REMEDIATING PTSD WITH NEUROFEEDBACK

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EEG Institute
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HOMECOMING FOR VETERANS

A national outreach program to provide **Neurofeedback** to veterans and active duty service members for the rehabilitation of **Post-Traumatic Stress Disorder** and **TBI**.

REMEDIATION OF PTSD SYMPTOMS
Using Neurofeedback Training
with Active Duty Service Members and Veterans

by Siegfried Othmer, Ph.D.[1]

We are currently experiencing a breakthrough in the remediation of Post Traumatic Stress Disorder (PTSD) through neurofeedback training. With our own best efforts, and growing support from the clinical community, this will ultimately resonate through the military as well as the Department of Veterans Affairs, as the campaign continues to grow. The strongest evidence for this new approach in fact comes from within the military itself. By now more than 350 service persons have experienced neurofeedback at Camp Pendleton, one of six military bases where this work is being conducted. So these new methods are already being field-tested in real-world situations. Specifically, we are talking here about neurofeedback based on the slow cortical potential, what we refer to as Infra-Low Frequency (ILF) Training. This method belongs in the larger field of biofeedback, which has many related applications in the realm of neurophysiological dysfunction that are already well-established.

Evidence has been accumulating for some years now that by utilizing EEG-based training instead of conventional biofeedback, favorable outcomes in the alleviation of brain dysfunction are more comprehensive and are achieved more consistently. This appeared to be particularly true of PTSD, even based on a small number of original cases in our clinic. With the benefit of larger numbers, a firm picture finally emerges. Consider just one critical symptom, namely suicidal ideation. Surveying the cases tracked to date, it appears that suicidal impulses subsided in every case where it had been an issue. As the number of cases continues to grow, this is a highly significant observation at a time when we are losing some eighteen veterans per day to suicide.

Although we had seen exceedingly rapid response to neurofeedback before, the larger numbers being treated through our pilot programs on military bases and individually through our network of neurofeedback clinicians now allow us to judge that some 25% of trainees obtain substantial symptom relief for all their PTSD symptoms in only a small number of sessions (< 10). Some 50% respond at a more moderate rate, and some 25% either respond slowly or perhaps not at all. It is estimated that under more ideal conditions than currently prevail, the intractable core of non-responders may be as small as five percent. These results are unprecedented, and they point the way to a promising future for those veterans whose prospects at the moment are still bleak.

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The approach of EEG training is both non-medical and non-psychological. Rather, it belongs in the emerging field of Applied Psychophysiology and of Behavioral Medicine. As such, it complements the other therapeutic approaches that are already well accepted. It is based on a training model, in which the brain is simply trained in a variety of ways to enhance its own functional capacities. The subsidence of symptoms is then an indirect consequence of the higher level of function. The point of departure is to approach PTSD in terms of its physiological expression. PTSD is known to be broadly disruptive of good physiological function, and the resulting dysfunction becomes the target of therapy. However, it does so only indirectly. The immediate target of the therapy is the enhancement of regulatory control within our central nervous system. Symptom abatement is then the marker of a successful training strategy.

An approach which is entirely based upon the enhancement of function lends itself well to broad adoption within the active duty military. Preparation for military service is largely about fitness training. No great conceptual leap is required to add brain training to that regimen. No diagnostic thresholds need to be met to qualify. Literally everyone can potentially benefit from brain training, irrespective of their initial level of competence. In fact, the more competent the brain is at the outset, the more it can potentially benefit. So this method is not simply targeting dysfunction. Hence, it fits readily into the culture of optimum performance and the standards of personal fitness that reign within the military. As it happens, this same approach also seems to expunge the symptoms of PTSD most effectively.

The new approach is in line with the latest findings in the neurosciences with respect to how brain function is organized. The brain's largest burden is to regulate its own activities, essentially a house-keeping task. It is the quality of what is called the brain's 'resting state network' function that determines the readiness and competence of the brain to meet its external challenges. PTSD disrupts these resting state networks, and EEG neurofeedback restores their functional integrity. As such, it constitutes a comprehensive remedy for the condition.

Now that we have compelling evidence for this, every returning service person ought to be given the opportunity to train his or her brain to restore it to optimal functioning status. It is a good assumption that everyone exposed to combat pays a price in terms of brain function at some level. In many of those cases, those consequences linger over the longer term. We are now in a position to pay our military volunteers back in the best way possible---a nervous system restored to optimal functioning.

In the following, some of the exciting data supporting this work will be presented, along with the prior research that gave rise to it and some heart-warming case histories. Historically, in the more than twenty years of development in neurofeedback training, research has contributed to evidence-based findings for neurofeedback in work with ADHD, epilepsy and addictions. So indeed there is an extensive foundation already for these new findings. The new methods simply improve on what was already a successful training strategy.

Our position is that the data presented here mandate further research and further clinical exploration. And our hope is that those afflicted, whose lives have seen such significant improvement, will inspire a growing field of collaborators to join our campaign.

KEY POINTS

A clear breakthrough is being achieved in resolving PTSD by using the EEG as a training variable in biofeedback. This technique is known as EEG biofeedback, or more commonly neurofeedback.

Since biofeedback is an accepted therapy for self-regulation (relaxation), EEG biofeedback could be adopted directly into military and VA programs to complement existing therapies.

High-intensity use of neurofeedback at Camp Pendleton has shown it to be the most effective single method in the arsenal, although multi-modal treatment is clearly necessary and appropriate.

A novel protocol, Infra-Low Frequency (ILF) Training, has been introduced at Camp Pendleton that looks particularly promising.

Retrospectively, this approach is deserving of further research to lay the basis for broad integration into the military and the VA for functional recovery and return to optimal functioning.

PTSD AND THE DISREGULATION MODEL

As the population of those treated with neurofeedback for PTSD grows, certain common patterns of responses are becoming noticeable. The most remarkable among them is that many veterans are responding to neurofeedback quite quickly. Such a rapid response may not even have much to do with how long the condition of PTSD has persisted, since we observe rapid response even among Vietnam era veterans. When the response is quick, it also tends to be comprehensive, covering all or nearly all complaints and observable dysfunctions. And the quicker the response, the more it is likely to be fairly uniform across clinical categories. That is to say, we are observing a similar learning curve for most or all of the symptoms. These observations are best illustrated with some specific case reports.

In **Figure 1**, we show one case report in which all symptoms except for high blood pressure responded to the point of clinical insignificance within eight sessions, and that progress held for some time. High blood pressure often responds well to Infra-Low Frequency Neurofeedback, and also to more conventional protocols, so perhaps more time is needed here. Noteworthy is the wide range of symptoms that did respond: all sleep symptoms, including night sweats; joint pain; migraines; and depression.

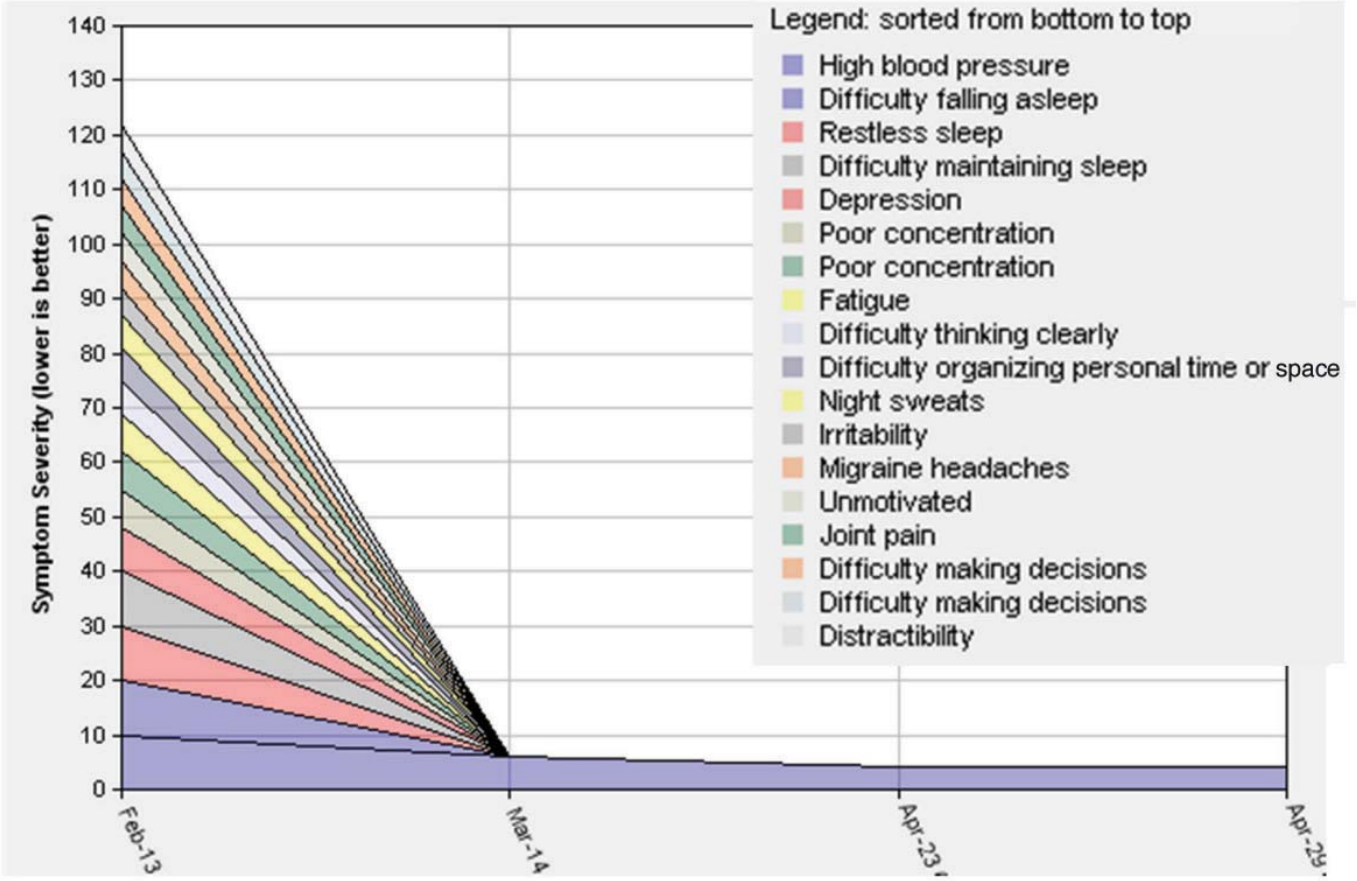


Figure 1: (#225) Response in 8 Sessions

Figure 2 shows symptom response for another rapid responder. Again the response covers a variety of disparate symptoms: rages; anxiety; depression; obsessive worries; muscle tension headaches; chronic constipation; and lack of appetite awareness. Symptom severity appears to be plateauing, but for most symptom categories we are below the level of clinical concern. There was an overall reduction of 90% in symptom severity in seven sessions. The similarity in learning curves across the disparate symptoms is better reflected in **Figure 3**. Symptoms are shown in an approximate order of responsiveness.

