

Article

Biofeedback in medicine: who, when, why and how?

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ABSTRACT

Biofeedback is a mind–body technique in which individuals learn how to modify their physiology for the purpose of improving physical, mental, emotional and spiritual health. Much like physical therapy, biofeedback training requires active participation on the part of patients and often regular practice between training sessions. Clinical biofeedback may be used to manage disease symptoms as well as to improve overall health and wellness through stress management training. Research has shown that biofeedback interventions are efficacious in treating a variety of medical conditions, and many Americans are turning to biofeedback and other less traditional therapies for their routine healthcare.

Clinical biofeedback training is growing increasingly popular in the USA, as many people are seeking out relatively new approaches to healthcare. This article provides an overview of clinical biofeedback training, outlines two models of training, details research which has established how effective biofeedback is in patients with a given disease, and describes who should be referred for biofeedback training.

Keywords: autonomic nervous system, biofeedback, psychophysiology, relaxation response, self-regulation, stress-management

Biofeedback

Biofeedback is a self-regulation technique through which patients learn to voluntarily control what were once thought to be involuntary body processes. This intervention requires specialised equipment to convert physiological signals into meaningful visual and auditory cues, as well as a trained biofeedback practitioner to guide the therapy. Using a screen such as a computer monitor, patients get feedback

that helps them develop control over their physiology. Just as looking into a mirror allows one to see and change positions, expressions, etc., biofeedback allows patients to see inside their bodies, with a trained practitioner serving as a guide directing them to use the feedback to regulate their physiology in a healthy direction.

Surface electromyography (sEMG) is perhaps the most common physiological variable monitored using biofeedback. sEMG feedback is used in a variety of disorders such as tension headache, chronic pain, spasmodic torticollis and temporomandibular joint dysfunction. Electroencephalography (EEG) feedback, also called neurofeedback, is used in ADHD and epilepsy and is increasingly the focus of research and other applications.

Some of the other commonly monitored variables are used when the goal of biofeedback is to reduce sympathetic arousal. These include heart rate, respiration rate, skin surface temperature (at the fingertips), skin conductance and heart rate variability.¹ This physiological information is normally not viewed as being under conscious control, but biofeedback provides real-time data, helping to bring such physiological processes under the control of the patient.² Common disorders treated in this way include hypertension, anxiety and medical conditions exacerbated by stress. Biofeedback also helps to make patients aware of the thoughts, feelings and behaviours related to their physiology. Over time, they can learn to self-regulate without feedback screens in front of them.

Two models of biofeedback training

Biofeedback training is used in a variety of settings in order to improve academic, athletic and corporate performance, as well to improve health and wellness. This training may follow one of two learning models, each of which provides feedback so that the client learns techniques that help to correct any present malfunctioning.

Operant conditioning and feedback learning

Operant conditioning is a model of learning which utilises consequences as a means to modify the occurrence or type of behaviour.³ For biofeedback, a straight operant conditioning model relies solely on the reinforcement of the signal displays in order to prompt patients to change their physiology. Feedback learning often functions together with operant reinforcement. An example outside the healthcare arena is learning to putt a golf ball. As the individual sees where the ball goes, the feedback helps to improve the next stroke. In biofeedback, seeing the physiological data go in a better direction results in

feedback learning, and positive reinforcement learning is usually satisfying. The therapist is simply there to explain what the biofeedback equipment is measuring and how it relates to the patient's physiology. Operant conditioning and the feedback learning model have been used in the management of many medical disorders including Raynaud's disease and faecal incontinence.⁴

Psychophysiological psychotherapy

Patients who are suffering from a disease that has a major stress component may also be helped by biofeedback using a psychophysiological psychotherapy model of learning. In this model, it is necessary to understand the patient as an individual. Stress management and other psychotherapeutic interventions may be used in combination with biofeedback training in order to make patients aware of how the stress in their lives has an effect on physiology. This model of learning uses both a psychophysiological assessment, described below, and a psychological evaluation in order to determine the thought and behaviour patterns that contribute to the patient's physiological vulnerability. This application of biofeedback training, which includes stress management, may be the most successful in treating stress related disorders.

