EEG SPECTRUM

EEG Biofeedback: Medicine, Therapy, or Learning?

Siegfried Othmer, Ph.D. and Susan F. Othmer, B.A.
June 1994

1) EEG Biofeedback: An Overview

There are three emerging trends within the field of EEG biofeedback. One branch is trying to gain legitimacy by proving itself within the terms of the traditional medical model. The second is focused on education: training the brain for enhanced performance. The third finds its roots in truly person-centered psychotherapy, with all its intrinsic complexity, and with the goal of a heightened sense of self and of personal autonomy. The field of EEG biofeedback got its start with Joe Kamiya, who was examining the physiological correlates of different states of consciousness. But the field continued, in its modest way, with a change of emphasis to disabilities: epilepsy and Attention Deficit Disorder (ADHD). These conditions are medically managed, and therefore the claims of biofeedback are being subjected to criteria more appropriate to medical interventions.

Some practitioners in the field came to realize that the techniques of EEG biofeedback had much to offer people who did not meet clinical criteria for any mental disorders. Mental capabilities could be augmented with the training in people who were manifestly quite competent. To this kind of training an education model is more appropriate. The association of biofeedback with medically recognized conditions is not particularly helpful in these applications, and in fact may even be somewhat detrimental, given the likelihood of a turf issue with respect to who may administer the training professionally where medical conditions are involved.

In support of psychotherapy, biofeedback is creating major tectonic shifts in the very areas which are most resistant to such ministrations: severe alcoholism, Post-Traumatic Stress Disorder (PTSD), Multiple Personality Disorder (MPD), and chronic pain. When the cases of severe alcoholism are looked at collectively, it appears that these are highly correlated with early trauma, such as child abuse. The same is true of MPD, and of chronic pain. EEG biofeedback is opening up opportunities of major reconstruction on the consequences of early trauma suffered by many children, and of severe threat or loss suffered in adulthood. This opportunity for recovery remains even late in life.

2) EEG Biofeedback: The Better Medicine?

New insights are accepted most readily when they add incrementally to our understanding and our belief system--enough novelty to arouse curiosity and interest; not too much to threaten what we already believe. For this reason, the use of EEG biofeedback for mental disorders would probably best be defended by analogy to medical approaches--if that were possible. But controversy roils. Many long-time practitioners feel that biofeedback will always be unfairly judged when it is seen from the perspective of the medical model. Others believe that the defense must be made on that turf in order to persuade those who need persuading, regardless of whether that places the technique at a disadvantage.

According to the medical model, the efficacy of biofeedback must be proved in controlled studies with respect to each individual canonical disorder. These disorders are treated as if they were all independent; proof for one says nothing about the other. Moreover, since EEG biofeedback is a physiologically based tool, it is argued that results must be proved with a physiologically based measure. It is not enough to get clinical results;

we must also see change in the EEG. And there must be a unique relationship of protocol to disorder; preferably a single, unique protocol for each.

According to the medical model, a person must meet "clinical diagnostic criteria" to legitimize use of the biofeedback "tool". Since the tool uses the EEG, there must be an observable "deficiency" in the EEG, correlated with the disorder, which is to be remedied. And the technique must in fact remediate that deficiency in the EEG before legitimacy of the technique can be accepted. Even if this strategy could be defended on its own narrow ground, and even if it resulted in the acceptance of EEG training by the dominant medically oriented culture, it confuses the essence of what biofeedback is about, and severely undervalues the technique in terms of its range of application. It perpetuates the patriarchal medical paradigm in which the repository of essential wisdom lies within the EEG or CAT scan or PET image, as interpreted by its elect acolytes, leaving the patient the tyrannized victim of yet another procedure. A single piece of hard data overrides the patient's own experience, behavior, and performance as having little or no import. By being even more effective than prior modalities, EEG training enhances the opportunity for health professionals to arrogate to themselves even more power over the individual.

It is increasingly recognized that the disease model of mental disorders has significant shortcomings. Disorder is inherently disorderly. Disorders are not easily compartmentalized by binary criteria: you have it or you don't; you are or you aren't. These conditions are measured on a continuum, with a somewhat arbitrary line drawn at the point where a person deviates too far from the norm. Every individual fluctuates over time, which makes divisions even more arbitrary and uncertain. These complications are particularly apparent in the case of Attention Deficit Disorder. One of the tools used to assess attention deficits is the computerized continuous performance test. On one such test, the T.O.V.A., (Test of Variables of Attention (Ref.), variability in performance over the 22-minute test is the most consistent indicator of a problem! This variability may be said to have a fractal property, in that it is similar on all time scales used to look at it. We also find that clean, single diagnoses are rare, particular in the case of attention problems. Children meeting criteria for Attention Deficit Hyperactivity Disorder are likely to also have Oppositional-Defiant Disorder (60%), anxiety disorders, depressive disorders, or Conduct Disorder (Biederman [1992]). This does not even consider milder conditions such as dysthymia, specific sensory processing problems, sleep disorders, elimination disorders, teeth grinding, addictive propensities, and Tourette Syndrome. With such a high degree of overlap of different disorders, is it not more correct to regard ADHD as intrinsically heterogeneous? Is "pure" ADHD not a researcher's fiction that serves his own research needs for an arbitrary limitation of variables? We grant that the category exists, because it can be defined to exist, and the set is not empty (researchers do find subjects), but it is largely non-representative of the clinical population at large. The manifest heterogeneity poses a problem to the disease model. We would like to shift the spotlight to the word disorder as being the central descriptor, and one which governs our thoughts with respect to remediation. There are indications that mainstream thinking is also coming around to the view that ADHD may be an intrinsically heterogeneous condition (Silver, 1994).