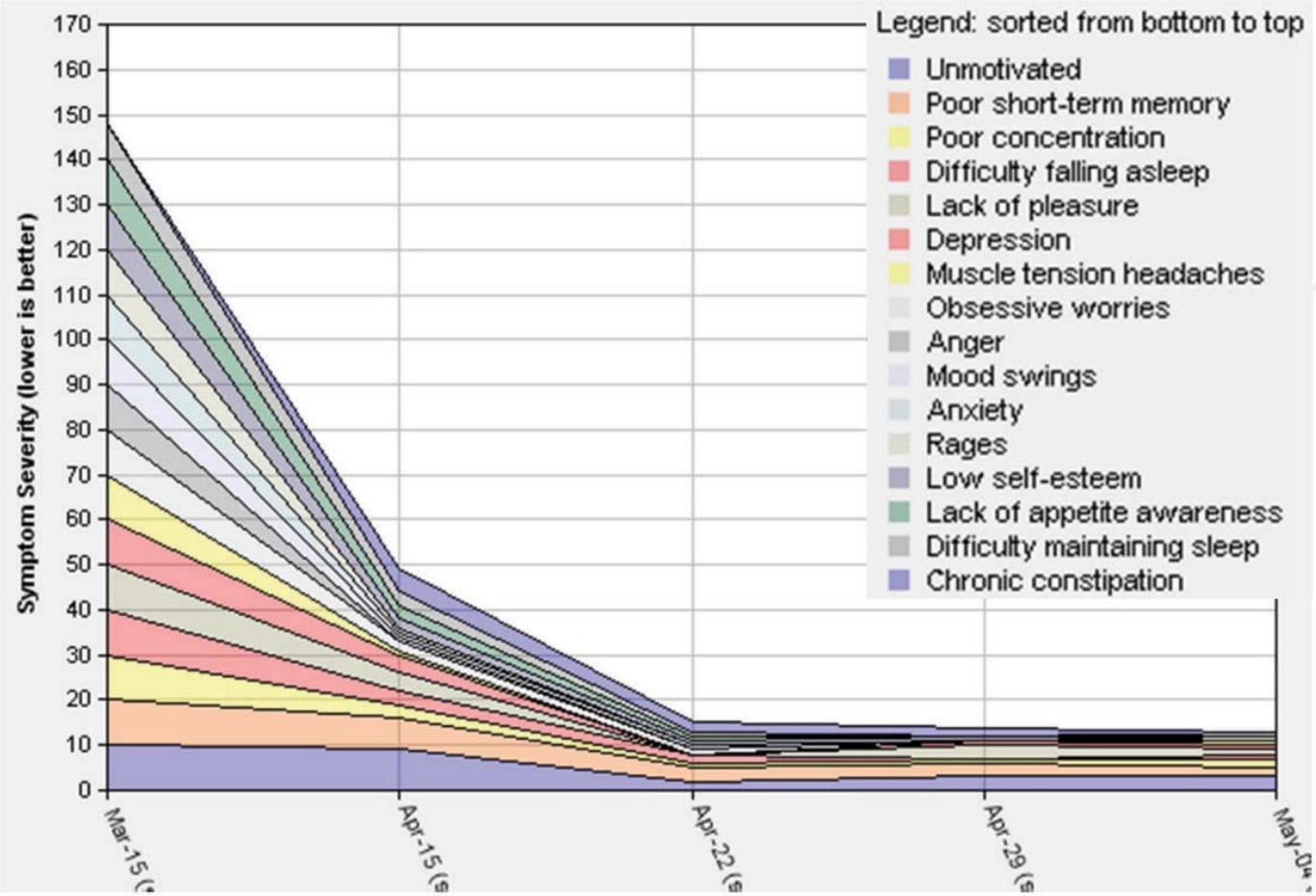


Figure 2: (#177) Response in 7 Sessions (91%)

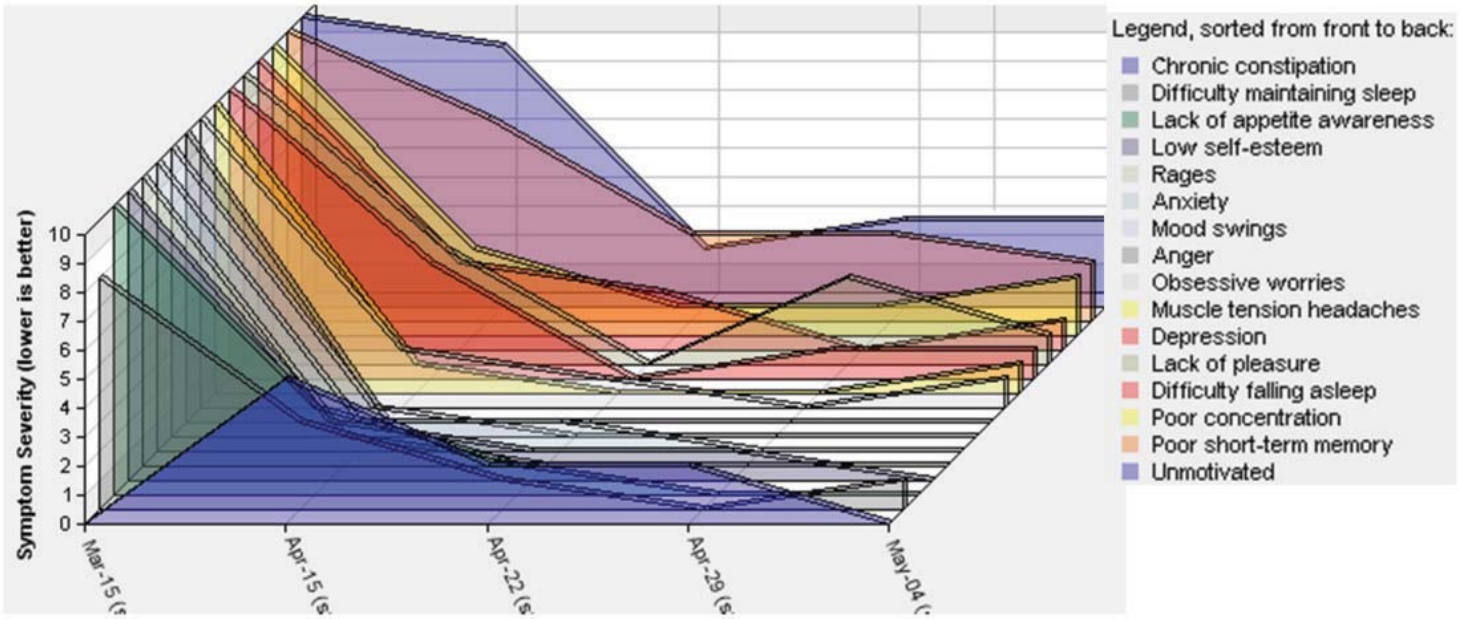


Figure 3: (#177)

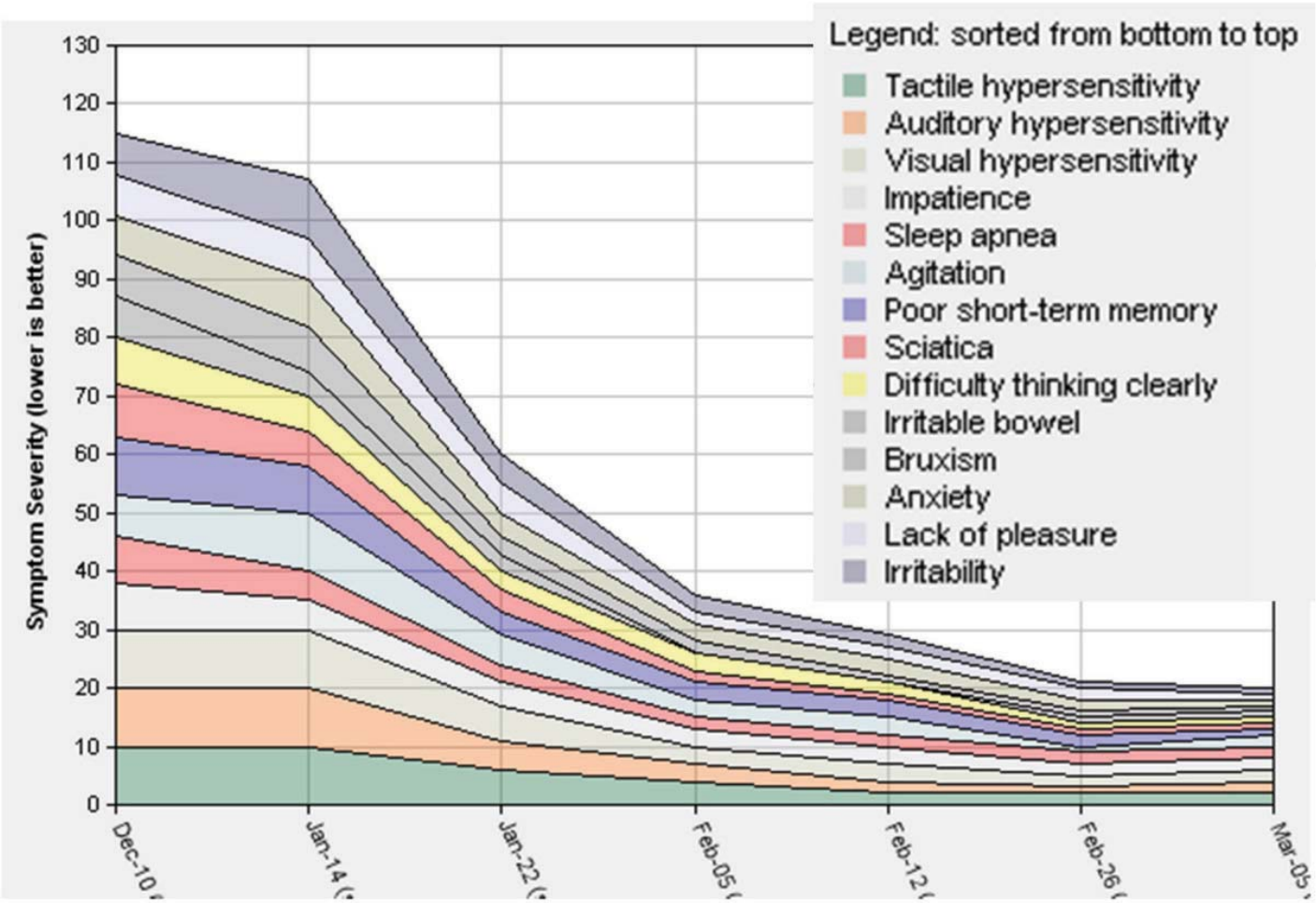


Figure 4: (#311) 83% Symptom Reduction in 10 Sessions

We show another case in **Figure 4** in which the overall symptom reduction is more than 80% in ten sessions. Complaints here include bruxism, sensory hypersensitivity, irritable bowel, sciatica, and sleep apnea, along with the more classic PTSD symptoms of irritability, anxiety, and agitation. The individual learning curves again show great similarity, as best viewed in **Figure 5**.