Training not treatment

Biofeedback therapy is a process of training as opposed to a treatment. Much like being taught how to tie their shoes or ride a bicycle, individuals undergoing biofeedback training must take an active role and practise in order to develop the skill. Rather than passively receiving a treatment, the patient is an active learner. It's like learning a new language.

When a patient comes in for clinical biofeedback therapy, an emphasis is placed on education. As sensors are placed on the patient's skin, the therapist explains what each sensor will be measuring, assuring the patient that the sensors do not cause any pain or shock but rather are simply recording signals from the body and displaying those signals on the screen. The therapist chooses signal displays which take into account both the needs and limitations of the individual being seen, and then explains each signal. This may be as simple as 'the green line is muscle tension, the blue line is temperature', etc.¹ Patients are then taught how the signals being displayed relate to their physiology. For example, the

therapist may say, 'Raise your shoulders' or 'Scrunch your face,' using the muscle tension signal on the screen to point out the patient's physiological responses.

Patients are also shown how their physiology is reactive to mental stimuli, particularly stressful situations. This is often done with a psychophysiological assessment including a series of activities and recoveries. First patients are asked to relax, and then they are asked to engage in a stressful activity such as the Stroop Color-Word Test⁵ or the Serial Sevens Test⁶ before once again being asked to relax. The therapist can then pause the feedback and show the patient his or her physiological reactivity to the mental task, as well as the extent and speed with which the physiology returned to baseline values. At this point the therapist may explain what the optimal values are for each of the physiological variables being measured as well as how they relate to patient health. For example, the therapist may say, 'Keeping the green line down below two microvolts means that your muscles are already relaxed'. This may also be related to the patient's current condition by saying something such as 'If you practise letting go of the tension in these muscles, then you will experience headaches less frequently or with less intensity'. The therapist may then provide the patient with suggestions of how to use imagery or self-talk to reduce stress. The final aspect of biofeedback training is reinforcement by the therapist that the patient is doing a good job and is more in control of his or her recovery and wellness.

Indications for referral

Individuals may be referred for biofeedback training as either an alternative or an adjunctive therapy. Current treatment may be producing an insufficient response or even no response at all. Individuals who are intolerant of medication or for whom pharmacological treatment is contraindicated (e.g. the patient is pregnant or may become pregnant, or the patient is breast feeding) may be referred for biofeedback training. Patients who for any reason are not adhering to their current treatment regimen may also respond to biofeedback training. Some patients may request additional help or therapy. Individuals who have stress as a significant component of their medical condition can be referred for biofeedback training combined with psychotherapy. There is also significant self-selection, as patients who value self-control are likely to ask for biofeedback or be most receptive when it is offered.

Efficacy of biofeedback interventions

In 2001, a Task Force of the Association for Applied Psychophysiology and Biofeedback and the Society for Neuronal Regulation outlined criteria for levels of evidence-based clinical efficacy of psychophysiological interventions.⁷ The official standards for inclusion of research studies in this task force report are described below.⁷⁻⁹

Level 1: Not empirically supported

Evidence for Level 1 efficacy is supported only by anecdotal reports and/or case studies which are not peer reviewed.

Level 2: Possibly efficacious

Evidence for Level 2 efficacy is supported by at least one study of sufficient statistical power with well-identified outcome measures but which lacks random assignment to a control condition internal to the study.

Level 3: Probably efficacious

Evidence for Level 3 efficacy is supported by multiple observational, clinical, wait list controlled, within-subject and intrasubject replication studies that demonstrate efficacy.

Level 4: Efficacious

Evidence for Level 4 efficacy meets all of the following criteria:

- a in a comparison with a no-treatment control group, alternative treatment group, or sham (placebo) control utilising randomised assignment, the investigational treatment is shown to be statistically significantly superior to the control condition, or the investigational treatment is equivalent to a treatment of established efficacy in a study with sufficient power to detect moderate differences *and*
- b the studies have been conducted with a population treated for a specific problem, for whom inclusion criteria are delineated in a reliable, operationally defined manner *and*
- c the study used valid and clearly specified outcome measures related to the problem being treated *and*

- d the data are subjected to appropriate data analysis *and*
- e the diagnostic and treatment variables and procedures are clearly defined in a manner that permits replication of the study by independent researchers *and*
- f the superiority or equivalence of the investigational treatment has been shown in at least two independent research settings.

