Practical Issues Concerning EEG Biofeedback

Devices, Protocols and Methods

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Introduction

This report provides practical information regarding the use of EEG biofeedback ("neurofeedback") for a variety of uses. It will survey some ofthe major issues, approaches and methods that are currently in use, and describe their overall benefits and limitations. This should help the user or practitioner to evaluate and select neurofeedback instruments, and to put them to use for the needs at hand.

There are a variety of approaches to EEG biofeedback, and several major schools of thought and practice. These approaches and schools are also represented in the ways vendors approach the user population, and how products are designed and positioned i n the marketplace. One factor that distinguishes the BrainMaster system is the fact that it attempts to address most or all possible approaches, and does not limit the user to any one philosophy or method. This flexibility gives the user exceptional freedom to set up protocols and configurations, but also demands somewhat more understanding and direction on the part of the user when compared to other, more limited, designs.

Because much of the direction and history of EEG biofeedback has been established by vendors and individual users as well as through systematic research, certain products and practitioners may be used as examples of the major directions and methodological approaches. These may be cited and described here, despite a possible shortage of specific published material that can be cited as reference material. The absence of peer-reviewed publications is of particular concern in this area, and it is hoped that many of the devices and methods reported here will become the subject of more systematic study in the future. This should help to remove the overtones of personal opinions and preferences, and replace them with the results of objective findings.

Clinical vs. nonclinical use

Biofeedback is used for both medical and non-medical uses, and the dividing line between them may be thin. This discussion will provide information of value in situations where it is desired to improve relaxation, attention, focus, concentration and self-awareness, or as an adjunct to meditation, counseling, hypnosis, or achieving altered states of consciousness. These are not strictly medical applications, and can be considered primarily as personal improvement and conditioning for the brain and mind, in contrast to theraputic interventions. While it is quite possible to administer EEG biofeedback without professional intervention, in cases where it is desired to relieve the conditions of a medical problem, professional help should be sought.

Currently, the United States Food and Drug Administration (US FDA) recognizes only relaxation training as an accepted use of EEG biofeedback. All other uses are considered either experimental and unproven (depression, seizures, headaches, autism, tourettes), or nonmedical (general improvement in concentration and attention, and performance improvement). It is curious that, although ADD is clearly regarded as a medical disorder (an opinion that is being met with increasing controversy), the improvement of attention is not regarded as a medical treatment.

It is a fact that an EEG system designed to allow the user to control a computer for recreational, educational, or entertainment purposes is not a medical instrument. The FDA allows such devices to be produced and marketed freely, as long as they pose no undue health risk to the user. Vendors may even claim that the devices are fun, improve certain mental abilities, and can benefit the user. In this way, they are not unlike musical instruments or scientific hobby products (microscopes, telescopes, etc) that provide an indirect benefit by virtue of knowledge and discipline that they provide. However, if direct benefits are claimed for relaxation or relief from the symptoms of disorders, then the device is considered medical.

The BrainMaster system is provided in two versions, addressing both the medical and the nonmedical communities. When it is marketed for clinical purposes, specific claims are made, and these claims have been reviewed and cleared by the US FDA. Moreover, the BrainMaster is manufactured and marketed in compliance with applicable federal laws. In the nonclinical embodiment, most of the same functions and capabilities are present, but they are presented in the context of an educational and recreational device. It is nonetheless true that the actual benefits may be essentially the same in both embodiments depending on how the user configures and applies the device, although the labeling and claims are different. This is not unlike a scalpel being marketed on one hand for surgical use, and on the other hand for use in a science lab. The same instrument is being provided in both cases, but with different intent. Clearly, the difference lies primarily in the claims, and in the expectations and applications of the user.

The ADD/ADHD controversy

Although EEG biofeedback can be used to improve attention and concentration, and this can be considered as a personal improvement application, in cases of suspected or diagnosed ADD, the use of this procedure might be regarded as a medical procedure. It may thus be argued that neurofeedback treatment intended to reduce the symptoms of ADD, especially when the removal from stimulants (Ritalin, etc) is desired, that neurofeedback is being used in a medical context. However, if a parent, teacher, or counselor uses neurofeedback in a home or educational setting to educate a child on how to reach a state of relaxed attentiveness, that the treatment may be considered education, not treatment. Overall, our ignorance and prejudices regarding the brain and mind in general, and regarding ADD/ADHD in particular, severely compromise our ability to establish complete and consistent policies and approaches to these issues.