The heterogeneity posited above does not even deal with other neurological conditions that also have attention deficits among their symptoms, such as traumatic brain injury, birth injury, ischemic attacks in the elderly, and the consequences of immune dysfunction in women with silicone breast implants. In fact, attention deficits are ubiquitous among the disorders listed in the DSM-IIIR, even if they are not diagnostic for them. It may almost be said that when the brain is not well, it does not pay attention well. One could argue that many disorders of brain function be seen as deficiencies in the brain's ability to pay attention to itself. We have found that EEG biofeedback training is helpful generally with attention problems, even when they are traceable to various organic conditions.

3) EEG Biofeedback: Self-regulation Training

A larger and more fitting perspective for EEG biofeedback starts with consideration of the healthy brain, one which has the versatility to modulate arousal states and attentional styles as the immediate situation requires. The competent brain must be able to navigate at will all the way from high-vigilance states to restful respites, and from narrowly focused activity to broad and inclusive focus. In the disordered brain, this ability is diminished to some degree, or brain function is compromised by discontinuities in cortical processing, or breakdowns in intra-cortical communications. The EEG reflects first and foremost the state of arousal in which the individual finds himself. EEG biofeedback training, by favoring specific frequency bands, can "move" a person to a different arousal state in the general case, provided that the person is willing merely to "try to train". This is claiming no more than that a person can be changed in physiological state by temperature and EMG training, about which no controversy remains. We are simply using the more "central" information of EEG correlates of physiological states rather than peripheral measures. Moving a person to a different physiological state may benefit him in terms of the experiences he may have in that state, or in terms of an enhanced ability to navigate among different physiological states autonomously. Also, exercising the ability to maintain a particular state tends to reinforce and stabilize the mechanisms by which various states are maintained. These abilities need have little to do with pathology. In fact, these abilities are greater, and can perhaps be enhanced even more, in the more mentally competent person.

Whether someone derives benefit from the training therefore has little to do with any traditional diagnostic categories of mental disorders. The training accomplishes three essential tasks, in our view (for which a case will be made in what follows):

1) It enhances the ability of the individual to access and maintain different states of physiological arousal;

2) it enhances and supports the mechanisms by which the brain manages cortical hyperexcitability;

3) it reinforces equilibrium states, i.e. homeostasis.

With respect to the first, EEG biofeedback training enables remediation of disorders of arousal such as anxiety and depression; promotes entry into diminished arousal states of alpha and theta for therapeutic objectives or experiential forays; and increases the inventory of attentional states (from narrow to broad focus). EEG training makes a unique contribution here, insofar as traditional biofeedback approaches have tended to address mainly conditions of overarousal and adverse stress reactions such as anxiety, hypervigilance, and panic disorders (all typically lumped under the rubric of "stress management", a term which the medical establishment has allowed biofeedback practitioners to use in order for the technique to appear innocuous and of marginal significance). EEG training also addresses conditions of underarousal such as genetically based (endogenous) depression and that which results from trauma (reactive depression) with equal facility. The efficacy for ADHD can also be seen in terms of remediation of an underarousal condition.

With respect to enhancement of stability conditions (2), we can identify several degrees of instability for our purposes: In the most extreme case, EEG training stabilizes the brain against chaotic excursions into pathological states such as seizures, rages, and migraines. Secondarily, it stabilizes the brain against more minor excursions which manifest themselves in such phenomena as temper tantrums, night terrors, vertigo, sub-clinical seizures, ordinary headaches, motor and vocal tics, obsessive-compulsive behaviors, episodic dyscontrol (out-of-control behavior such as rages), panic attacks, bipolar disorder, and PMS. Thirdly, it stabilizes the brain against the even lesser disruptions and discontinuities of cortical function which manifest in disturbances of attentional mechanisms, of sequential and parallel processing, of visual and auditory processing and memory, of other specific learning disabilities, and of the normal sequence of sleep stages.