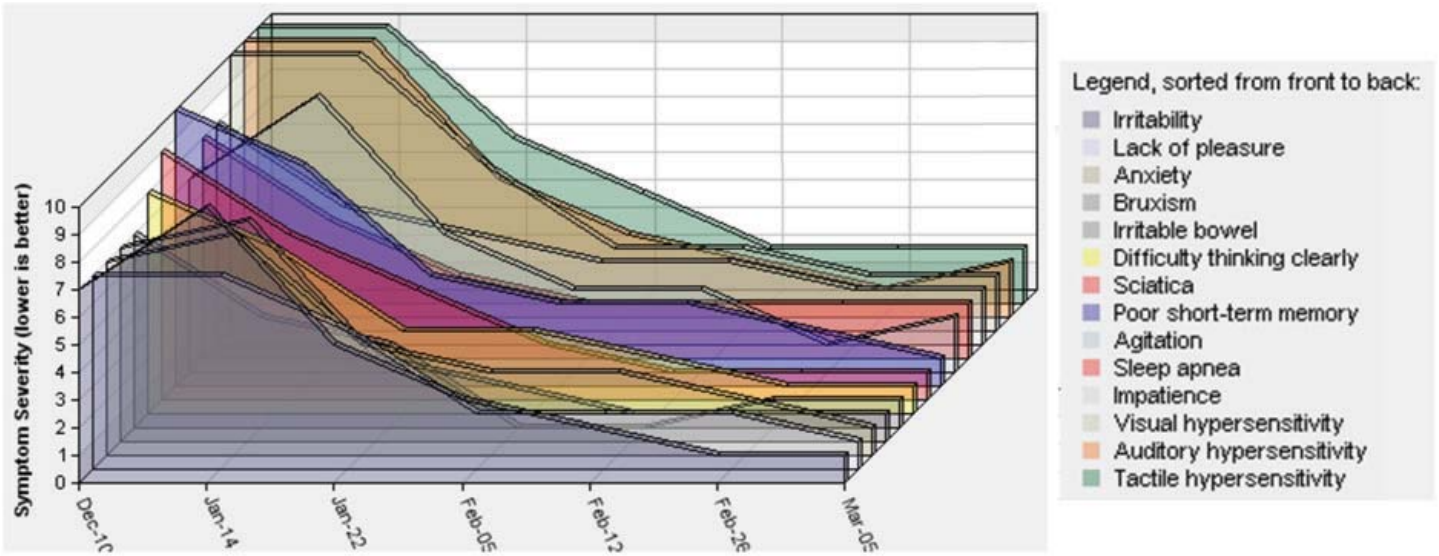


Figure 5: (#311)

Yet another fast responder is illustrated in **Figure 6**, where all of the symptoms are seen to become negligible by the first re-appraisal at the ninth session. The major symptoms here include panic anxiety, nightmares, chronic constipation, tinnitus, and migraine headache. Follow-up over several months demonstrated a general maintenance of control, with occasional mild symptom recurrence in six out of the eleven categories. These results over time are best seen in **Figure 7**.

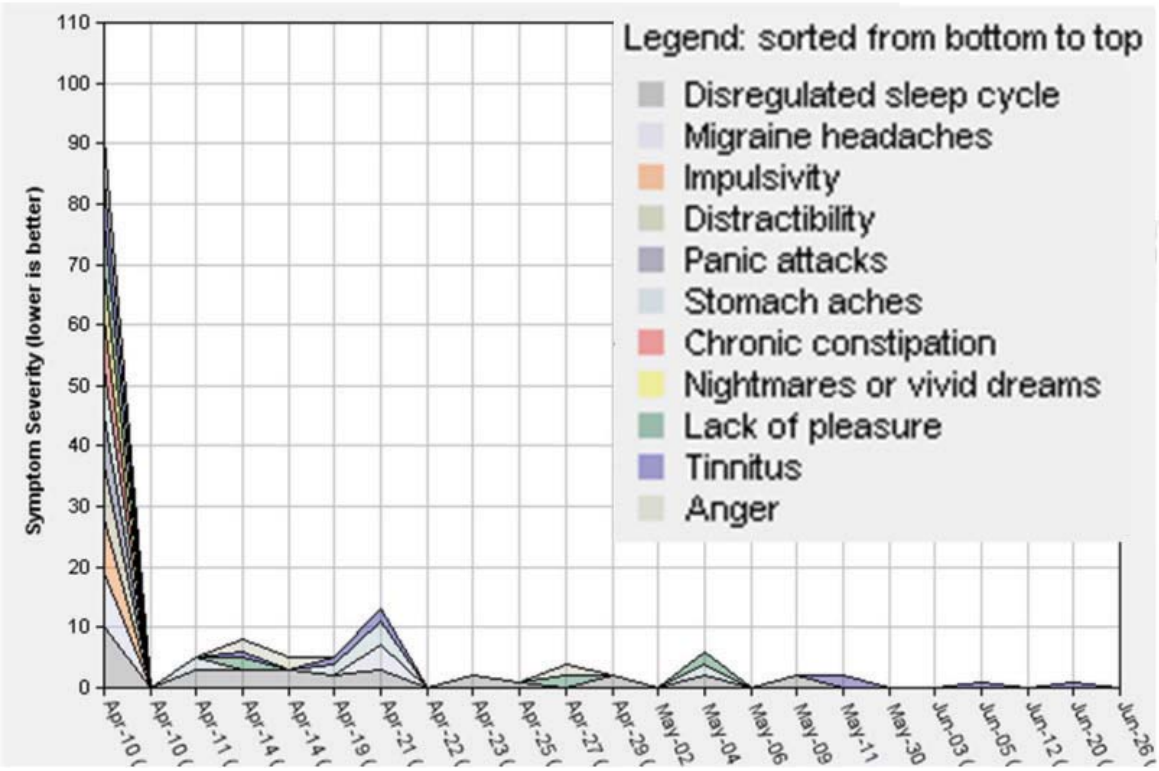


Figure 6: (#2) Symptom Abatement in 9 Sessions

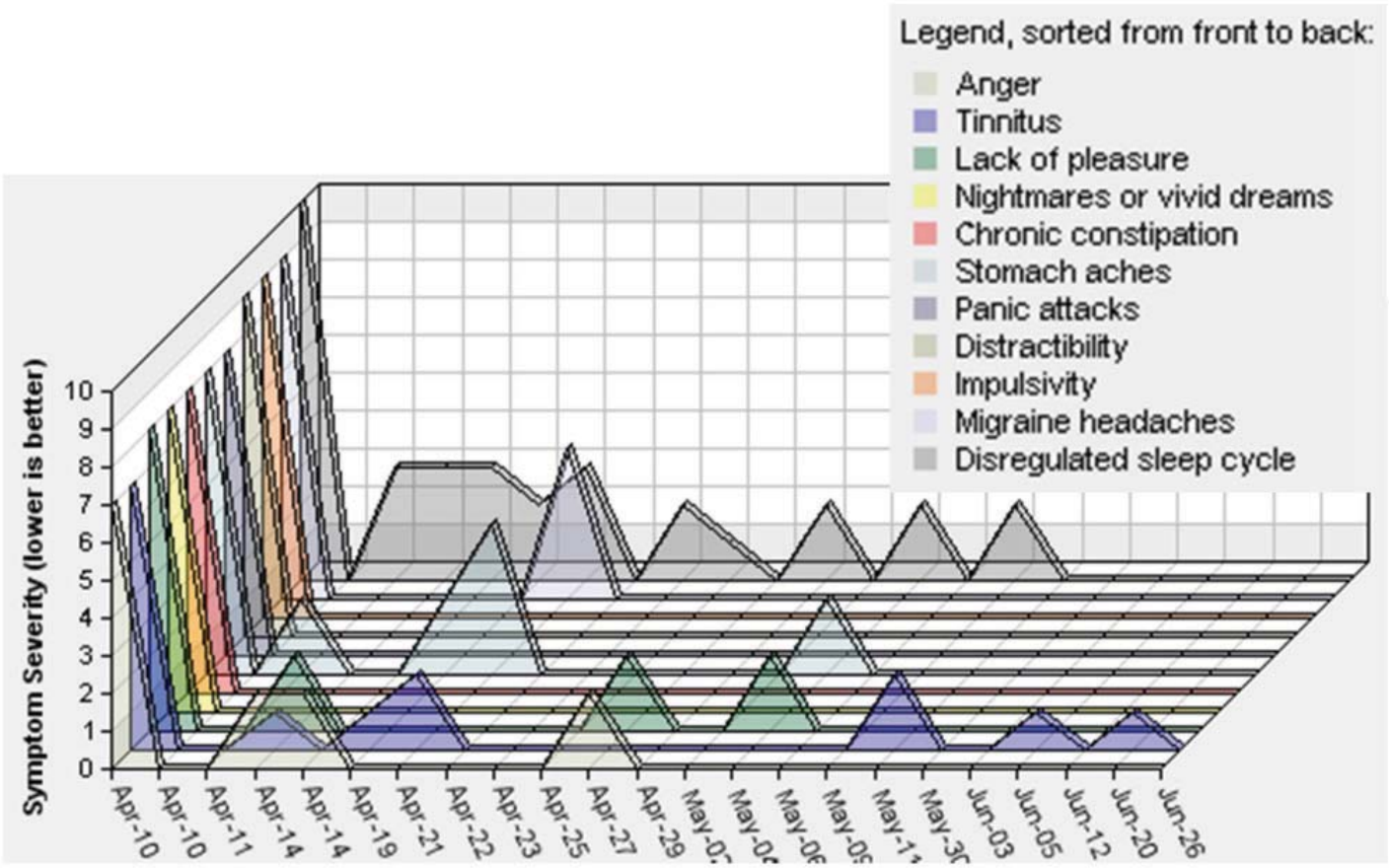


Figure 7: (#2)

