

## Neurofeedback is a form of Applied Behavior Analysis

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Both neurofeedback and Applied Behavior Analysis (ABA) have deep roots from the 1960s and '70s where learning theory was applied to behavior problems. There has been some divergence in the communities, but we still see biofeedback articles in ABA journals. The question of whether neurofeedback is a form of ABA depends on definitions and whether neurofeedback fits within that definition.

First, neurofeedback is a form of biofeedback dealing with neurological signals coming from the brain, such as brainwaves as detected by an electroencephalograph (EEG). Neurofeedback is an operant conditioning procedure for rewarding selected spontaneous behavior of the brain's electrophysiology in order to shape subtle behavior and obtain improved functioning.

By feeding back an aspect of this EEG signal to the subject, clients alter the signal by modifying the underlying physiology. In the case of ADHD, neurofeedback practitioners attach passive EEG sensors to the top of the scalp and monitor feedback such as slow theta waves (4-8 Hertz). Rewards are set in order to inhibit theta waves. The reward can be a brighter movie, more interesting graphics or progress in a video game. It is also helpful to reinforce medium fast SMR brain waves (such as 12-15 Hz). Audio-visual rewards are typically conditional on achieving both goals simultaneously. Neurofeedback systems may have a few or several hundred EEG based target thresholds as well as different strategies for providing reinforcement.

The three professional organizations that promote biofeedback research and practice are the Association for Applied Psychophysiology and Biofeedback (AAPB), the Biofeedback Certification Institute of America (BCIA) and the International Society for Neurofeedback and Research (ISNR). They have defined biofeedback this way:

“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 monitor 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.”

The following definition is broadly accepted for Applied Behavior Analysis. The definition includes 7 dimensions and 5 characteristics. My responses following in *italics* are meant to point out that neurofeedback fits within and often exceeds these parameters.

### Definition

ABA is defined as the science in which the principles of the analysis of behavior are applied systematically to improve socially significant behavior, and in which experimentation is used to identify the variables responsible for change in behavior. It is one of the three fields of behavior

analysis. The other two are [behaviorism](#), or the philosophy of the science; and [experimental analysis of behavior](#), or basic experimental research.

Baer, Wolf, and Risley's 1968 article is still used as the standard description of ABA. It describes the seven dimensions of ABA: application; a focus on behavior; the use of analysis; and its technological, conceptually systematic, effective, and general approach.

## Characteristics

Baer, Wolf, and Risley's seven dimensions are:

- Applied: ABA focuses on areas that are of social significance. In doing this, behavior scientists must take into consideration more than just the short-term behavior change, but also look at how behavior changes can affect the consumer, those who are close to the consumer, and how any change will affect the interactions between the two.
  - *The brain is the core of the central nervous system which regulates all higher order thinking, feeling and behaving.*
- Behavioral: ABA must be behavioral, i.e.: behavior itself must change, not just what the consumer SAYS about the behavior. It is not the goal of the behavior scientists to get their consumers to stop complaining about behavior problems, but rather to change the problem behavior itself. In addition, behavior must be objectively measured. A behavior scientist can not resort to the measurement of non-behavioral substitutes.
  - *Brainwaves are behavior. (Dead men don't make brainwaves.) The EEG is a signal that is non-linear, non-stationary and noisy. But training brainwaves produces substantial and ending results in a good majority of subjects.*
- Analytic: The behavior scientist can demonstrate believable control over the behavior that is being changed. In the lab, this has been easy as the researcher can start and stop the behavior at will. However, in the applied situation, this is not always as easy, nor ethical, to do. According to Baer, Wolf, and Risley, this difficulty should not stop a science from upholding the strength of its principles. As such, they referred to two designs that are best used in applied settings to demonstrate control and maintain ethical standards. These are the reversal and multiple baseline designs. The reversal design is one in which the behavior of choice is measured prior to any intervention. Once the pattern appears stable, an intervention is introduced, and behavior is measured. If there is a change in behavior, measurement continues until the new pattern of behavior appears stable. Then, the intervention is removed, or reduced, and the behavior is measured to see if it changes again. If the behavior scientist truly has demonstrated control of the behavior with the intervention, the behavior of interest should change with intervention changes.
  - *Early reversal research by Lubar on ADHD in the 1970s trained theta waves up, then down and up again. ADHD symptoms followed as expected: subjects attention got better, then worse then better again. These studies are now considered unethical. There are thousands of case studies and research studies in the literature with*

*consistent findings. Beyond these research designs are randomized controlled trials. There are now decades of research with a wide variety of ailments.*