With respect to reinforcing homeostasis (3), the training can achieve normalization of the pain threshold, normalization of appetite, and normalization of the blood glucose level. The stabilization of arousal level already discussed in 1) above can also be viewed as a return to homeostasis. The best evidence of the power of this tool may be seen in the fact that clients are liberated from dependency on all types of medication which modulate arousal, including anti-depressants, stimulants, sleep medications, pain medications, and anti-anxiety medications, including those we select ourselves, such as alcohol.

When EEG biofeedback is tried by the mentally competent person, he augments his natural mental skills and his range of control further. What is this worth? That is not for us to say, but we can provide information about choices to the person training, and let him make that decision. Biofeedback, at its best, is empowerment of the individual. We are simply the agency of that empowerment. An analogy may be useful here: When Klaus Tennstedt was first offered the opportunity to conduct the Vienna Philharmonic, he was asked by a reporter:

"I guess you won't have to rehearse very much with the Philharmonic?"

"On the contrary", came the reply, "with that instrument at my disposal, just think of the possibility of refinement, of nuance, that is not possible with ordinary orchestras. We will rehearse more, not less."

Thus with EEG biofeedback.

EEG biofeedback training, when done well, takes into account the heterogeneity of the candidate population and adjusts the training appropriately. In the case of all generalized diagnoses such as depression or ADHD, we must assess who the person is who has been so diagnosed, and we must characterize the individual in terms of patterns of physiological arousal and attentional style. We must know his family and genetic history, and any history of trauma. Out of all this comes a preferred starting training protocol. This initial approach is tried during the intake session. We then teach the individual to observe himself so that he can be a witness to the impending changes. At the next training session, we ask about the results which have been achieved. In at least forty percent of cases, the person will have something to report which is clearly traceable to the training in that first session: sleep may have changed; mood or irritability may have changed; alertness and school behavior may have changed. This allows us to judge within three training sessions (in most cases) that we are on the right track; otherwise we change protocols. The multi-dimensional assessment we do on a session-by-session basis is the home turf of the qualified psychological or educational professional. Success is also aided by an informed, self-aware participant, who in fact ends up bearing the primary burden for a successful outcome.

It is apparent that EEG training can confer both specific benefits for certain deficits and generalized benefits for mental functioning in terms of alertness, attention, vigilance, and physiological arousal. Whereas these benefits are most striking in those who have the most obvious deficits, they are also discernible in those who are functioning adequately already, and who find their mental skills, the brain's energetic reserve, and their emotional resilience enhanced. The fact that EEG biofeedback training remains optional for such folks does not detract from the intrinsic significance of this claim. EEG training should be seen as education of the brain, and the brain that is more highly capable of learning is in fact in a better position to take advantage than the severely disabled brain. As we move in the direction of peak performance, however, we gradually lose our moorings in terms of our ability to monitor progress by conventional tests. We move even more in the direction in which the trainee himself perceives that he is functioning better in his life, or is managing his challenges better. A mountain climbing analogy comes to mind. At the outset, the instructor leads the climb, and the student follows. Ultimately, the student leads the climb, and the instructor follows.

4) Proving validity of EEG Biofeedback in the Medical Model

In the present climate, in which a predominant medical paradigm still clings to the notion that disorders are essentially hard-wired and therefore intrinsically immutable, part of our biofeedback community feels compelled to legitimize itself by conforming to the traditional medical model. They seek to show that a one-to-one correspondence exists between specific disorders such as ADHD and specific parameters in the EEG, and that these specific parameters change with training in a predictable way. This certainly has not been shown to be true, and it may not even be true.

Numerous studies in the past have shown a correlation between ADHD and EEG anomalies. This does not mean, however, that such data have significant predictive power. Currently, such EEG studies are performed with brain maps, or quantitative EEG (QEEG). Here the EEG activity is measured for a variety of cortical sites concurrently, and analyzed in terms of the amplitude distribution over the range of EEG frequencies. The most recent definitive study of the QEEG phenomonelogy of ADHD was performed by Chris Mann et al., who found that if all the EEG data was taken collectively from baseline, reading, and drawing tasks, a false negative rate of 20%, and a false positive rate of 26%, could be achieved. With a prevalence of ADHD taken to be 10%, the positive predictive power of the EEG, making use of Bayes' Theorem, is only 0.37. Others claim that a single EEG parameter, the ratio of EEG amplitudes in the theta and beta domain, is predictive of ADHD as well as being predictive of who may be expected to respond to the EEG training. This claim is contradicted by Mann's findings, in that he avers that baseline data is not by itself predictive of ADHD. How much less, then, would be the predictive power of only a single parameter derived from baseline measurements.

There is a certain internal logic to the proposition that EEG parameters should be diagnostic which requires that they also be uniquely predictive of a protocol, and that they should be able to define the successful end-point of the training. If the QEEG or the theta/beta ratio were only able to predict membership in the ADHD cohort, this would in itself be only marginally useful clinically, since the protocol varies depending on the existence of comorbidities, and also depending on the ADD subtype, i.e. whether it is primarily a problem of behavioral disinhibition (ADD+H), or whether it is primarily a problem of attention and vigilance (ADD-H). No single EEG parameter can embody such predictive power, and evidence has simply not been adduced to prove the case even with a with a full QEEG.

