Similarities and Differences Between Brainwave Optimization (HIRREM) and Electroencephalographic Biofeedback

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In terms of technological lineage, Brainwave Optimization™ (more formally known as High-resolution, Relational, Resonance-based Electroencephalic Mirroring or HIRREM) can be considered as an advance on the methodology of electroencephalographic biofeedback (also known as "EEG biofeedback" or "neurofeedback.") For purposes of this discussion, we will generally refer to it as "EEG biofeedback."

In order to clarify the similarities between HIRREM and EEG biofeedback, it may be helpful to present the following joint statement regarding the definition of biofeedback, agreed on by two professional societies, the International Society for Neurofeedback Research (ISNR) and the Association for Applied Psychophysiology and Biofeedback (AAPB):

> Biofeedback is a process that enables an individual to learn how to change physiological activity for the purposes of improving health and performance. Precise instruments measure physiological activity such as brainwaves, heart function, breathing, muscle activity, and skin temperature. These instruments rapidly and accurately "feed back" information to the user. The presentation of this information—often in conjunction with changes in thinking, emotions, and behavior—supports desired physiological changes. Over time, these changes can endure without continued use of an instrument. (www.aapb.org, accessed Aug. 31, 2010.)

The International Society for Neurofeedback Research further explains that neurofeedback is based on the following premise:

> Resulting information [about brainwave activity] is fed back to the trainee virtually instantaneously with the conceptual understanding that changes in the feedback signal indicate whether or not the trainee's brain activity is *within the designated range* [italics added]. (www.isnr.org, accessed Aug. 31, 2010.)

In broad principle, the joint AAPB/ISNR definition of biofeedback and neurofeedback highlights two core similarities between HIRREM and neurofeedback.

How HIRREM and EEG Biofeedback are Similar

First, this technology and biofeedback are similar in that both use *precision instruments to measure physiological activity*, and *present this information back to individuals* in such a way that *desired physiological changes are supported*.

Second, both this technology and biofeedback aim to facilitate *changes that eventually can endure without continued use of an instrument*.

Sharing this goal, both HIRREM and EEG biofeedback can be considered as methodologies that aim to enhance the human being's capacity for *self-regulation*. Both HIRREM and EEG biofeedback share a basic belief in the power of human physiology to improve its own functioning through innate mechanisms, together with a belief that such mechanisms can be catalyzed through technologically advanced, but non-invasive means.

Both HIRREM and EEG biofeedback share an orientation that neural oscillatory dynamics are primary processes, and that patterns of neurotransmitter activity at the synaptic junction are secondary.

How HIRREM and EEG Biofeedback Differ

The definitions of EEG biofeedback and neurofeedback also highlight two concepts which distinguish HIRREM from both.

First, the ISNR definition explains neurofeedback as a form of operant conditioning. The approach of the neurofeedback provider is to begin by designating a desired range of intensity (typically, the average amplitude of a frequency band, as measured in micro-volts) for the client's brainwave activity. This range is deemed to be a normative value, based on population averages. Then, a feedback signal is (or is not) provided to the client depending on whether the client's brain is generating activity within that range of amplitudes. The client is taught to try to generate certain ranges of amplitudes, and is rewarded by watching a video play or hearing a pleasant tone whenever they produce the pre-specified amplitude ranges. Or, certain brainwave amplitudes are inhibited, generally by removal of the positive feedback signal. Within a given training session, typically only one or two different types of feedback are given.

In contrast, HIRREM *provides feedback signals that are dynamically modified, in near real-time, so as to reflect activity of those frequencies of the EEG that are dominant within a floating middle range of the EEG frequency spectrum.*

Provision of the feedback signal is *not* contingent on whether the client has generated brainwave amplitudes that meet a pre-determined threshold. Providers of this technology do *not* designate ranges of EEG amplitudes as being normative or desirable. The approach is thus *not* a form of operant conditioning and there are no reward or inhibit parameters to inform the client training process.

In a real sense, the technology is essentially "non-judgmental" toward the brain's functioning. It recognizes aberrance, but does not aim to overwrite it. In contrast, EEG biofeedback technology is essentially "judgmental" in that the machinery aims to control or overwrite the client's brainwave amplitudes through the conditioning influences of rewarding or inhibiting stimuli.

Second, the AAPB and ISNR definitions explain that biofeedback and neurofeedback are educational processes, in the sense that clients are encouraged to have a conceptual understanding of the feedback being given, and therefore to consciously learn to change their physiological activity. In contrast, HIRREM *focuses little or no attention on conscious learning and does not encourage clients to develop conscious control over their physiology*.

EEG Biofeedback Asks the Person to Train Their Brain; HIRREM Asks the Person to 'Step Aside'

Sessions utilizing HIRREM are largely and explicitly devoid of extended conceptual engagement or educational dialogue between providers and clients. Rather, clients are encouraged to gently release any explicit intentions for control over their physiology.

Although precise estimations are difficult or perhaps currently impossible, there is little doubt that our normal waking consciousness can manage only an infinitesimal fraction of the information-processing power of our nervous system as a whole (Norretranders 1998). For example, consider the maximum speed (postulated to be between 12 to 40 bits per second) at which our conscious mind can receive and comprehend the contents of written words. In contrast, other elements of our nervous system—including divisions that manage sensory, motor and internal self-regulatory functions—process vastly larger amounts of information (postulated to be hundreds of millions of bits per second or more).

By providing precision information to clients without relying on the slower processing speeds associated with conscious learning, HIRREM aims to recruit and engage the larger-scale information processing power of neural systems not typically associated with conscious awareness or learning.