Major Application Areas

EEG Biofeedback is used for a variety of uses, too many to detail here. However, the most important applications currently include:

Nonclinical uses include mental fitness, peak performance, and personal awareness training. Examples are:

- Improvement of attention, concentration, and focus (increase low beta, beta, reduce theta)
- Improvement of relaxation (increase alpha, theta)
- Assistance with meditation (increase alpha, theta)
- Improvement of personal awareness (observe all components)
- Improvement of mental fitness (reduce all components)

There are many clinical uses, and certain practitioners treat a wide range of disorders and conditions. However, certain areas are finding widespread use. The clinical experience has been very encouraging, although systematic studies are still needed. The areas where EEG biofeedback is found helpful include:

- Relieving the symptoms ADD/ADHD (increase low beta, beta, reduce theta)
- Relieving depression (increase beta)
- Reduction of seizures (increase low beta, reduce theta, delta)
- Treatment for autism (increase beta, low beta)
- Treatment for tourettes (increase beta, low beta)

Choice of Electrode Locations

Choosing the electrode locations is a complex issue, and there are no hard and fast rules. However, it is clear that correct placement of electrodes is important. If electrodes are not placed properly, disadvantages can range from no effect at all, to negative effects of biofeedback training. The choice of electrode location depends on the individuals history and condition, thetype of training desired, the frequencies chosen for training, and the specific background and preferences of the investigator.

Certain basic principles have emerged, primarily through clinical experience, but also through some research studies. Few systematic studies of the effects of various electrode placements have been carried out. Nonetheless, research has proven the efficacy of certain placements, which have met with general acceptance. Some of the general principles are detailed here, and specific placements are described in the section on training protocols.

Monopolar vs. Bipolar placements

All EEG amplifiers are "differential," which means that they measure the signal taken between two inputs. The amplifier takes the difference betweenthe measurements, and amplifies the result. Therefore, all EEG measurements require two electrodes per channel. This is in addition to the need for a system "ground" electrode. Depending on how these electrodes are located on the head, either "monopolar" or "bipolar" recording is possible.

Each channel requires two recording electrodes, designated "active" and "indifferent" (or "reference"). If the amplifier provides separate connections for each channel, then bipolar recording is possible on each channel. However, some amplifiers only provide a single reference for all channels. In this case, bipolar recording is not possible for all channels.

For monopolar recording, one electrode (active) is placed on the designated scalp location, and the other (indifferent) is placed in a "neutral" location such as an ear. In this case, the indifferent electrode is located where there is little or no brain activity to record. The EEG recording is primarily a reflection of the brain activity beneath the active electrode.

In bipolar recording, both electrodes are placed on scalp locations, andthe EEG recording reflects the difference between them. Therefore, it reflects the activity in an area that is between the two sites. This provides a more accurate representation of the brain activity in a specific area, and is more sensitive to localized activity. For example, beta will be more pronounced using a biploar recording, and theta will be less pronounced, because it is a more widespread activity, and will be cancelled out by a bipolar recording.

Left vs. Right sided training

Generally, electrodes are placed so that a particular EEG channel is associated with one side of the brain. It is thus necessary to pay attention to which side of the brain will be trained. Although this is not an extensively researched area, certain guidelines and rules have emerged.

For example, low beta is generally trained on the right side (C4). A common placement is to use C4 referenced to the right ear (A2). Another common method is to use the vertex (Cz) referenced to the right ear. This is perhaps the most common training method of all, and it is found to produce improvements in concentration, focus, and overall organization. Generally, theta is inhibited, as low beta is being enhanced.

Another common protocol is to train beta on the left side (C3). This type of training is found to increase overall mental energy, concentration, and alertness.

Curiously, if these protocols are switched left-to-right, certain undesirable results may be observed. For example, training low beta on the left side can lead to depression and a lack of mental energy. Following such an experience with even a small amount (5 to 10 minutes) of left-sided beta training can reverse this effect, resulting in the restoration of mental vigor. On the other hand, right-sided beta training can have undesirable effects, of a different type. If an individual has tendencies toward antisocial, beligerent, or other negative thoughts or expressions, right-sided beta training can exaggerate this. The effects can be very pronounced.

It might be expected that the effects of lateralized training might depend on handedness, but this has not been extensively studied. It has been observed, however, that certain individuals respond better to the opposite side for training, and it may be necessary to experiment with a trainee to determinethe best plan.