With respect to predicting outcomes of the training on the basis of EEG phenomonology, this is even more fraught with potential error. The EEG amplitudes in specific bands may be influenced not only by cortical activity within that band, but by Fourier components of signals whose fundamental frequency is either higher or lower than the band of interest. Hence, EEG amplitude in the training beta band may either increase or diminish with training, depending on the magnitude of such "poisoning" of the signal. We looked over our data several years ago, and we found in reviewing 167 client files that more than half changed in the "wrong" direction in terms of theta/beta ratio over the course of training, quite irrespective of progress made in the training. The fact that most of the clients did not change significantly one way or the other is perhaps the most significant finding. We don't preselect clients for high theta/beta ratio at the outset, and so these results should not be surprising. We do observe a trend toward normalization of the EEG.

This issue is important because a misunderstanding of EEG phenomenology caused this field of EEG biofeedback to be derailed once before. In Barry Sterman's work on epilepsy, which was conducted on cats, a distinct rhythmic burst of EEG activity, a spindle centered on 14 Hz, was observed at sensorimotor cortex, the primary sensory processing area for inputs from the periphery (skin, etc.) Sterman trained cats to enhance this activity, and

found an impact on sleep, and on seizure threshold. The same effect was observed on humans, and it was assumed that that would be accompanied also by enhanced brainwave activity in the training band around 14 Hz. Unfortunately, the human EEG differs from the cat EEG in a significant respect: it does not show such 14 Hz bursting activity in the waking state. Instead, the EEG of the waking, alert human brain is desynchronized, and any coherent neuronal activity which may be present is "buried" in this noisy, desynchronized EEG. All efforts to replicate Sterman's work which hewed to his protocol, without any exception, found reduction in seizure incidence, as did Sterman. None of them found the increased spindle activity at 14 Hz which they thought they were training for (Sterman himself found changes only in the sleeping brain, where recognizable spindles do occur at around 14 Hz in Stage 2 sleep--private communication). Hence, the hypothesis was rejected. Gains in seizure incidence were ascribed to some non-specific effect of the training, and the baby was thrown out with the bath water.

It is now apparent, many years later, that the training exercises a "mechanism" operative at this frequency, and that the expected EEG outcome is "normalization of the EEG", not the development of a peak in the EEG spectrum at 14 Hz, which would be uncharacteristic of the human EEG. We may train operationally to increase EEG activity at 14 Hz, say, but this is merely a way of challenging one of the brain's essential control loops. Putting the brain in better control then yields a more appropriate EEG, which in the alert and attentive state means a desynchronized one. Hence, the outcome for the EEG does not follow simple-mindedly from the training protocol. We are now, twenty years later, in danger of falling into the same conceptual trap that sidelined Sterman's epoch-making work.

The biofeedback training protocol which has been used most extensively for epilepsy by Sterman is SMR training (12-15Hz) around C3 at sensorimotor cortex. This has been true irrespective of any seizure focus elsewhere on the cortex, and irrespective of the nature of the seizure; yet the training has been effective. Similarly Lubar has used fixed protocols for ADHD for most of the research on ADHD to date. And Michael Tansey's use of a single protocol assumes that he is addressing an underlying mechanism as well. Very little evidence has in fact been brought forward that the objective should be altered to one of specifically training away the EEG anomalies, with the direct objective of eliminating quantitative deviations from QEEG norms. The strongest case for using brain map data to guide the EEG training can be made for those instances in which we have localized injury, as in seizure disorder, traumatic brain injury, or stroke. Even here, the historical data demonstrates efficacy for training a mechanism, rather than training tailored specifically toward suppressing EEG anomalies. No doubt additional and important gains are to be made by training at the location of the deficit, as determined by EEG data or other means. We use brain mapping in these cases ourselves, and have found the data very informative. We have also seen a number of instances in which the prediction of protocol on the basis of EEG data alone led to inappropriate choices.

One of the unfortunate plagues that the field of psychology visits upon itself is an envy of physics, a yearning for the provable fact, the hard number. This tyranny of numbers is unfortunate, since the faith is so misplaced. The hope that the quantitative EEG will finally provide the rigorous underpinnings for psychological interventions is so compelling that it will be pursued beyond all reason. To this, one must add the deferential posture the psychologist bears before medical authority, before medical research procedures, and especially before the disease model of mental disorders. And finally, one must lament the deferential posture the clinical psychologist bears before the academic research professional. At its best, psychotherapy is integrating and inductive in nature, and therefore contrary to the reductionist propensities of research. Why is the clinical psychologist defensive? The researchers are still arguing among themselves whether recovered memories are real. Rats don't help you answer that question. The truly interesting phenomena in clinical psychology are not reducible to researcher's categories. It would be tragic indeed

that in our attempt to prove validity to a skeptical medical community we find ourselves defending propositions which are in fact indefensible.