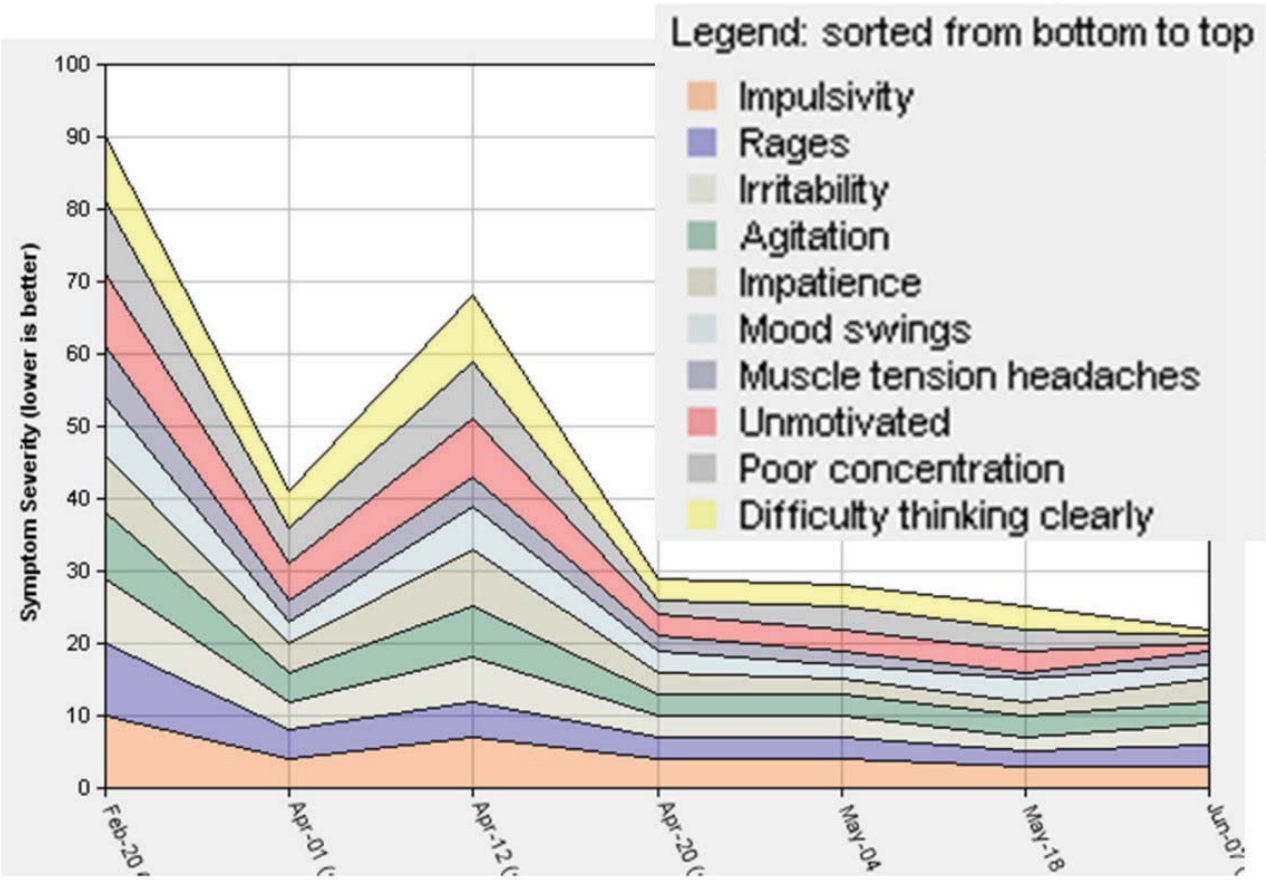


Figure 8: (#193)

A very different kind of symptom profile is illustrated in **Figure 8**. Here the decline in symptom severity is not monotonic, which one presumes may be attributable to the intrusion of life events. This profile reveals a pattern that we have observed repeatedly in this work, namely that the ebb and flow of symptom severity is highly correlated among symptoms that are not clearly related. There is an accordion-like quality of the overall symptom profile, one which is compressed by neurofeedback and may once again be exacerbated by adverse life events. Prominent symptoms here include rages, muscle tension headaches, agitation, irritability, and difficulty thinking clearly. The similarity in learning curves is even better revealed in **Figure 9**.

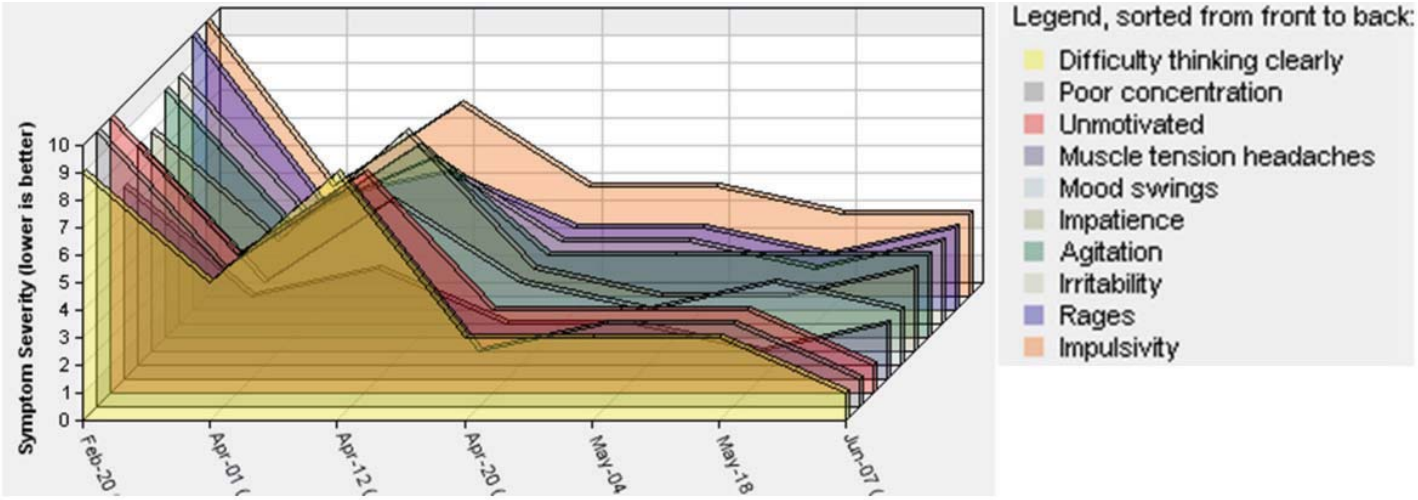


Figure 9: (#193)

This pattern of commonality in learning curves is even more strongly reflected in **Figure 10**, where we confront an even larger array of symptoms. The high correlation among symptoms is particularly apparent early in the training, with a greater dispersion in learning curves setting in later in training. Such correlation is surprising when one considers the disparate symptoms involved here, which include addictive behaviors, depression, fears, chronic constipation, migraine headaches, and bruxism.

Again the correlation between individual learning curves for different symptoms in **Figure 10** is more apparent when the data are plotted as in **Figure 11**. If one were to plot the average symptom severity along with the variation in severity at any point, it is clear that the dominant trend is one of mutual correlation.

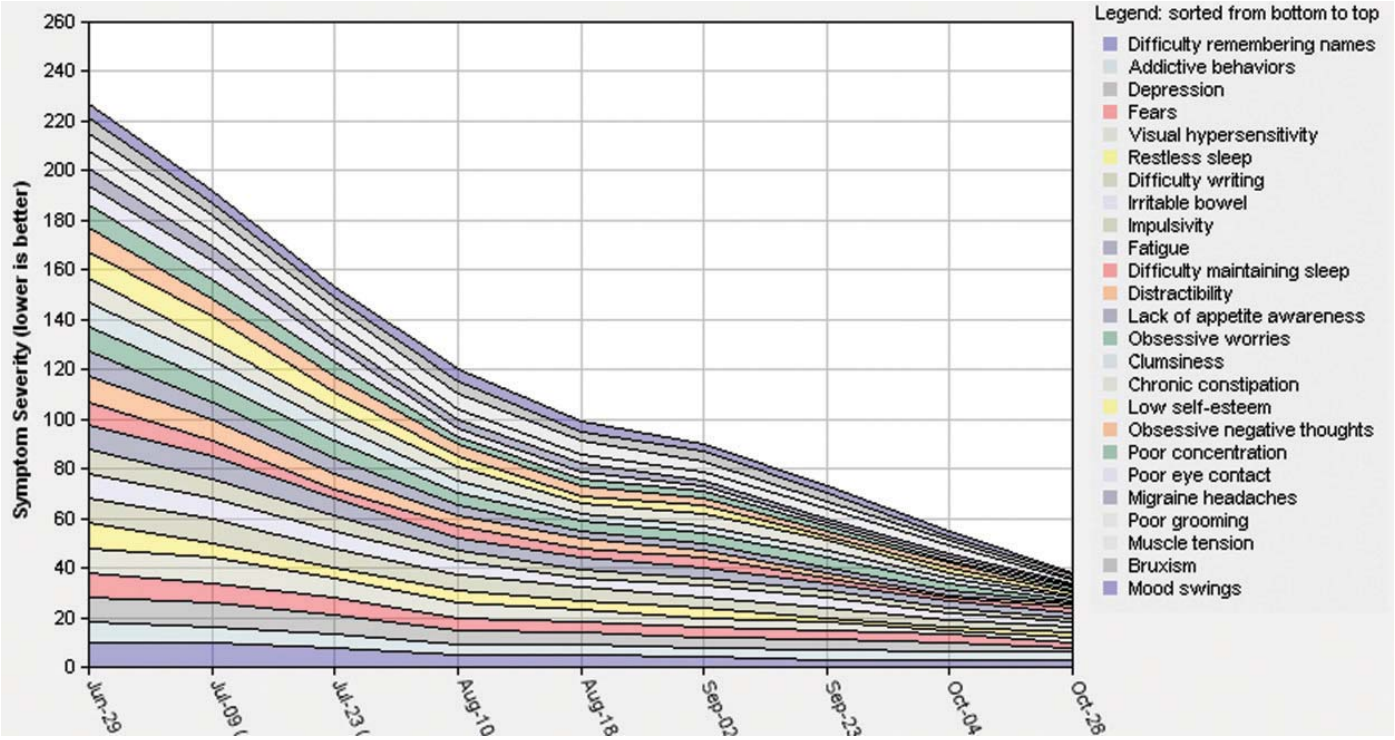


Figure 10: (#259 EEG)