There is an increasing trend toward training both sides simultaneously, usually with different settings. For example, training low beta on the right, while training beta on the left, can be used as a performance improving protocol. Generally, alpha, theta, and beta are suppressed on both sides. This produces a very selective form of training, and is finding widespread use for "peak performance" training.

Training of Specific Rhythms

All neurofeedback protocols are based upon reinforcing or inhibiting certain EEG components, either individually or in combinations. The simplest protocols involve training singular rhythms such as alpha or beta, with no additional constraints. This type of training was used during the early days of EEG biofeedback, and "alpha biofeedback" was very common during the 1960s and 1970s. However, it was found that these simple training methods produced nonspecific effects of relaxation and also possibly drowsiness or lethargy, without the ability to train the brain to enter specific states. The most notable limitation of the early alpha training was the inability to distinguish a relaxed alpha-only state from one in which the brain produced large amounts of both alpha and theta, indicating a deep, almost trance-like state. This lack of specificity hampered the ability to produce reproducible results, and earned EEG biofeedback the reputation of being a very nonspecific method, not very distinct from EMG or any other relaxation method.

Although EEG training is based on the concept of reinforcing or inhibiting specific components, it is not exactly clear why this works, or what is happening at the level of the brain. What is known is that certain rhythms are associated with subjective states, and with behavioral correlates. It is therefore believe to follow that training the rhythms will result in the achievement of brain states that are associated with the desirable attributes, and in which the undesirable attributes are reduced. However, any EEG component has both "positive" and "negative" aspects. For example, theta may be associated with distractability and daydreaming, but it is also associated with intuition, and a connection with deeper levels of conscio usness. As another example, beta waves are associated with focused, deliberate, logical thinking, but they are also associated with agitation and irritability. Therefore, an argument canbe made to reinforce or to inhibit any EEG rhythm at any particular time, and the choice of protocol is not a simple question of logic. It depends on the state and goals of the trainee, and the intentions of the trainer.

Another issue is the fact that while the presence of a rhythm may indicate a particular brain state, the absence of a rhythm is also indicative of a state. This is because the presence of an EEG rhythm indicates the synchronous, coordinated activity of a large population of brain cells, but this does not necessary indicate that this population is actively involved in any particular processing. For example, when the brain is engaged in active thought, alphais suppressed, because brain cells that are busy working independently, and are not available to generate the resting, "idling" alpha rhythm. Therefore, protocols that inhibit one or more rhythms are being developed, and found to be useful. This will be discussed later in conjunction with "squash" protocols.

During the last 10 years, the value of complex protocols has been well established. The most notable improvement has been the ability to increase one rhythm, while keeping another rhythm in check. Another improvement has beenin the ability to provide different feedback signals for the individual components, providing an additional level of information to the trainee.

In addition to using more than one component of a single EEG channel, training may also use two (or more) channels. In this case, two or more EEG amplifiers are used, and the recordings are made from different areas of the brain. The most common form of this is to use "bilateral" recording, in which the left and right brain are recorded separately, usually in a symmetric fashion (such as the Mind Mirror). However, other methods are possible, in which specific sites from different locations are trained, for specific purposes.

In dual channel training, certain "derivative" measurements may be used including synchrony, coherence, or combinations of channels. For example, one may train the brain to produce alpha, but may specifically reward synchronous alpha produced in-phase by both hemispheres. As another example, one may reward the production of beta in a specific area, while simultaneously inhibiting the production of widespread theta.

Choice of Protocols

The training protocol includes the choice of EEG frequencies that are reinforced or inhibited and which sites are measured, in conjunction with the plan for establishing and modifying training thresholds, and the arrangement of training sessions. There are a variety of standard training protocols in use, and it is possible to create an endless variety of protocols. The effects of training will depend on the choice of frequencies and sites, in conjunctionwith the setup of the sessions, how thresholds are determined, and the instructions and feedback provided to the trainee.

Low Frequency vs. High Frequency Training

There are two basic directions that EEG training can take. If low frequencies (alpha or theta) are reinforced, the training will result in states of relaxation as well as possibly focus, intuitive awareness, or deeper levelsof consciousness. At the extreme, low-frequency training can produce stupor, lethargy, or even trance-like states. In common training protocols, either alpha or theta (or both) can be rewarded, and the user may move into deeper and deeper states, producing both rhythms in increasing amounts.