These two principles—mirroring and a focus on the high-capacity information-processing power of the nervous system—represent the two features of this technology that most significantly differentiate it from biofeedback and neurofeedback.

Precision Data Collection Allows Brain to Evolve, Change in Real-Time

A third general difference between HIRREM and EEG biofeedback concerns the amount of data granularity. The technology *observes electroencephalographic activity at increasingly high resolutions.*

Greater resolution or granularity of data collection and processing occurs in the dimensions of both time and the EEG frequency spectrum. With respect to temporal resolution, HIRREM provides auditory feedback to the client within 25 milliseconds after the EEG signal has been generated. In comparison, most EEG biofeedback systems provide feedback to the client within up to 2.5 seconds, if given through visual graphics. With respect to frequency spectrum resolution, HIRREM can discriminate and provide feedback for EEG information that originates with windows that are as narrow as 0.1 hertz. In comparison most EEG biofeedback systems provide feedback over broad ranges of the frequency spectrum, for example over 4-8 hertz or 16-24 hertz.

Increasing EEG data resolution, without a predetermined end point, is a core objective of the HIRREM developer team. As knowledge and opportunity grow, technology software and hardware are being upgraded regularly.

Selected References:

Avnon Y. et al. Autonomic asymmetry in migraine: augmented parasympathetic activation in left unilateral migraineurs. Brain. 2004; 127(9): 2099-2108.

Craig B. Forebrain emotional asymmetry: a neuroanatomical basis? Trends in Cognitive Sciences Vol. 9 No.12 December 2005.

Gerdes et al. Demonstration Summary of Brain State Technologies Training for Inmates in the Nevada Department of Corrections, 2007.

Hilz M. et al. Hemispheric influence on autonomic modulation and baroreflex sensitivity. Annals of Neurology. 1 May 2001; 49 (5): 575-84.

Kumar V., Ed. Robbins and Cotran's Pathologic Basis of Disease, 8th Ed. Elsevier, 2009.

Norretranders T. The User Illusion. New York: Viking Penguin, 1998.

Ortiz J. and Raine A. Heart rate level and anti-social behavior in children and adolescents: a meta-analysis. Journal of the American Academy of Child and Adolescent Psychology. 2004, 43(2): 154-162.

Porges S. The poly-vagal perspective. Biological Psychology 74 (2007) 116–143.

Rabe et al. Regional brain activity in posttraumatic stress disorder after motor vehicle accident. Journal of Abnormal Psychology. 2006; 115 (4) 687-98.

Rabe et al. Changes in brain electrical activity after cognitive behavioral therapy for posttraumatic stress disorder in patients injured in motor vehicle accidents.
Psychosomatic Med. 2008; 70: 13-19.

Schore A. Right brain affect regulation: an essential mechanism of development, trauma, dissociation, and psychotherapy, in Fosha D, Siegel D, and Solomon M, Eds., The
Healing Power of Emotion. New York: WW Norton, 2009.

Sterling P. Principles of allostasis: optimal design, predictive regulation, pathophysiology, and rational therapeutics, in Schulkin J, Ed., Allostasis,
Homeostasis, and the Costs of Physiological Adaptation. New York: Cambridge University Press, 2004.

Wittling W. The right hemisphere and the human stress response. Acta Physiologica. 1997; (640) 55-9.

Wittling W. et al. Hemisphere asymmetry in parasympathetic control of the heart. Neuropsychologia. 1998 May 1; 36 (5): 461-68.

Yoon BW. Cerebral hemispheric lateralization in cardiac autonomic control. Archives of Neurology. 1997; Jun, 54 (6) 741-4.

About Lee Gerdes

Lee Gerdes is Founder and CEO of Brain State Technologies®. He is the creator of Brainwave Optimization with Real-Time Balancing™. Today, Brain State Technologies has the largest interrelational and functional database of brainwave patterns, having served and assessed more than 30,000 client's brains. The network includes about 140 affiliates offices, located in 15 countries and growing.

Lee is the author of Limitless You: The Infinite Possibilities of a Balanced Brain, published in 2009 by Namaste Publishing. His work emanates from a combination of his interests in how the brain works and how it affects mind, body. He has been a systems analyst, pastoral counselor, management consultant, and vice president of solutions for NetPerceptions where he pioneered the discovery of algorithms for predicting consumer purchase behavior ("If you bought this, you'll like this.")

Lee's education includes Doane College in Crete, Nebraska; Columbia University in New York; John F. Kennedy University in Orinda, California and Wartburg Seminary in Dubuque, Iowa.

About Sung Lee, M.D.

Dr. Sung Lee is research coordinator for Brain State Technologies. He works with Brain State Technologies founder Lee Gerdes to help discover, test and expand current and new applications for optimizing brainwaves, and hence, human potential. Trained in internal medicine, mind-body health and clinical research methods, Dr. Lee operates a practice that provides Brainwave Optimization™ in Sedona, Arizona.

Dr. Lee graduated with honors from Brown University and studied at the University of Cambridge in Cambridge, England. He completed his medical training at the University of California at San Francisco, Yale-New Haven Hospital, and the New York Presbyterian Hospital. He led studies to test the efficacy of mind-body health practices to improve quality of life and to reduce fatigue in patients with breast cancer and Parkinson's disease at the Weill Medical College of Cornell University. From Cornell, he holds a Master's of Science in Clinical Epidemiology and Health Services Research. He is a member of the Advisory Board of the International Brain Education Association and a scientific advisor to *Brain World* magazine.

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