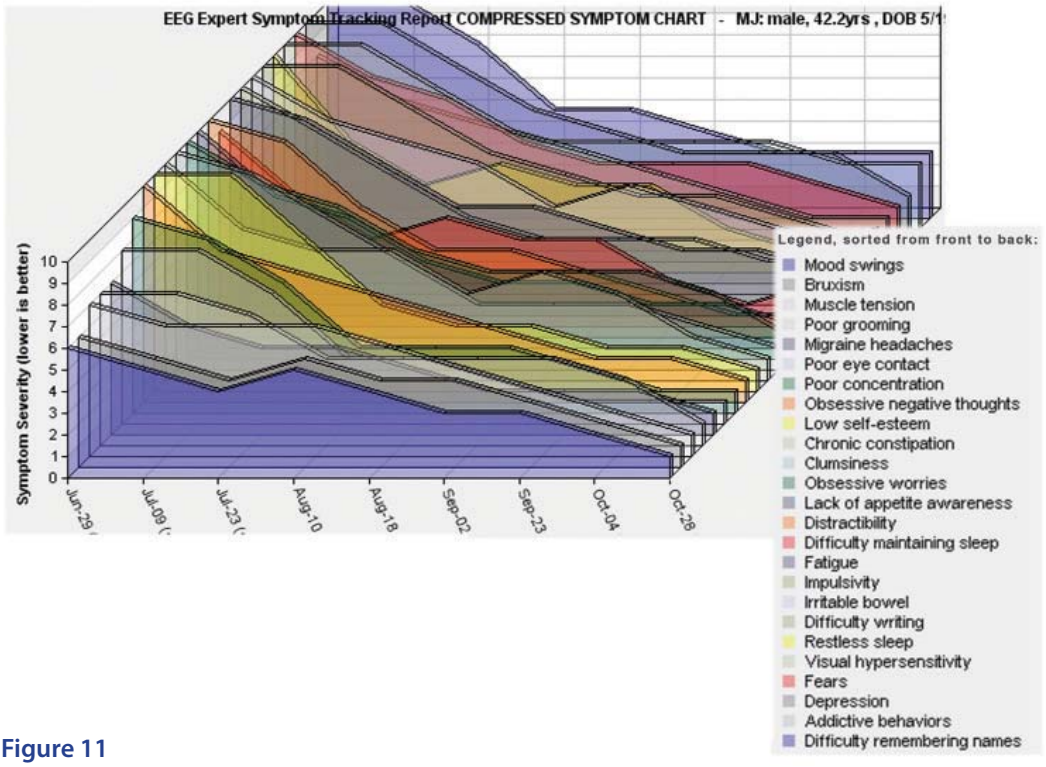


Figure 11

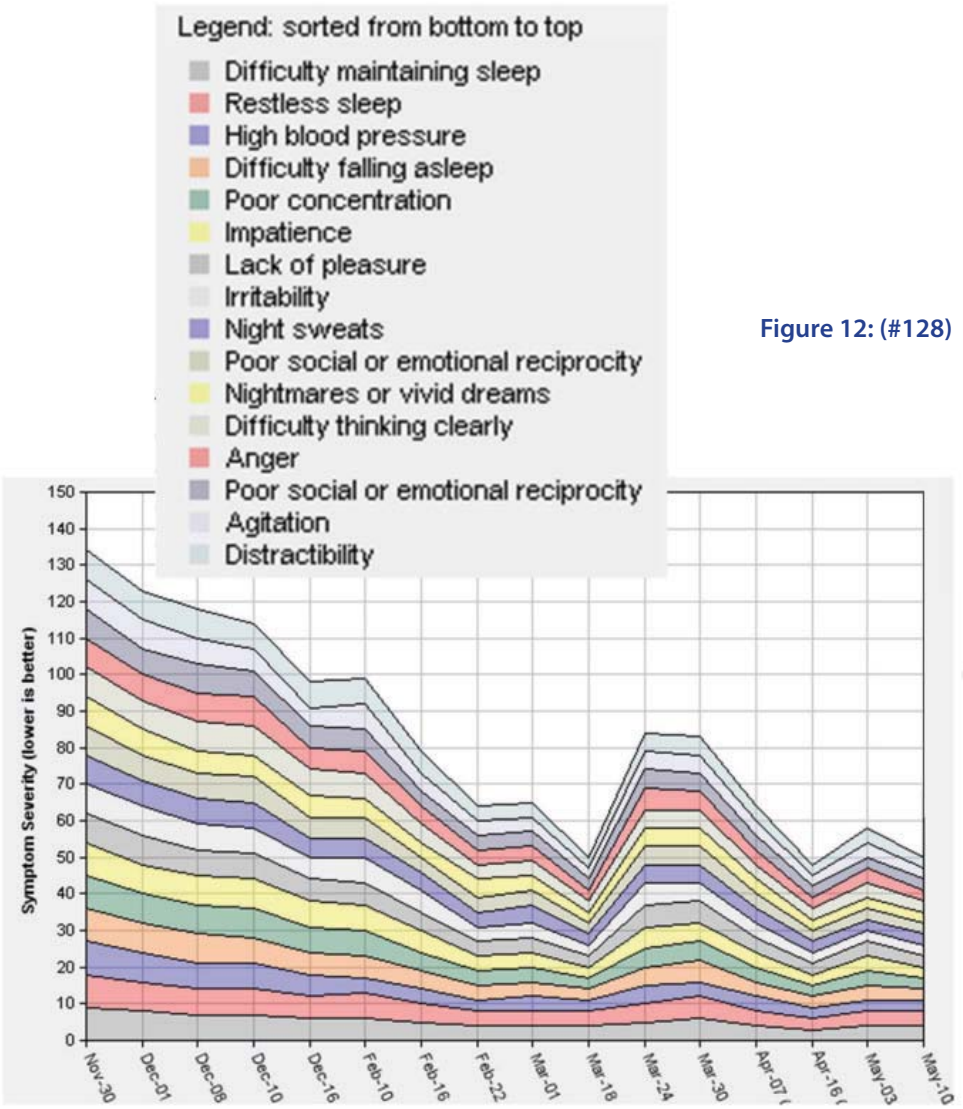


Figure 12: (#128)

Just for good measure, we augment the above with yet one more report, in **Figure 12**. Here the correlation among symptoms is very apparent, and carries through the entire record. This is further confirmed with the recovery plotted as in **Figure 13**. This correlation covers symptoms including agitation, anger, nightmares, night sweats, poor concentration, and high blood pressure.

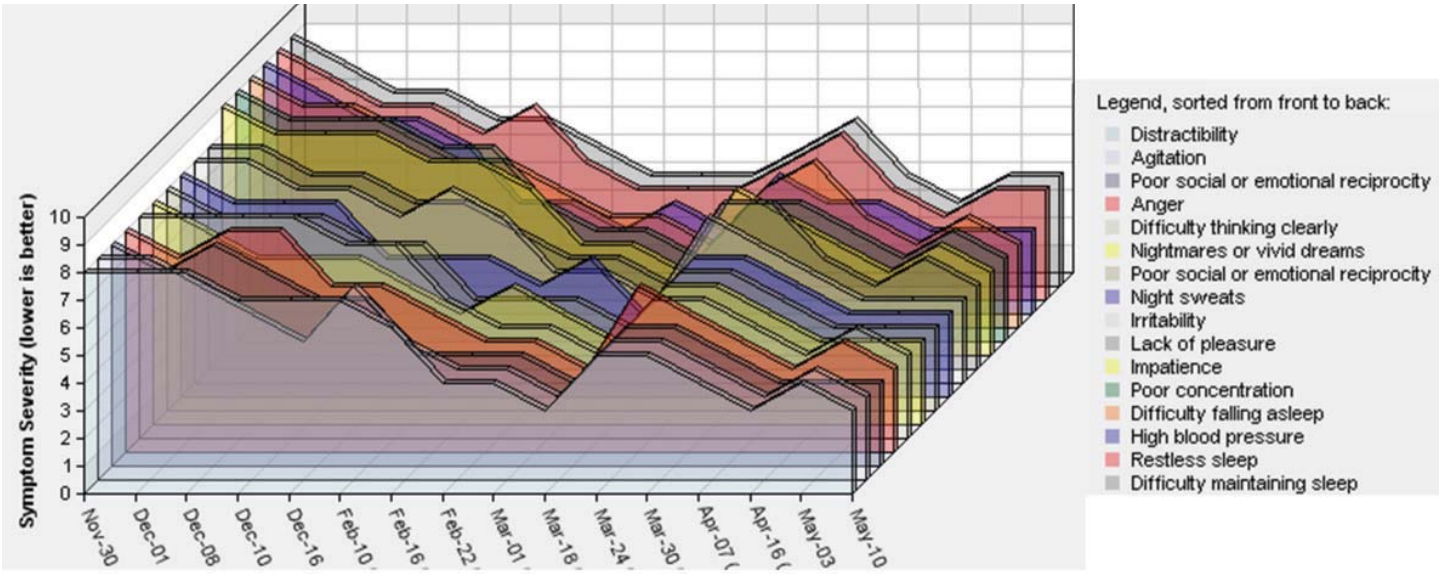


Figure 13: (#128)

The astute observer may detect that one symptom is shown twice in the record (poor social and emotional reciprocity). Opportunistically, one can use this as a check on internal validity. The variability in scores for the same symptom turns out to be comparable to the variability between different symptoms. We are limited here by the natural variability in scoring on a ten-point scale.

KEY POINTS

Rapidity of recovery from PTSD constitutes an existence proof that neurofeedback is effective in remediation of PTSD when used as part of a multi-modal treatment.

Completeness of recovery using neurofeedback makes the case that the deficits in PTSD lie largely in the functional domain, and are therefore accessible to a functional remedy.

Similarity in recovery curves across disparate symptoms implies the existence of a common failure mechanism that affects all of them jointly.

Rapidity of recovery implies that only a small number of protocols (one or two) were sufficient to effect the remedy in these cases.

This further argues for the existence of a single dominant failure mechanism.

Rapidity of recovery indicates that neurofeedback effectively targets this mechanism.

GROUP SURVEY DATA ON RECOVERY FROM PTSD

The availability of symptom tracking data from a variety of independent sources makes possible a survey of responses for individual symptoms with sufficient statistical weight to allow for patterns to be observed and meaningful conclusions to be drawn. The advantages of having data from real-world environments more than compensates for the deficiencies from not having a formal research design in place. This just means that there are additional factors in play that contribute to the overall variance.

The symptom tracking program was used to track more than 60 symptoms, divided into seven classifications. The classifications are as follows: 1) Sleep-related symptoms; 2) Pain syndromes; 3) Physical symptoms; 4) Psychophysiological symptoms; 5) Sensory system dysfunctions; 6) Psychological symptoms; 7) Deficits in cognitive function. The list of symptoms is given in **Table 1**.

Table 1

Symptom Categories, PTSD (57)

Sleep-Related Symptoms

- Nightmares and vivid dreams
- Difficulty falling asleep
- Difficulty maintaining sleep
- Disregulated sleep cycle
- Restless sleep
- Night sweats
- Nocturnal bruxism
- Sleep apnea

Pain Syndromes

- Migraine pain
- Muscle tension headaches
- Chronic nerve pain
- Joint pain
- Stomach aches
- Jaw pain

Physical Syndromes

- Fatigue
- Effort fatigue
- Heart palpitations
- Hypertension
- Irritable bowel
- Skin rashes
- Chronic constipation
- Asthma
- Tinnitus
- Allergies

Psychophysiological Symptoms

- Flashbacks of trauma
- Agitation
- Anger
- Fears
- Anxiety
- Panic attacks
- Aggressive behavior
- Paranoia
- Depression
- Suicidal thoughts
- Mood swings
- Compulsive behavior
- Addictive behavior
- Obsessive worries
- Obsessive negative thoughts

Sensory System Dysfunctions

- Motion sickness
- Auditory hypersensitivity
- Tactile hypersensitivity
- Visual hypersensitivity

Psychological Symptoms

- Impatience
- Irritability
- Lack of pleasure
- Low self-esteem
- Hyperactivity
- Distractibility
- Lack of motivation

Cognitive Deficits

- Poor short-term memory
- Poor concentration
- Difficulty thinking clearly
- Difficulty making decisions
- Difficulty organizing time and space

In the following, a representative survey is shown for one or more symptoms from each of the above categories. For the category of sleep symptoms, the averaged response profiles are shown for “nightmares and vivid dreams.” This category likely includes nocturnal flashbacks, which are often mislabeled as migraines, which heightens the clinical significance of this particular symptom. Shown in **Figure 14** are several curves corresponding to different durations of training. This had to be done because the duration of training was so highly variable over the group. Each line therefore represents an invariant number of participants.