High frequency training, on the other hand (low beta or beta) is employed to produce a state of alertness, organization, and a bright, externalized state of mind. Such training is usually done for shorter sessions, and sessions may be broken up into short (2 or 3 minutes) training runs, separated by brief rest periods, sometimes called "microbreaks". At an extreme, this training can produce agitation, irritability, and a very outward focus.

The following table summarizes some of the most notable differences between low frequency and high frequency training, and serves to distinguish them.

Characteristic	**Low-frequency Training**	**High-frequency Training**
Component(s)	alpha: (reinforced) relaxation, focus theta: (reinforced) takes to deeper level	beta: (reinforced) activation smr: (reinforced) organization theta: (inhibited) distractability
Goal	Deeper awareness	Balance, control, alertness
Level of Effort	Effortless, letting go	Effort, yet relaxed
Speed of response	Brain responds slowly, feedback can be slow	Brain responds quickly, to rapid feedback

Use of feedback	Primarily an indicator, an index	Want to "crank" thresholds & perform
Reward percent	Generally near 80%	Generally 50-60%
Type of feedback	Mostly "yes", some "no"	Mostly "no", some "yes"
Trainee context	Immersion into relaxed state	Tuning, improving brain
Application	Exploration/Recovery	Mental fitness
Brain Areas	Parietal, Occipital	Motor area
Modality	Auditory, trancelike	Visual, gamelike
Sessions	1/2 to 3 hour, no breaks	20-30 minutes, may have breaks
Relaxation	Total relaxation	Relaxation with muscle tone
Environment	Quiet, low lighting	Normal lighting & surroundings
Theraputic use	Deep seated issues, recovery	Attention, depression, other
Volition	Abandon volition	Has volitional element
Self-improvement	awareness, one-ness, growth	peak-performance
Eyes	Eyes closed	Eyes open
Crossovers	yes (from alpha state to theta state)	no
Increase	Look for increase 2x to 3x	Do not look for sustained increase
End state	altered state of consciousness	Awake & alert state
Spatial	widespread in space (brain)	localized in space (brain)
Followon goal	Experience altered state now & benefit later, but not reproduce state after training	Ability to produce this state after training, during daily life
Age	not done with children	children and adults

Choice of Session Plan

The neurofeedback session may be broken up in some manner to separate the the training intervals from intervals of rest and review of results. There are two basic approaches to this. Some systems automatically stop the training after a certain period of time (generally 2 or 3 minutes), to give the trainee a chance to see the EEG levels and scores on a display screen, and rest for a brief period. Thus, a 20 to 30 minute session would consist of 10 to 15 such periods. This serves to break up the training, making it less monotonous, and providing periodic feedback to the user. This method is generally used in conjunctionwith a training screen that the trainee is expected to focus attention on, with a concerted effort to achieve training points. Thus, the periodic breaks provide an opportunity to relax, in a situation in which sustained concentration would probably be very difficult.

There are other systems, however, that simply provide a continuous feedback screen to the trainee, and this is presented without pausing, for up to 20 or 30 minutes. During this period, the user may look at the feedback displays, read, think, daydream , or perform any desired task.

The use of microbreaks is becoming increasingly important as practitioners realize the importance of the concentration/relaxation cycle, common to high achievers. Basically, a high achiever learns to alternate brief periods of focused concentration with periods of relaxation, and is able to enter one or the other state, on demand. Generally, the shorter and deeper the relaxation breaks, the more effective the performance during the concentration cycle.

Adjustment of Training Criteria

There are three basic approaches to the adjustment of training criteria.We are specifically referring to the thresholds that re set for the components being trained, and whether these thresholds are changed. The three approaches represent two extremes of variability, and a middle ground.

At one extreme, the training thresholds are set once at the initial evaluation and training session, and are never changed throughout the entire training period, which may last for weeks or months. The philosophy is that these thresholds are appropriate for the trainee, and should not be changed. Instead, the user experiences the benefits of learning the EEG "skills" in the form of higher scores and the concommittant sense of achievement.

At another extreme, the training thresholds are changed semi-regularly, in order to maintain the user at a constant rate of reward. For example, the thresholds may be set every 1 or 2 minutes, so that the trainee is generally getting rewards a certain percentage of the time, such as 20%. The advantage is that the user is receiving a consistent rate of rewards, but is faced with a task of varying difficulty, in accordance with their abilities.

The middle ground consists of a plan in which the thresholds are adjusted at the beginning of each session, and kept constant during the session. The user is informed of their levels, and attempts to achieve a certain level of reward performance (for example, 1000 points), as the difficulty of the task is raised from session to session. This approach may also be used in conjunction withthe awarding of prizes such as toys or books, lending a tangible reward to the overall plan.