We also deal with many conditions that are not associated with any known features in the EEG. A particularly good example is PMS, where we have observed dramatic recoveries from lengthy histories with PMS syndromes. The protocol we have used is essentially the same in all cases of PMS, regardless of what the EEG looks like. And most of the EEGs in fact look fairly normal. There is no known EEG correlate of PMS. One may be found eventually, but we will not discontinue our successful intervention to wait for that day. If the training works, we don't need a manifest EEG anomaly to justify our intervention. Many modalities are in use for which the mechanism remains obscure. It is quite generally true that clinical progress drives research, not the reverse. No apologies need be made. These observations are more evidence that we are training a brain mechanism; we are not training overtly to normalize the EEG, even though that may be an outcome.

Not even neurologists abide by the strictures to which our besieged EEG biofeedback practitioners feel themselves bound. Would neurologists support diagnosing epilepsy on the basis of the EEG alone? It may be surprising to know that they do not. If children's EEGs were to be measured to see who might be epileptic, an enormous number of false positives would be identified. And if a normal EEG is seen in a child with a manifest seizure history, the neurologist will not let the EEG override the behavioral phenomenology. According to George B. Murray, authority on complex partial seizures at the Harvard Psychiatry Department, "The EEG manifestations of complex partial seizures do not usually appear with Cartesian clarity.... The scope of the EEG manifestations can be as broad as the entire field of EEG" (Murray, 1981). This is not auspicious for a diagnostic. Further, the neurologist would not determine which anti-convulsant to use on the basis of the EEG. Most of all, he would not quit using the anticonvulsant just because it failed to result in normalization of the EEG! In fact, most anti-convulsants have only a minor, if any, influence on the EEG. And Ritalin has no effect at all on the EEG of ADHD kids! The irony is that if the administration of Ritalin were governed by these restrictive standards, there would be almost none prescribed! By setting EEG standards for the practice of EEG biofeedback, we are not preparing the ground for acceptance by the medical community as much as we invite its ridicule.

Worst of all, an infatuation with EEG anomalies--of which only the most extreme are identifiable by current methods--constrains the field to an unfortunate focus on pathology. This focus is not all bad--that is how most of us make our living. But many of us see the larger potential of EEG training for the already competent or functional brain: to the "gifted but learning-disabled" child; to the highly successful engineer who now snores heavily at night and exhibits sleep apnea episodes; to the corporate executive who would rather nap in the afternoon than face his schedule; to the gifted artist whose knees turn to butter during auditions, or whose hands turn sweaty during piano recitals; to the pentathlete who needs to calm himself rapidly to fire his weapon after running or skiing; to the long-distance shooter in basketball who cannot get himself out of a slump; to the writer whose creativity is undone by too much alcohol. There is no framework for this which is consistent with the medical model.

The field of medicine insists that any new approach must be validated by controlled studies in which neither the researcher or the subject is influenced by extraneous factors beyond the therapeutic agent being tested. Hence, both researcher and subject must be "blinded" with respect to what is happening to them, to eliminate subjective effects and tester bias. Also there must be controls, in order to further validate the "neutrality" of the test itself, and to measure placebo effects. One significant problem is finding control groups for many of the conditions we work with: cerebral palsy, traumatic brain injury, stroke, and epilepsy. The patterns of deficits in these cases are unique to the individual, and not

uniform over a larger group of subjects. Even with ADHD, where control groups are at least possible, they usually are defined narrowly, which leaves out most of the interesting cases, namely those which also involve other learning and behavior problems.

A more basic problem is that of maintaining subject and researcher blindness. EEG training cannot be done without intelligent guidance by the therapist, who must set reward eriteria and monitor progress for the purpose of any mid-course corrections in terms of protocol. The subject is clearly part of the process, and is actively engaged in it. He cannot be blind to what is happening, since this is a learning process, not a unique way of infiltrating a better drug. Attempts are sometimes made to give the individual someone else's EEG to train on. This is called "sham training". Unfortunately, the subterfuge is too easily discovered. And the changes with the training are too profound to be ignored. Soon everyone knows it's real, and can discriminate between that and the sham training. The problem is similar to the one encountered in China, when they tried a controlled study of the presumed health-giving effects of the garlic. It was obvious to everyone who was getting the real garlic, and who was getting the fake stuff!

Hence, the only kind of biofeedback which can be successfully tested in a sham protocol is bad biofeedback in which the person is oblivious to his own active involvement. And the only clients you can do it with are the compliant ones who will do anything you ask. That leaves out young, hyperactive children. The only way these children are able to participate at all is that they quickly grasp the connection between what is going on on the screen and what is happening in their heads. A video biofeedback game may hold their interest for a few minutes, but that novelty wears off. What holds them hour after hour is the process itself. You cannot fake that.