The horizontal axis shows the sequence of symptom appraisals, which typically took place every two or three training sessions. The vertical axis shows the severity on a ten-point scale, averaged over the particular cohort. In this case of nightmares and vivid dreams, symptom reduction by at least half was achieved by the fourth symptom appraisal.

For the category of pain syndromes, **Figure 15** shows the response profile for migraine pain. The severity index is intended to encompass incidence and duration of the migraines, as well as the pain severity. It is noteworthy that one

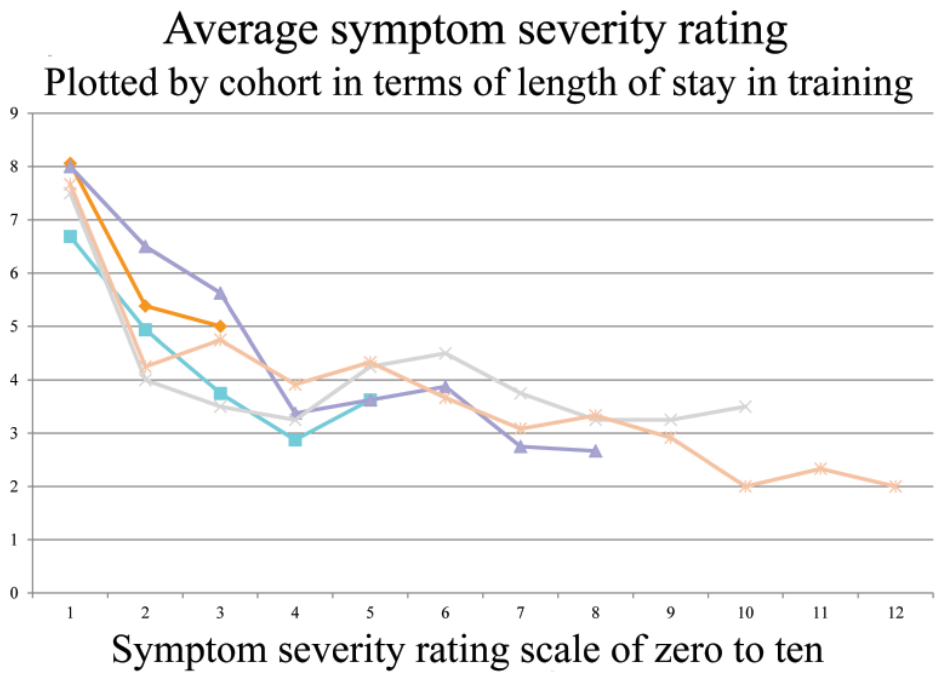


Figure 14: Nightmares and Vivid Dreams

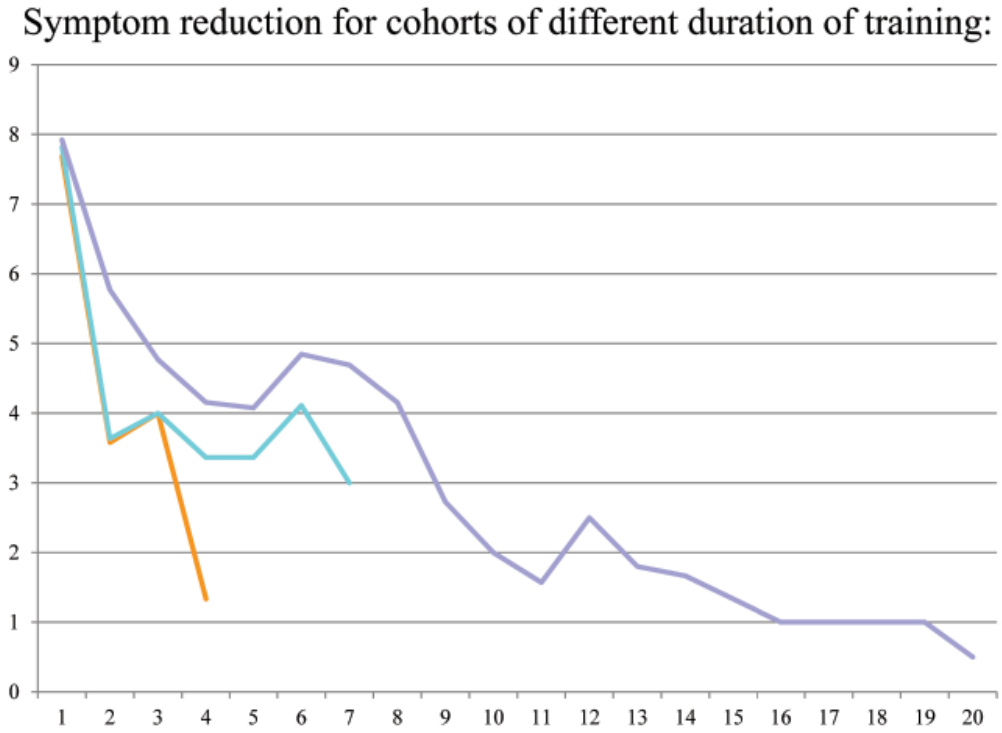


Figure15: Migraine Pain

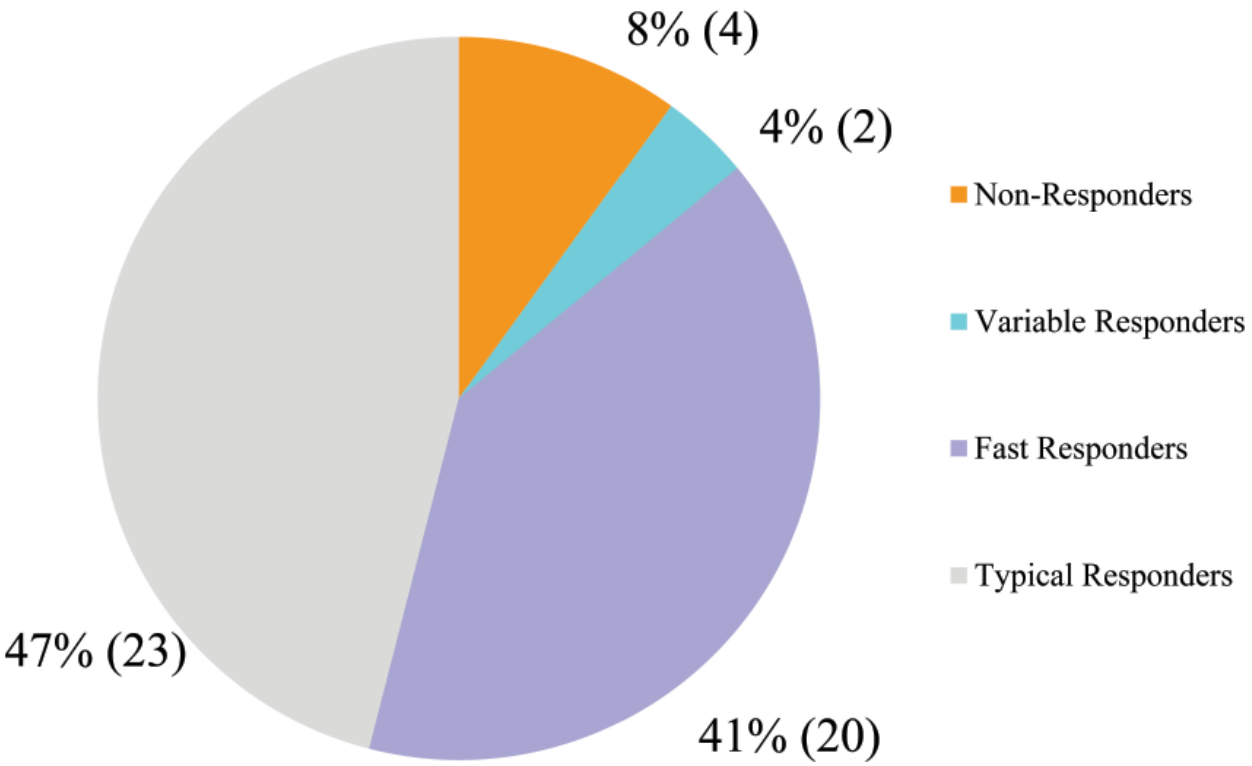


Figure 16: Response Distribution (migraineurs)

commonly sees very rapid response to the training. The distribution among fast, typical, variable, and non-responders is shown in **Figure 16** for migraines. Some 40% are rapid responders, and less than 10% are non-responders. The response to neurofeedback was more consistent for migraine than for any other symptom.

Physical symptoms are represented by the category of fatigue, shown in **Figure 17**. Again, severity scores are cut in half by the fourth appraisal of symptom severity, among the responders (which amount to some 70% of the whole sample for whom this was an issue). In this case even the non-responder category shows some tendency toward normalization.