There is no conclusive research demonstrating the difference between these methodological approaches. As a result, methods are employed primarily on the basis of what the equipment provides (or dictates), rather than an objective choice on the part of the trainer.

Approaches to Auditory Feedback

In any biofeedback system, there is generally a visual or auditory form of feedback, so that the trainee has an indication of what is going on. This display or sound provides a indication of the trainee's internal state, andit is through the awareness of that state that the individual learns.

One fundamental issue in the feedback system is the timing of the feedback. Two issues dominate here. One is the speed with which the system can respond to changes in the EEG. This is a function of the sampling rate and the type of filtering used. Most systems use digital filters as opposed to FFT's because the FFT (Fast Fourier Transform) requires the desired signal to be in the middle of an epoch before it can be measured. This is because the signal is typically "windowed" with a tapering function such as a Hamming or Hanning window, that greatly reduces the signal amplitude near the edges of the epoch. This necessary to reduce an error condition known as "leakage" when signals at the edge ofthe epoch are truncated, producing false frequency information.

Typical epoch sizes are 1/2 to 1 second. Thus for a burst of beta to be in the middle of an epoch, 1/4 to 1/2 second must pass, after the signal appears. This intrinsic delay is considered excessive for practical biofeedback. On the other hand, a digital filter can respond within 1 or 2 cycles of a wave, and can thus respond to a beta wave within 100 milliseconds.

Most digital filters have a response "time constant" that indicates the rate at which the system can respond to changes. The time constant is a functionof the filter type, and the filter bandwidth. Generally, a wider bandwidth will correlate with a faster response time. Most useful EEG biofeedback filters have a width of 2 to 5 Hz, and can have a time constant between 20 and 100 milliseconds. This specification can be a useful indication of the responsiveness of the system.

Given that the system can respond to changes in the EEG, there are two possible indications. One is the visual or auditory indication that a change has occurred. These include displays such as waveforms and bargraphs, or soundssuch as proportional pitch. Well designed systems can provide extremely sensitive and informative feedback of these types, and these are helpful in teaching the trainee when EEG changes occur, and can also indicate their direction and magnitude.

The second timing issue is that the desired EEG signal must be sustainedfor an appreciable time before feedback rewards are produced. This prevents the system from responding to transient signals due to noise or brief EEG events that are not sufficient to warrant rewards.

In the design of a feedback system, several approaches to sounds are available. One is to play a given sound whenever a reward point is scored. This occurs when the EEG meets the reward "criterion," for example, to have the components within their acceptance range for 1/2 second. Another approach is to have a sound occur whenever any component meets its individual criterion. For example, one might hear one sound when there is alpha produced, and another sound when there is theta produced. Yet another approach is to have a proportional sound, such as the pitch of a tone, or the volume of a sound, as an indication of how much of a component is present. All of these methods are useful, and their choice will depend on the needs at hand.

When training with a complex protocol, such as enhancing beta while inhibiting theta, a single reward sound may be preferred, since is a single, simple feedback signal. As another example, if one is training for deep meditative states, and both alpha and theta are to be rewarded, it may be desirable to have a different reward sound for each type, so that the trainee gains the benefit of the additional information, regarding the details of their current brain state.

Approaches to Visual Feedback

There are two basic approaches to display screens. One is to provide accurate, up-to-date information regarding the EEG signal. Such informationcan take the form of the raw or filtered waveform, bargraphs or pie charts, line graphs, or similar displays. The benefit of these displays is that they are succinct, simple, and provide no-nonsense information that is often appreciated by the trainee. Even young children can find these stimulating and engaging, and relevant to the training experience.

The other approach is to provide "game" or other screens that are controlled by the EEG signals, but that provide the information in a derivative form. These include flying games, puzzles, faces, animations, and countless other displays. These have the advantage of being entertaining and engaging, thus securing and maintaining the attention of the trainee. It is sometimes found that a trainee becomes bored with a more mundane and down-to-earth display, and that a change of displays will reactivate their attention.

Despite the widespread use of both types of visual display, there is no systematic research to demonstrate which approach is preferable. It is largely a matter of the experience and tastes of the individual practitioner that determines which screens are desirable, and how they are used.