The second approach recommended for controlled studies is A-B reversal designs. This poses a different methodological problem. Biofeedback cannot be "withdrawn" or "reversed" in the B-phase in the same manner as medications. It is learning, after all. And you cannot ask the brain to unlearn any more than you can unring a bell. One of the persistent and recurring lessons of this field is that once the brain has achieved a higher state of stability through EEG biofeedback, it tends to be self-sustaining until disrupted by further insult to the brain. The brain quite naturally reinforces those strategies which it has found to be successful. Concern about back-sliding, once the brain has consolidated its gains, is largely overdone. The early success achieved in reversal designs by Sterman and Lubar were likely due to the fact that the reversal phases were introduced early, before learning had significantly consolidated.

There is an even more fundamental methodological problem with controlled studies of EEG biofeedback. The key driver for such studies of drug efficacy is not merely to control for tester biases, but rather to distinguish the real effect of the drug from the ever-present "real" placebo effect, namely the subject's physiological response to the proverbial "sugar pill". Ullman and Sleator (1986), in a double-blind placebo-controlled crossover study of Ritalin, found 18 subjects (out of 118) who made 50% improvement on teacher rating scales with a placebo, which matched their improvement on Ritalin. On the basis of this finding, they recommend that all children considered for medication be tried on a placebo first. The "real" placebo effect is so strong that the best medical studies incorporate a placebo washout period to identify the placebo responders before the subjects are assigned to treatment and control groups. Evidence of the body's own healing response is marbled throughout medical research. It is the skeleton in their closet. It is the noise in their system.

The conceptual confusion embodied in the placebo effect is made pointedly clear in the study by Quy et al., intended to replicate Sterman's work with epilepsy. After dismissing the efficacy of Sterman's protocol, Quy postulated several other options, which included spontaneous remission, the placebo effect, and general attention training. The question arises,

how does one meaningfully distinguish between the hypothesis of spontaneous remission and placebo effect? How does one distinguish general attention training from the specific attention training that might be accomplished by the SMR training? The categories "spontaneous remission" and placebo effect have historically been used simply to differentiate the effects of medical procedures from all other possible responses by the subject. They are categories without content. Indeed, spontaneous remission assumes an effect without agency, which is not subject to scientific investigation. The term cannot be used to differentiate between different kinds of self-healing because it has no observable attributes! The survival of this totally unscientific concept of spontaneous remission into the scientific discourse of the present day simply testifies to the woeful lack of interest by our medical establishment in the mechanisms of self-remediation.

Self-healing is what biofeedback is all about. For us, self-healing is signal, not noise. Why would we want to control for it? Are there good and bad kinds of self-healing? Biofeedback is not something we do to a person, it is something the person does to support and strengthen his own brain's intrinsic competences for self-regulation. The only burden on us is to determine whether learning is in fact occurring, and we do that by testing.

5) Proving validity of EEG Biofeedback in the Education Model

If we shift our perspective on EEG biofeedback and regard it from the standoint of learning and education rather than curing a disease, efficacy can be established the same way we evaluate all learning, namely by testing performance. This approach also allows for a measure of control of researcher bias, in that one can have the testing done independently. This we have done in all of our studies. Whereas testing is the way in which we should measure progress and prove ourselves to the rest of the world, the biofeedback therapist does not have to wait for post-training test results to confirm that something has been accomplished. Again, if good feedback is being given, such confirmation comes on a session-by-session basis, as the client (or the parent) reports the changes he observes. Nothing we have learned to date about EEG biofeedback was initially established by controlled studies. It was and remains simply a matter of good, skilled observation. Controlled studies are best used to validate what has already been demonstrated clinically.

Focusing on EEG biofeedback as an educational tool completely changes the terms of debate. For example, teaching one chimpanzee sign language says something about the capability of chimpanzees. No one would insist that we now do a double-blind and controlled study to rule out the possibility that we were misled, or that we happened upon a chimp with unique gifts. In fact, we don't use such studies to prove the ability to learn in any respect whatsoever. When a yogi was able to survive for several hours in an air-tight refrigerator without depleting the reservoir of oxygen (an experiment which would have killed anyone not so trained), he demonstrated that he had learned to regulate his metabolic rate. We don't need the evidence of hundreds of yogis to persuade us when one will do nicely. It is a matter of perspective whether one regards this finding as being of marginal significance or central. Western medicine has always regarded it as marginal. We regard as central to what we contend: man can learn to modify his physiological function.