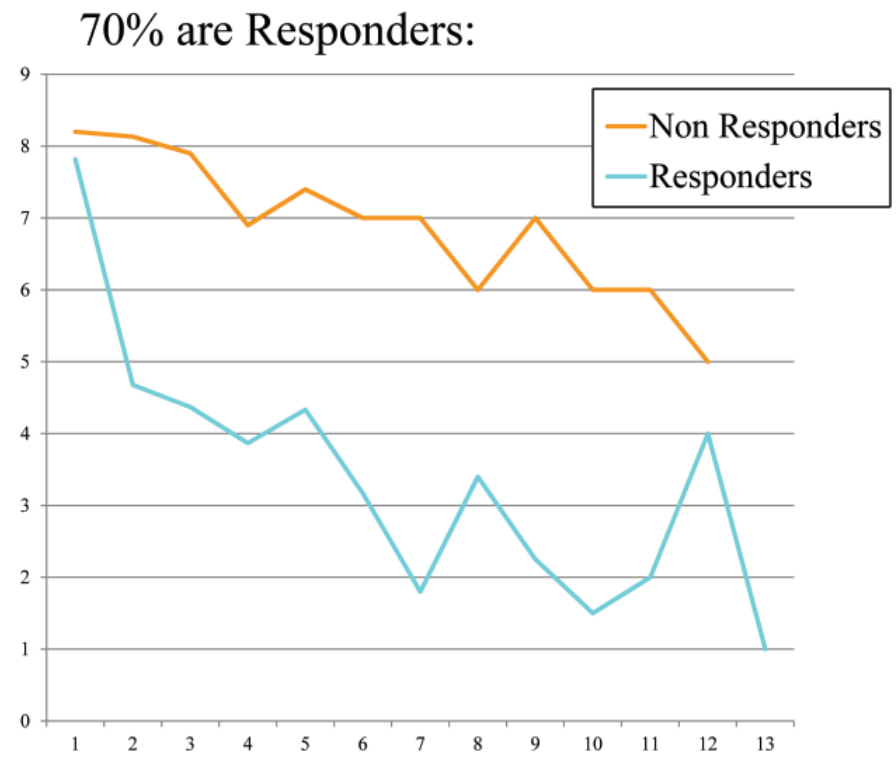


Figure 17: Fatigue

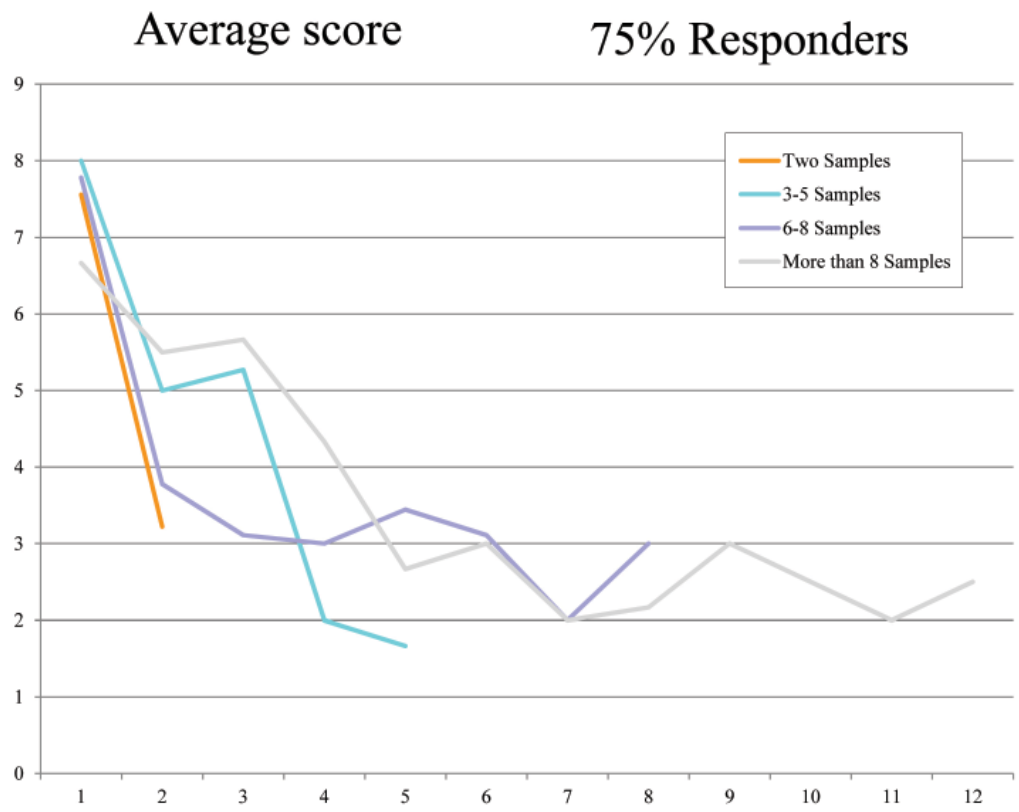


Figure 18: Flashbacks of Trauma

The important category of psychophysiological symptoms is represented by five symptoms for present purposes: The response profile for flashbacks of trauma are shown in **Figure 18**. The severity indices are cut in half by the fourth or fifth symptom appraisal. Three out of four of those affected are represented by these data. Trends in depression scores are shown in **Figure 19**. There is a consistent finding of a fast initial favorable response to the training, a quite remarkable pattern. Depression scores are consistently cut in half by the third symptom re-appraisal. Four out of five of those affected are represented by these data.

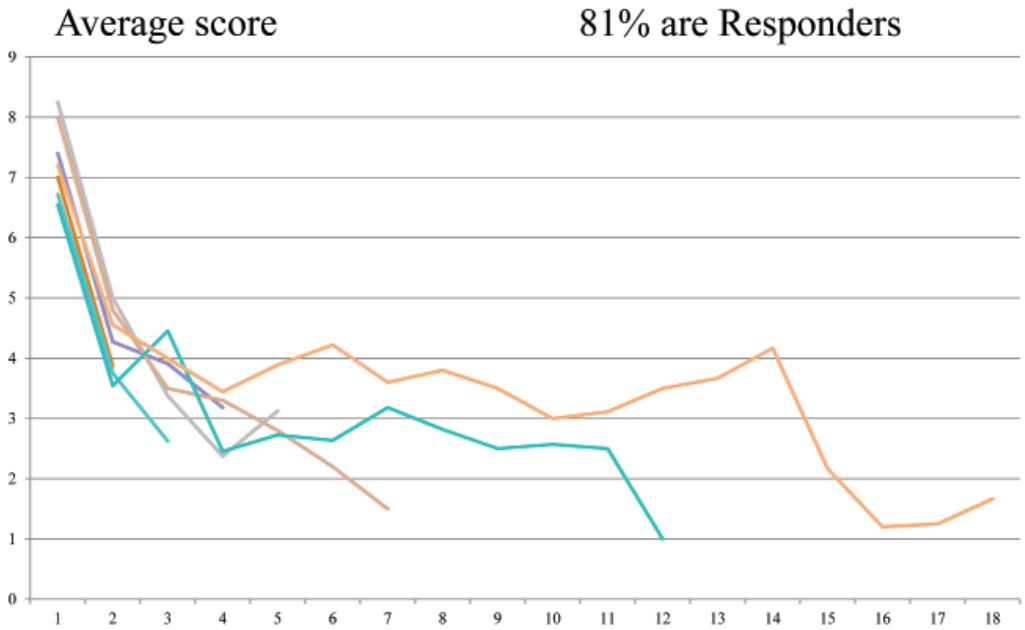


Figure 19: Depression

Results for anxiety are quite similar to those for depression, and are shown in **Figure 20**.

Results for panic attacks are shown in **Figure 21**. Four out of five of the affected are in the category of responders, and the expectation is that with sufficient training panic attacks will no longer be an issue. (This expectation is based on similar experience over the years with our clinical population.)

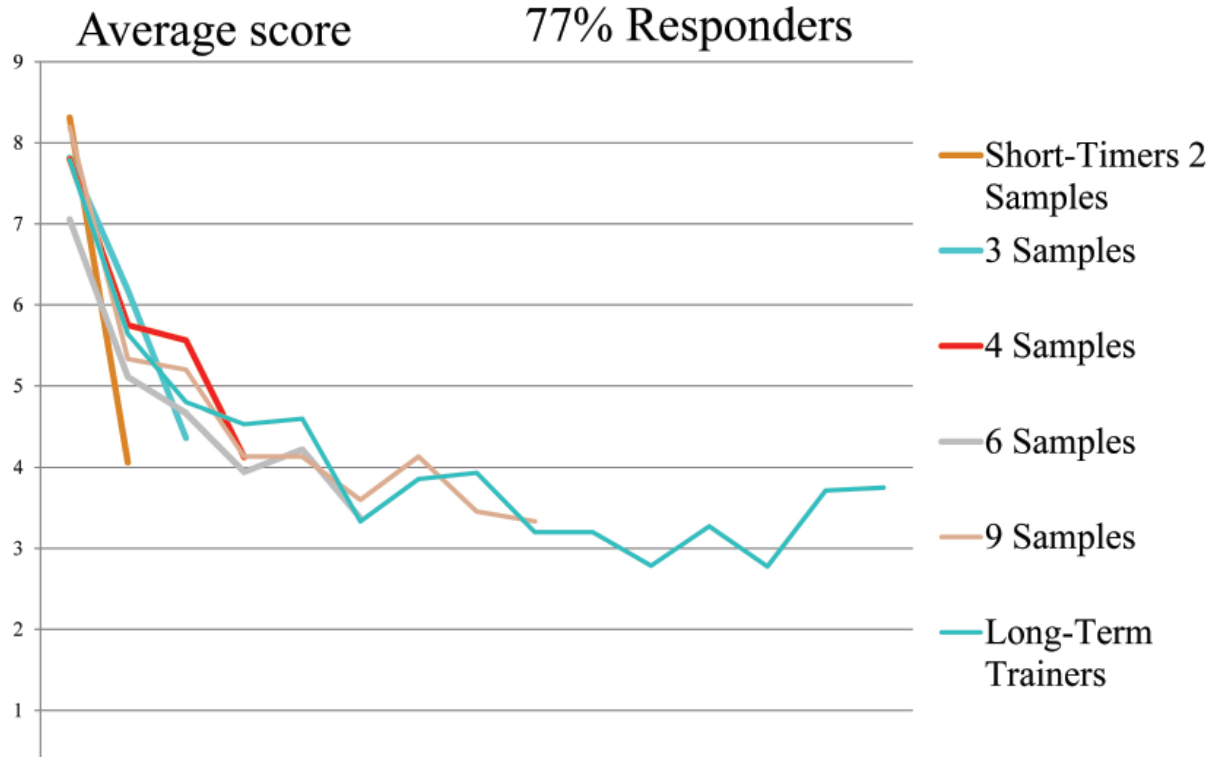


Figure 20: Anxiety

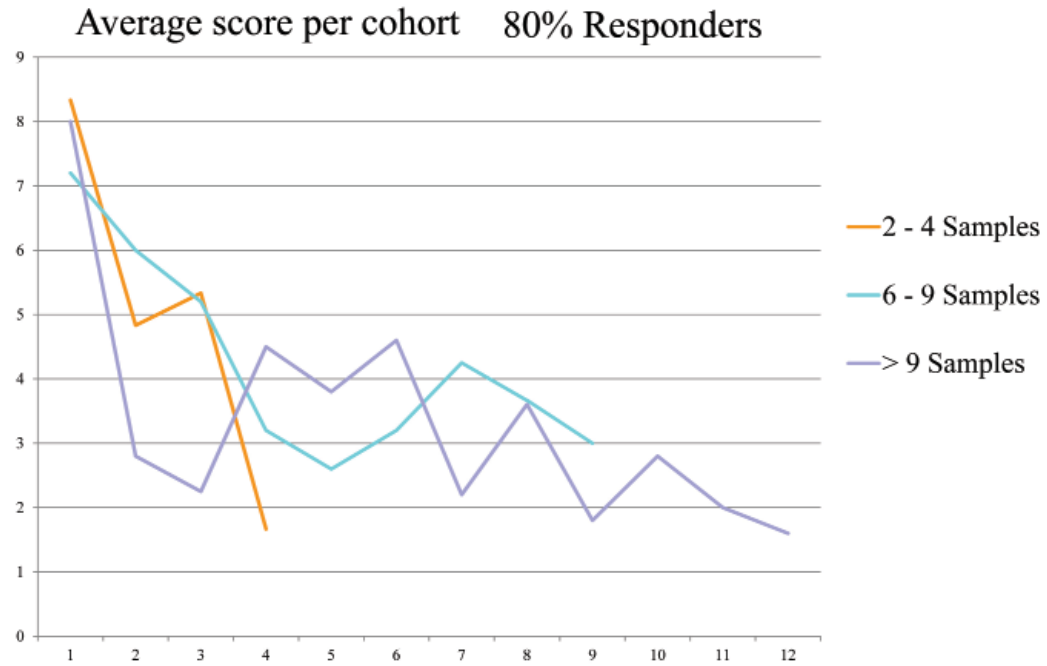


Figure 21: Panic Attacks

Finally, results are shown for the category of aggressive behavior **(Figure 22)**. There is a quick and strong early response to the training, and substantial elimination of aggressive behavior is anticipated with sufficient training. Nearly four out of five are in the responder category.