Level 5: Efficacious and specific

Evidence for Level 5 efficacy meets all of the Level 4 criteria and, in addition, the investigational treatment has been shown to be statistically superior to credible sham therapy, pill, or alternative bona fide treatment in at least two independent research settings.

Efficacy ratings for specific conditions

Using the criteria detailed above, Yucha and Montgomery⁷ rated the current evidence on the efficacy of biofeedback training on various diseases and reported this in 2008. These ratings are summarised in Table 1. Keep in mind that if a condition has a lower efficacy rating, this does not suggest that biofeedback is not helpful in that condition, but rather that relevant research has not yet been conducted. Also, when combined with conventional medical management, an individual may very much benefit from a 'possibly efficacious' biofeedback application. An initial evaluation can usually reveal whether physiology monitored by biofeedback is outside normal limits and whether correcting it is likely to help the symptoms or disorder. For example, someone with a tension headache but normal electromyogram (EMG) readings from the trapezius and forehead sites probably won't benefit from EMG biofeedback, but someone with elevated readings probably would.

Table 1 Efficacy ratings for biofeedback training on various medical conditions*

Level 5 Efficacious and specific	Level 2 Possibly efficacious
Urinary incontinence (females) ¹⁰	Asthma ³⁰
	Autism ³¹
Level 4 Efficacious	Bell's palsy ³²
Anxiety ¹¹	Cerebral palsy ³³
Attention deficit hyperactivity disorder ¹²	Chronic obstructive pulmonary disease ³⁴
Chronic pain ¹³	Coronary artery disease ³⁵
Constipation (adult) ¹⁴	Cystic fibrosis ³⁶
Epilepsy ¹⁵	Depressive disorders ³⁷
Headache (adult) ¹⁶	Erectile dysfunction ³⁸
Hypertension ¹⁷	Fibromyalgia/chronic fatigue syndrome ³⁹
Motion sickness ¹⁸	Hand dystonia ⁴⁰
Raynaud's disease ¹⁹	Irritable bowel syndrome ⁴¹
Temporomandibular disorder ²⁰	Post-traumatic stress disorder ⁴²
	Repetitive strain injury ⁴³
Level 3 Probably efficacious	Respiratory failure: mechanical ventilation ⁴⁴
Alcoholism/substance abuse ²¹	Stroke ⁴⁵
Arthritis ²²	Tinnitus ⁴⁶
Diabetes mellitus ²³	Urinary incontinence (children) ⁴⁷
Faecal incontinence ²⁴	
Headache (paediatric) ²⁵	Level 1 Not empirically supported
Insomnia ²⁶	Eating disorders ⁴⁸
Traumatic brain injury ²⁷	Immune function ⁴⁹
Urinary incontinence (males) ²⁸	Spinal cord injury ⁵⁰
Vulvar vestibulitis ²⁹	Syncope ⁵¹

* Ratings were made by Yucha and Montgomery⁷ based on data from the cited references

Biofeedback gaining popular acceptance

Clinical biofeedback training is steadily gaining acceptance with the American public. Biofeedback is recognised by the National Institute of Complementary and Alternative Medicine as one of the mind–body therapies and many doctors and patients think of biofeedback as a form of complementary and alternative medicine (CAM). The last decade has demonstrated a significant increase in the prevalence of CAM use. A recent in-person survey of health- and illness-related experiences showed that in the USA alone, approximately 38% of adults and 12% of children are using some form of CAM for general healthcare and wellness or to treat a range of symptoms and diseases.⁵² In 2007, Americans spent nearly \$34 billion on CAM practitioners and products.⁵³

As more and more Americans seek out such complementary and alternative therapies for their healthcare and as research continues to reveal the efficacy of biofeedback for more and more medical disorders, it is likely that it will become an accepted therapy for more disease conditions. A large study being undertaken this fall at the Cleveland Clinic, with funding from the Bakken Heart–Brain Institute, seeks to investigate the efficacy of biofeedback in treating three populations of patients – those with coronary artery disease, diabetes or multiple sclerosis. We hope to establish in these and other diseases that biofeedback is successful in improving quality of life and clinical status, as well as possibly reversing biological aspects of each disease.

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CONFLICTS OF INTEREST

None.

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