The education model of EEG biofeedback also dispenses with the canard of the infamous "placebo". Whereas drugs have to be proven to be "better than placebo", that does not apply to learning. If learning has been demonstrated, no one would aver that the event occurred by virtue of a placebo effect. In other words, each instance of learning counts. We don't have to meet a statistical standard. Let me cite another example. Parents brought a child with cerebral palsy to one of our offices in a stroller. He was 2 1/2 years old, and had "never expressed any interest in his legs", according to the parents. After a mere ten training sessions, he was walking from one side of the waiting room to the other. Learning had occurred. Now it would be churlish to insist that we must succeed in this at least 75%

of the time before such an approach would be considered of interest. People line up for fertility procedures which have a demonstrated success rate of two percent, and they pay good money for them.

6) EEG Biofeedback: Pathway to Peak Performance

Many are startled by the broad claims that we and others have made for the EEG training technique. Our objective was to compel the professional community to break out of compartmentalized thinking, to shift from a fixation on specific disorders to a focus on process. Nevertheless, it is the number and breadth of claims with respect to various disorders that elicit skepticism, and the message about process may be getting lost. I daresay that everything we have claimed to date will eventually be confirmed even by the standards that others may set. Even now, however, all the individual "claims" are mutually supportive of the underlying message of brain "responsivity", and of biofeedback as an effective tool for eliciting it. The essential message is that the biofeedback training, seen as a tool with general applicability, should have a favorable impact on a variety of mental disorders which have the common elements recited previously: lack of control of arousal level; lack of flexibility of brain state; and diminished cortical stability. (We make no claims for all the others.) Moreover, with respect to the hope we hold out to people in these regards, the watchword is progress, not perfection; remediation, not cure.

Barry Sterman did not discover some unique feature of epilepsy which allows it to respond to his protocol. Joel Lubar did not discover some idiosyncratic feature of ADHD which renders it susceptible to remediation by training. And Eugene Peniston did not discover a unique characteristic of alcoholism that causes it to yield to our ministrations. They all discovered aspects of the intrinsic plasticity of the brain, its ability to learn about itself, which is one of its most basic capacities. The first person to appreciate the generality of the method was perhaps Les Fehmi, who found that the entire enterprise of EEG biofeedback could be understood in terms of how the brain pays attention. Significantly, he is able to elicit similar transformational experiences reported for biofeedback through verbal channels, by employing only the language of attention. By teaching the brain the skill of paying attention, either verbally or by biofeedback, it moves autonomic function ineluctably toward a condition of homeostasis.

Without a doubt, the research of Joe Kamiya and Les Fehmi, and the controlled studies of Barry Sterman and of Joel and Judith Lubar were necessary to establish the field. Without them, progress in this field would have been much delayed, perhaps by a generation. However, once a new paradigm is established, inductive methods may be more fruitful. After twenty-five years, Sterman has done biofeedback research only on epilepsy; and after twenty years Lubars have worked only with ADHD. Building on what has been done, clinicians are now expanding the field with a necessarily more comprehensive vision, and are discovering how all of these findings connect.

This larger view of EEG biofeedback is not "revealed truth", and it is not innate wisdom on anybody's part. It has compelled itself on clinicians by virtue of results that were being obtained with clients. If one is doing EEG biofeedback well, these results happen. They are not always favorable. However, if undesirable results are being obtained, they simply call for redirection of the training strategy. We educate the client to anticipate a range of results. When these results are experienced, the client reports them, and we make mid-course corrections where required. Gradually we proceed from dealing with the most egregious symptoms to the more benign. The client progressively learns about himself, and is thus empowered.

The EEG training is a matter of increasing the person's competence sequentially and incrementally. An analogy I find amusing is to increasing the "flight envelope" of an

aircraft: higher ceiling (peak performance); higher g-turns (stress tolerance); and lower landing speed (ability to relax from a vigilant state). This does not entail a single approach, but usually several. As key issues are resolved with a particular protocol, subsidiary issues come to the fore. They will usually require a different approach. When the training is done well, the brain wants this new competence.

An example of work toward "peak performance" may be helpful. A successful insurance executive came to us regarding his son, who needed our help. Once he understood what the training was about, he became interested for himself as well. As he watched the EEG parameters dance before his eyes, he noticed that he had difficulty mastering a particular challenge, one having to do with anxiety. The more he tried, the worse it got. Being a man used to bending the world to his will, it was intensely frustrating to be confronted so ineluctably with his failing. He learned that he needed to "back off" a little, and "allow" the anxiety measure to subside. He could not force it.

He then realized that this had relevance to his skeet shooting, where he was very competitive. Once he missed a skeet, he would become anxious, and would do worse on subsequent pulls. His performance would spiral downward relentlessly. Being aware of the pattern, there was no solution but to maintain a perfect score. Once he started missing, he would anticipate the pattern of subsequent failure; anxiety would set in, and he would of course then continue to miss targets. After he achieved mastery over his EEG in the comfortable setting of our office, he was then able to handle the challenge of failure in his skeet shooting. He later reported to us that the training was helping him master many professional challenges as well.

