# Neurofeedback is a Form of Applied Behavior Analysis.

**by Joseph Cautilli and Gary Ames**

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 a good portion of 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 brain waves as detected by an electroencephalograph (EEG). This is an operant conditioning procedure or rewarding selected spontaneous behavior of the brain's electrophysiology in order to shape subtle behavior and obtain improved functioning.

By feeding back as aspect of this signal to the subject, clients become able to alter the signal and the underlying physiology. In the case of ADHD training, neurofeedback practitioners attach EEG sensors to the scalp and monitor feedback slow theta waves (4-8 Hertz). Rewards are set in order to inhibit theta waves. The reward can be a brighter movie or progress in a video game. It is also helpful to reward medium fast SMR brain waves (12-15 Hz). Rewards are typically conditional on achieving both goals simultaneously.

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 behavior including disordered behavior.* Neurofeedback has been growing for the past 60 years. There have been thousands of published papers from dozens of countries, documenting many thousands of patient's successes.

**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 as proven by the dead man's test. Certain changes in this subtle behavior has an impact on how we think, feel and behave.*

**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 got*

*better, then worse then better again. These studies are now considered unethical. There are many case studies in the literature with consistent findings. Beyond these research designs are randomized controlled trials on many conditions. The totality is a compelling body of research.*

- **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." These demonstrate safety and effectiveness in a wide range of applications.
    - *The biomedical engineering of neurofeedback equipment is quite detailed and replicable with a high degree of rigor. There are established protocols with precise sensor placement using an international standard. There is substantial agreement among neurofeedback professionals on how to treat ADHD by inhibiting slower theta waves and encouraging greater SMR or beta waves.*
- **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 conditioning procedure. The brain is complex. Brainwaves are non-linear, non-stationery and noisy. The research is voluminous. Neurofeedback training normalizes brain maps and behavior.*
- **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.
    - *These demonstrate safety and effectiveness in a wide range of applications. The social significance of the broad, significant and enduring changes made by neurofeedback is beyond question.*
- **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.
    - *When training brainwaves we typically see general improvements in the prime symptoms. These results are durable in follow up studies. In addition, common*

*co-morbidities and unrelated also resolve with training. 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 the established protocols, the field of neurofeedback is fertile in new approaches. Some of these are methods are counter-intuitive, yet neurofeedback professionals and system developers follow the results for improved outcomes. The BrainPaint system of neurofeedback has used artificial intelligence to refine reinforcement strategies with data from 10,000 sessions per month for over a decade. The AI solves for how to do the most good without doing harm.*
- **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 is produces results whose explanations are available to all of the public.
    - *Neurofeedback generates many behavior samples per second which can be analyzed in vast detail. Studies have used many different dependent variables.*
- **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 thriving component of their practice where specialized equipment is rented for home training under the guidance of the professional. School-based neurofeedback is a proven concept.*
- **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.
    - *Neurofeedback results can be seen changing during a session and tracked across sessions. Behavioral results can be tracked as often as practical. There is typically see 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
    - Direct and continuous measurements enable practitioners to detect small improvements in performance that might have otherwise been missed
    - As a practitioner uses behavioral techniques with positive outcomes, the more they will become optimistic about future success prospects
    - The literature provides many examples of success teaching individuals considered previously unteachable.

        - *The track record of treating diverse disorders, even intractable genetic brain injuries and disorders, so completely that medications can be withdrawn without a resurgence of symptoms gives me great hope for the future.*

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.

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