- **Technological:** This means that if any other researcher were to read the study's description, that researcher would be able to "replicate the application with the same results". This means that the description must be very detailed and clear. Ambiguous descriptions do not qualify. Cooper et al. describe a good check for the technological characteristic: "have a person trained in applied behavior analysis carefully read the description and then act out the procedure in detail. If the person makes any mistakes, adds any operations, omits any steps, or has to ask any questions to clarify the written description then the description is not sufficiently technological and requires improvement."
  - *The biomedical engineering of neurofeedback equipment is quite detailed and replicable with a high degree of rigor and FDA approval. There are established protocols with precise sensor placement using an international standard. There is substantial agreement among neurofeedback professionals on how to treat disorders, as well as specific camps with unique perspectives. A technician with 10 hours of remote training can run sessions on clients using a turnkey automated system using artificial intelligence.*
- **Conceptually Systematic:** A defining characteristic is in regards to the interventions utilized; and thus, research must be conceptually systematic by only utilizing procedures and interpreting results of these procedures in terms of the principles from which they were derived.
  - *Neurofeedback is an operant condition training procedure. Many studies have successfully trained down the theta/beta ratio to alleviate diverse conditions. Eyes-closed alpha-theta training is often used for addictions and PTSD.*
- **Effective:** An application of these techniques improve behavior under investigation. Specifically, it is not a theoretical importance of the variable, but rather the practical importance (social importance) that is essential.
  - *Beyond effective is efficacious and specific. See bibliography.*
- **Generality:** It should last over time, in different environments, and spread to other behaviors not directly treated by the intervention. In addition, continued change in specified behavior after intervention for that behavior has been withdrawn is also an example of generality.
  - *Neurofeedback seems to provide pervasive and enduring benefits for a variety of conditions. fMRI studies show improved functioning within the brain.*

In 2005, Heward, et al. added the following five characteristics:

- **Accountable:** Direct and frequent measurement enables analysts to detect their success and failures to make changes in an effort to increase successes while decreasing failures. ABA is a scientific approach in which analysts may guess but then critically test ideas, rather than "guess and guess again". This constant revision of techniques, commitment to effectiveness and analysis of results leads to an accountable science.

- *In addition to some established protocols, the field of neurofeedback is fertile with new approaches. For example, BrainPaint uses artificial intelligence to track clinical progress across thousands of systems in order to obtain training protocols, resolve side effects and for continuous improvement.*
- **Public:** Applied behavior analysis is completely visible and public. This means that there are no explanations that cannot be observed. There are no mystical, metaphysical explanations, hidden treatment, or magic. Thus, ABA produces results whose explanations are available to all of the public.
  - *Neurofeedback generates many EEG behavior samples per second which can be analyzed in detail. For example, we can see increased complexity of the EEG signal and restoration of brain function on fMRI. Much of the research tracks symptom changes using psychometric instruments or by observing behavior.*
- **Doable:** ABA has a pragmatic element in that implementors of interventions can consist of a variety of individuals, from teachers to the participants themselves. This does not mean that ABA requires one simply to learn a few procedures, but with the proper planning, it can effectively be implemented by most everyone willing to invest the effort.
- *Some neurofeedback therapists have a component of their practice where neurofeedback equipment is rented for home training under the guidance of the professional. With BrainPaint it is common for 1 technician to train 3 clients simultaneously.*

**Empowering:** ABA provides tools to practitioners that allow them to effectively change behavior. By constantly providing visual feedback to the practitioner on the results of the intervention, this feature of ABA allows clinicians to assess their skill level and builds confidence in their technology.

- *Brainwave results can be seen changing during a session and tracked across sessions. Behavioral results can be tracked as often as practical. There is typically a good correlation between electrophysiological goals and behavioral symptom reduction.*
- **Optimistic:** According to several leading authors, practitioners skilled in behavior analysis have genuine cause to be optimistic for the following reasons:
  - The environmental view is essentially optimistic as it suggests that all individuals possess roughly equal potential.
    - *Neurofeedback has proven to be broadly and enduringly effective, for a significant proportion of individuals.*
  - Direct and continuous measurements enable practitioners to detect small improvements in performance that might have otherwise been missed.
    - *Neuroimaging with fMRI can detect improvements after a single session. Clients typically see non-subtle improvement after a few sessions.*
  - As a practitioner uses behavioral techniques with positive outcomes, the more they will become optimistic about future success prospects.

- *This is my experience and the experience of my colleagues.*
- The literature provides many examples of success teaching individuals considered previously unteachable.
  - *Yes. Many. See the bibliography below.*

Further reading

Fultz, D. E.(2009). The Current Status of Behaviorism and Neurofeedback. International Journal of Behavioral Consultation and Therapy, 5(2), 159-162

Fultz, D.E. (2001). Behaviorism and neurofeedback: Still married. Journal of Neurotherapy. 6. 67-74.

ISNR.org. Comprehensive Bibliography for Neurofeedback

<https://www.isnr.org/isnr-comprehensive-bibliography>

<https://www.CalmFocus.com/research> BrainPaint specific.

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Gary Ames believes neurofeedback is an excellent way to relieve the symptoms of: [Anxiety & PTSD](#), [ADHD](#), [Depression](#), [Sleep](#), [Anger](#), [Concussion and TBI](#), [Migraine](#), [Addictions](#), and [Other Conditions](#).

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