn fairly easily to regulate a physiological process that is usually outside of their control (e.g. skin temperature).

FROM BIOFEEDBACK TO NEUROFEEDBACK

In the early 1960s at the University of Chicago, psychologist Joe Kamiya made the discovery that some of his research subjects could learn to alter the power and speed of their brainwaves if they were provided with information on the activity of their brains.[2] Further research into this field found that neurological biofeedback - or neurofeedback - had practical applications.

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[1] Keefe, F. J., & Gardner, E. T. (1979). Learned control of skin temperature: Effects of short-and long-term biofeedback training. *Behavior Therapy*, *10*(2), 202-210.

[2] Nowlis, David P., and Joe Kamiya. "The control of electroencephalographic alpha rhythms through auditory feedback and the associated mental activity." *Psychophysiology* 6, no. 4 (1970): 476-484.

Neurobiology researcher Barry Sterman was exploring the feasibility of neurofeedback in the 1960s.[3] He found that cats could learn to alter their EEG readings, if they were given rewards for producing the "goal" brainwave. With repeated exposure to neurofeedback training, the cats became adept at doing so. Sterman's subsequent, unrelated research project studied the effects of rocket fuel toxicity. Sterman injected cats with the rocket fuel, and found a close relationship between the cats' seizure activity and the amount of exposure to rocket fuel: the more rocket fuel, the more seizures. It is always scientifically pleasing to find a straightforward relationship, and Sterman began to draw conclusions from his results. However, he found some cats to be outliers, not fitting the relationship he expected. These cats seemed to remain seizure-free, even at dosages that had made other cats erupt into seizures. Upon further examination, Sterman found that it was his neurofeedback cats (that had been transferred to the rocket fuel study) that were throwing off his results. This finding was impressive: the cats who had received neurofeedback had a higher seizure threshold than did other cats. There was a clear clinical application for this exploratory technology. Research on neurofeedback for epilepsy began.

While these were astounding discoveries, this technique soon fell into disrepute for a number of reasons: some practitioners made claims for neurofeedback that were not based in evidence; others formed a close link with "flakier" movements that compromised the scientific integrity of the discipline; and laypeople feared that this technique was too close to "mind control." The result was that neurofeedback was kept only barely alive by a few diehard pioneers until its revival in the 1980s.

The field of neurofeedback has grown very rapidly in the last 20 years. The number of practitioners worldwide is approaching 2000, with the bulk of those practitioners residing in the USA, but significant interest in Canada, Europe, and elsewhere. The field is beginning to recover its former ignominy – now, the science is catching up with the claims that have been made for its efficacy. Even while new information is being collected and published, many health professionals such as psychologists, psychiatrists, and family physicians are unaware of current developments in the field.

[3] Sterman, M. B., & Friar, L. (1972). Suppression of seizures in an epileptic following sensorimotor EEG feedback training. *Electroencephalography and clinical neurophysiology*, *33*(1), 89-95.

LOOKING AT TRADITIONAL NEUROFEEDBACK AND DIRECT NEUROFEEDBACK

Traditional neurofeedback (TNF), as described above, is designed to alter brainwave patterns through operant conditioning. Sensors are placed in various locations over the scalp in order to measure the electrical activity of the brain. This information is then relayed through software onto a computer screen. The client watches the screen, receives the feedback, and is rewarded if they hit the target brainwaves and are able to maintain them. The practitioner sets up the software depending on the client's goals, establishing a target state based on a consensus standard from a normative database of neurotypical brain readings. (Essentially, an average of "healthy" brainwaves for people who are in the client's demographic.) Traditional neurofeedback is actively training your brainwaves, much like going to the gym to actively train your body.

Direct Neurofeedback (DNF), in contrast, is a very weak neurostimulation that is sent from an FDA-approved EEG device. The ultra low-intensity signal seems to cause a slight fluctuation in brain patterns and allows the brain to get out of fixed, "frozen" patterns and reorganize itself. Rather than actively training, it's more like rebooting a frozen computer. Clarity Neural Feedback (CDN) is a pulsed, ultra low-power version of cranio-electric stimulation, or CES. The signal sent back to the brain varies, and is adapted to the client's unique brainwaves. The EEG reading of each client influences the frequency of the signal sent back to the brain, which affects the brainwaves themselves, creating an ongoing feedback loop.

DIRECT NEUROFEEDBACK	vs	TRADITIONAL NEUROFEEDBACK
Ultra low neurostimulation	vs	Operant conditioning
Dysentraining the brain	vs	Training the brain
Fast Results—1-3 sessions	vs	Typically 5-15 sessions
Patient passive	vs	Patient active
Shorter sessions: ½ hr	vs	1 hr
Fewer sessions—20-25	vs	30-60 or more

The conditions affected by Direct Neurofeedback generally overlap those of Traditional Neurofeedback. However, it is common for a patient to plateau with traditional methods, but then see additional progress with Direct Neurofeedback.

SYMPTOMS THAT DIRECT NEUROFEEDBACK CAN AFFECT

Scientists have identified specific patterns of brain waves that contribute to a lack of wellness, and that tend to be related to disorders such as some of those listed here:

SYMPTOMS	
Anxiety	ADHD / ADD
Depression	Learning disability
Head Injury / TBI	OCD
Epilepsy	Migraines
Sleep disturbance	Chronic pain
Memory difficulties	Cognitive functioning
Panic attacks	Headaches

In all these conditions, the brain is stuck in some sort of dysfunctional homeostasis leading to ongoing dys-regulation. Direct Neurofeedback works because the brief micro stimulation causes a temporary fluctuation in brain patterns that allows the brain to reorganize or "dis-entrain" itself out of these frozen patterns, not unlike re-booting a frozen computer. One mechanism by which this works is diminishing the "fight or flight " response of the sympathetic nervous system, and enhancing the "rest and digest" response of parasympathetic nervous system. The onset of this effect is usually very fast and results in a balance in the autonomic nervous system.

HOW CAN DIRECT NEUROFEEDBACK AFFECT SO MANY SYMPTOMS?

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.

Despite its global effects, Direct Neurofeedback is extremely safe. It uses an FDA-registered EEG amplifier, which is small, lightweight and portable. Common side effects are mild, including: fatigue, a "wired" feeling, minor headaches, lightheadedness, and vivid dreams. After a session, past conditions might re-assert themselves temporarily, but without any long-term ill effects. Scientific research on DNF (and other forms of CES) support the claim that hundreds of thousands of individuals have received neuro-stimulation safely and without any adverse effect.[4] Extensive qEEG brain mapping is not required prior to treatment for obtaining effective results.

The client often feels a shift occur during the first session. Family and friends will likely begin noticing the shift in 1-3 sessions. Initial changes are temporary, but they last longer with each treatment. By the end of a series of training sessions these improvements are both substantial and "enduring" by the client's own account.

The clinical significance of CDN is tremendous. The range of conditions treated, the effectiveness of the treatment, the ease and efficiency of treatment, the lack of meaningful side effects and the enduring nature of the improvements all make Clarity Direct Neurofeedback a very potent clinical modality.

[4] Gilula, M. F., & Kirsch, D. L. (2005). Cranial Electrotherapy Stimulation Review: A Safer Alternative to Psychopharmaceuticals in the Treatment of Depression. *Journal of Neurotherapy*, 9(2), 7–26. doi:10.1300/j184v09n02_02