Some Common Plan

SMR (low beta) Training

SMR or low-beta training is a very common plan, and it is often used in the treatment of ADD/ADHD, seizures, or other disorders that indicate that the brain has trouble organizing its activity. It is usually done on the right side (C4), and sessions may last from 15 to 30 minutes. After an SMR training session,the trainee may feel relaxed yet energized, uplifted, organized, and efficient.

Beta Training

Beta training is a common method used for a variety of purposes. It energizes the trainee, and provides a very uplifting experience. There may be a significant "aha" experience when the trainee discovers the exact type of mental state that is associated with the beta production. Beta is often trained onthe left side (C3), although it can be trained anywhere. Possible negative side effects may include agitation, irritability, or a sense of being "hyper". Therefore, beta training sessions may be as short as 5 or 10 minutes. Often, a short period of beta training will be used at the end of an EEG session, to bring the trainee into a state of energy and alertness.

Alpha/Theta Training

Alpha/Theta training is often used to produce a state of relaxation. When theta is reinforced, it can lead to increasingly deep states of consciousnes, including contact with deep-seated thoughts and feelings. Alpha/Theta sessions can be quite long, extending to an hour or longer. As the session progresses, there is often a transition from a dominance of alpha to a dominance of theta ("crossover"). When the trainee spends some time in the theta state, they may be extremely relaxed, even stuporous or languid. It is often necessary to coach or counsel the trainee afterwards, to ensure that they do not leave in an excessively sensitive or internally directed state of mind.

Squash Protocols

Squash protocols seek to benefit the brain by teaching it to suppress the production of brain rhythms. The physiological rationale has to do with an understanding of the phenomena that produce measurable EEG energy. EEG waves are produced when large populations of cortical cells depolarize in unison, producing a significant surface potential. This synchronized behavior occurs at the frequency of the rhythm being measured, for example, 10 cycles per second for alpha activity. On the other hand, it is clear that much of the useful activity of the brain occurs when the cortical cells are not behaving in unison, but are acting individually. This is, in fact, the normal state of affairs when the brain is processing information.

Therefore, by training the brain to suppress EEG energy, we are reinforcing the independent behavior of the cortical neurons, as opposed to their synchronized, group behavior. It actually reflects some work when the brain stops producing EEG energy, and this reflects a desynchronized, hence active, state of affairs.

A squash protocol may be done on any part of the brain. However, certain practitioners perfer specific locations, such as the frontal areas, or the central area.

Mind-Mirror Type Training

This type of training is referred to by the name of a commercial productthat uses this type of display, but it refers to any training that uses a complete EEG spectrum as the display, and whose goal is self-awareness. It is often done with a counselor or coach who helps the user to understand and interpret the spectral display. Most EEG systems provide some form of complete spectrum in the display, and by learning to recognize the contours and shapes of the display, the trainee can gain an awareness of their mental states, style of thinking, and response to tasks or input.

But What do I Do?

Some final words may be helpful to the trainee who would like to know how to approach EEG training, in a practical way. It is part of our culture to think of ourselves as active agents, who "get things done" though our will and actions. However, we are discovering that the human brain and mind is more of a passive entity than an active one. Thought and growth are things that we experience, more than they are things that we cause. Often, they may even occur in spite of our attempted interventions, not because of them.

The general instructions used for someone undertaking EEG training may include "relax and let go," "let the computer tell your brain when it is doing the right thing," and "dont try, just let it happen". Many trainees experience an "aha" moment (or moments) during which they realize what is desired. Some may report, "Oh, that is what you want me to do". When asked what they did, they may say "I dont know how I do it, but I know when it is happening".

General Considerations

Perhaps the most compelling aspect of EEG training is that it confronts mind/body problem head-on. Scientists and philosophers have addressed the questions of what constitutes the mind, and what effects the mind may have on the body (and vice versa) for thousands of years, yet we are still not close to a concise understanding. Does the mind cause things to happen by virtue of its will, or is it merely an epiphenomenon of brain?

When we undertake EEG training, we provide the mind with information regarding the state of the brain. In working with this information, phenomena that are normally not known become known, and become subject to the learning mechanisms that the brain itself mediates. We do not understand the exact mechanisms by which the benefits of EEG training are achieved. They may involve the modulation of individual synaptic receptor cites, the reorganization of neural networks, or something as simple as the growth of vascularization inthe affected areas.

Whatever the mechanism, it is clear that learning via EEG training is not something that the trainee "does," but it is something that the trainee experiences. Surely, motivation, attitude, and the reinforcement of the therapist, teachers, family, and peers is important. These factors can be a deciding factor in the success of an EEG training program.