7) EEG Biofeedback in Support of Psychotherapy

EEG biofeedback has been shown to remediate addictions such as alcoholism. In this application, it has essentially no competition. The conventional approaches to alcoholism have an abysmal record. Much of alcoholism can legitimately be seen as self-medication for anxiety conditions. The brain ultimately adapts to the regular alcohol infusion and becomes dependent upon it. The same thing happens with prescription anti-anxiety agents. If anything, these are more highly addictive even than alcohol. EEG biofeedback is able to remediate the underlying anxiety condition, and to allow the individual to recover appropriately from his dependency. Dramatic clinical findings are also being reported for use of EEG biofeedback with PTSD, chronic pain, and MPD. These conditions have been largely refractory to medical intervention, and intransigent to conventional psychotherapeutic modalities. One is tempted to venture the generalization that wherever the field of medicine takes an expansive view of its role in mental health, we evidently have a self-regulation alternative. In the work with addictions, there appears to be a division between populations in which the chemical dependency is mainly physiological, and in which the addiction is maintained as a self-medication for deep psychic trauma, perhaps dating from early in life. In the latter case, training toward lower EEG frequencies, corresponding to states of reduced arousal, of decoupling from the outside world, and of internal focus, appears to have a special healing quality. In these states, which are alpha- and theta-dominant, there is opportunity for the wounded, non-verbal right brain to be heard without the censorship of the verbal left. Imagery relating to the prior trauma may surface, and may now be viewed from the perspective of the mature and adult brain. The underpinnings which sustain the addiction may be dissolved. The transformations observed in the course of such training are profound.

The same training may also have striking impact on those who have no addictive propensities. The training at low EEG frequencies has an integrative function which persons usually experience as a feeling of intense well-being. The training is anchoring in its effect, and it trains us in those momentary respites of relaxation that come between bursts of high

demand activity. The brain, at its best, performs effortlessly. As Les Fehmi has taught us, we have really learned a task when we can do it in alpha. The training is a counter to our natural societal tendencies toward narrowly focused activities. Training the brain for peak performance is not complete unless the person can also readily navigate in alpha.

In addition to training brain competence, the experience of low arousal states often is accompanied by major personal transformational shifts. We observe that the individual undergoing such transformations almost invariably sees the shift as toward his essential self. The transformations are not random or chaotic, and therefore need not be anticipated with dread and uncertainty. The training creates the environment for an encounter with one's essential self. This is soul work.

It is ironic that a person like Elmer Green, schooled as a physicist, should not feel embarrassed about using terms like "soul", or "subtle energies", and that a hard scientist like Francis Crick (also first trained in physics) should seriously concern himself with theories of consciousness. These matters embarrass psychologists steeped in behaviorism and still trying to be like physicists. The century started out with the exuberant claims of A.J. Ayers' "Positivism" that the only phenomenology of interest to scientists is that which is objectively measureable. The physical sciences experienced the humbling reality of a quantum mechanics which poses fundamental limits to our knowledge (the Heisenberg Uncertainty Principle) and resists fully deterministic interpretations; of chaotic systems that frustrate firm predictability, and of complex systems that give rise to emergent properties that are scale-dependent. By the end of the century, we have come face to face with phenomena that we know exist, and which should therefore be explored, but which are not conveniently measurable. Science is maturing to the point at which it is willing to enter the new terrain unabashedly.

Surely the perception of consciousness, or soul, is as real as the perception of pain, and equally resistant to quantification and concrete observation. Clearly the brain manages itself along with the rest of the body. Awareness of self is merely the complement of awareness of outside stimuli; at a sufficient level of complexity, the fusion of self-awareness with a perception of self-interest (self-preservation, self-propagation, etc.) becomes what we perceive as consciousness. Insofar as biofeedback increases the range of information the brain has about itself and can act upon, we are enhancing the scope of consciousness. At its best, psychotherapy nurtures the soul. Biofeedback is its physiological complement.

8) Summary

Three views of EEG biofeedback have been presented. One is oriented toward the remediation of pathology, based on established clinical categories of disorders. The second is based on increasing the competence, versatility, and stability of the brain generally. The third employs EEG biofeedback as augmentation of psychotherapy, and as a tool for discovering our essential selves.

The orientation toward mental disorders portends trench warfare against the prevailing medical establishment, disorder by disorder, drug by drug, and it promises contentious interactions with other health disciplines who consider their turf invaded. An orientation toward a general increase in brain competence and self-regulation is more appropriate to the underlying phenomenology, avoids the compartmentalization of mental disorders, and opens up the promise of benefit to the many who do not meet clinical criteria for "disorder" but can still manifestly be helped by the training. It augurs in a time of focus on health and peak functioning rather than on disease and disorder; an orientation toward education rather than toward treatment. It establishes a new modality which is congenial to those already trained in the field of clinical and educational psychology. It particularly avoids the turf issue (vis-a-vis M.D.'s) of whether psychologists shall diagnose mental disorders on