Auditory hypersensitivity is shown as a representative of the category of dysfunctions of sensory systems **(Figure 23)**. Symptom severity trends are quite favorable here, with even those in the category of non-responders showing tendencies toward improvement.

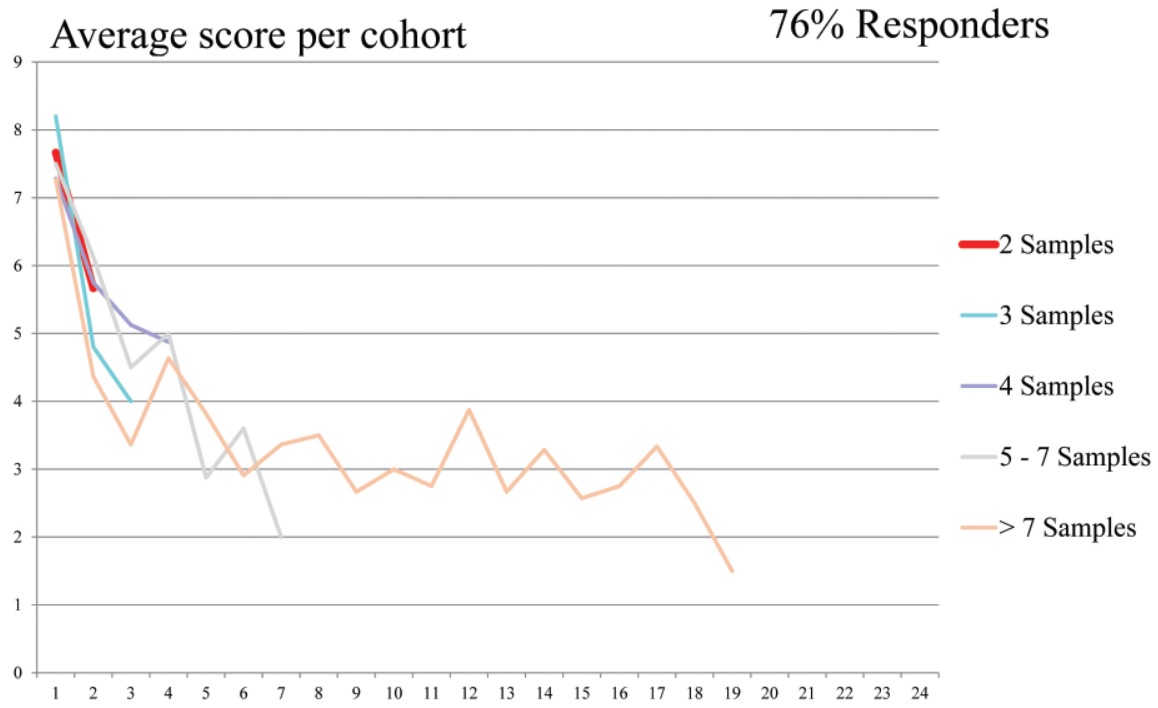


Figure 22: Aggressive Behavior

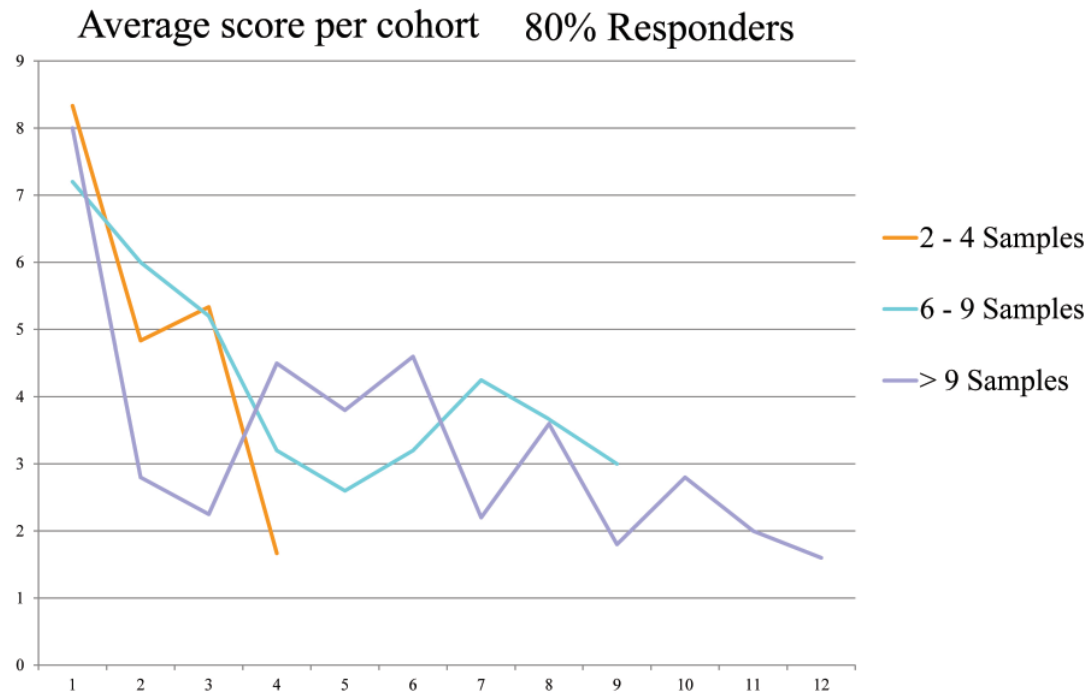


Figure 23: Auditory Hypersensitivity

The category of psychological symptoms is illustrated by the symptom of irritability, as shown in **Figure 24**. Nearly three out of four of the applicable clients find themselves among the responders. Early favorable response is a consistent observation.

Deficits in cognitive function is illustrated with the symptom of poor concentration. Severity scores are typically cut in half by the fourth or fifth appraisal.

In summary of all of the data that have been tracked in this fashion, it can be said that all of the more than sixty symptoms tracked show substantial tendencies toward functional normalization. This includes some categories where the number affected is small, but the response was consistent. These categories included suicidal thoughts (4 out of 4 responders); asthma (4 of 4); jaw pain (3 of 3); chronic constipation (5 of 5); skin rashes (3 of 3); heart palpitations (5 of 6); and allergies (8 out of 10). Less consistent response was observed for chronic nerve pain (5 out of 12 responders) and for joint pain (14 of 29).

Figure 24: Irritability

KEY POINTS

Comprehensiveness of recovery from PTSD across more than 60 symptom categories makes the case for treating PTSD principally as a psychophysiological disorder, albeit one with both psychological and medical aspects.

This is turn justifies considering all of these symptoms as aspects of the PTSD syndrome.

The statistics of recovery reinforce the hypothesis that PTSD is governed by a single, dominant failure mode.

The statistics of recovery imply that neurofeedback addresses this failure mode, and should therefore be considered the primary intervention for PTSD.

THE DISREGULATION MODEL

The correlation among individual recovery curves that is such a common observation in our work motivates the supposition that an overall quality of cerebral regulation can be defined, one that is governed by a single parameter. This quality factor crosses the boundaries between regulatory subsystems, and yet not all such systems are necessarily affected. One might think in terms of a perturbing influence acting upon a nervous system with differing intrinsic strengths and weaknesses.

It must be acknowledged that an extraneous factor also exists that tends toward correlation of symptoms. All the data are by self-report, and how well a person feels on a particular day is likely to color the specific appraisals of symptom severity to a degree.

A second consideration is that the case for a one-parameter model governing disregulation has been supported by our findings in neurofeedback over many years. Tightly bunched learning curves are common in our experience. In our perspective, then, all that was really needed was the confirmation that this general picture also held for PTSD.

A third consideration that favors the supposition of a single, dominant governing parameter for one's state of disregulation is that all of the results with PTSD patients are being obtained with a very limited set of protocols. Moreover, all of these protocols present a similar challenge to the brain.

To tighten up the case further, it is helpful to propose a specific model of neurofeedback that could at least in principle explain such broad and diffuse effects resulting from such a simple brain challenge. As it happens, all of the brain challenges involved in the Infra-Low Frequency Neurofeedback occur under very limited and tightly constrained conditions in the domain of EEG frequency, albeit at extremely low frequencies. That is to say, the governing parameter is narrowly distributed over the population, and additionally is tightly constrained in each individual case.

One may therefore argue that we are interacting with the brain's regulation of persistent states of neuronal activation, which we now believe to be governed by our resting state networks. The most parsimonious assumption is that we are interacting with the global coherence relationships that prevail in our resting state networks, in particular the default mode network, and thus compel their functional renormalization. If brain function depends upon the integrity of this organization, then it is reasonable to expect a simple challenge to these networks to have broad clinical effects.

Specifically, the brain challenge we impose is one that promotes the spatial de-correlation of resting state activity. Yet in the functional brain these states exhibit high spatial correlation in their key linkages. We appear to be moving in the direction opposite to the natural and intended state of these systems. This does not present a problem, however, because the brain will act to resist any interference with its internal affairs. It is this resistance, the response to our intervention, rather than the intervention itself, which represents the final stage of the process that results in better self-regulatory capacity. It is the subtlety of the challenge to the brain, not its sign, that determines the nature of the response.

PTSD IN THE DISREGULATION MODEL

Since we observe essentially complete resolution of PTSD-related symptoms in a significant percentage of cases, it is reasonable to recast PTSD as a disorder of physiological disregulation first and foremost. If the physiological disregulation is remediated, PTSD can no longer be diagnosed. If such disregulation is taken as the point of departure in understanding PTSD, then the clinical results tell us further than the disregulation typically extends well beyond the classic PTSD symptoms. Physiological regulation is disrupted quite broadly, and the symptom picture exposes whatever vulnerabilities characterize a particular nervous system. Moreover, this is true generally, irrespective of whether we are dealing with psychological or physical trauma.

The disregulation model of PTSD justifies the approach of looking at all of the person's symptoms of disregulation in each case, as we have done. It is their collective response to training that then indexes the recovery from PTSD. This is not to say that we are restricted here to the use of physiologically grounded techniques in remediation. But the results do argue that it would generally be more efficient to deploy the physiological remedies first, and leave the psychodynamic interventions until the physiology has been stabilized and renormalized.

Since the disregulation resulting from emotional or physical trauma depends so critically on the vulnerabilities of the nervous system at the time of exposure, it also follows from our results that training the nervous system prior to exposure should be effective in buffering the system against descent into dysfunction. Since many of these vulnerabilities do not reveal themselves until after exposure, it follows that for a prevention or stress inoculation program to succeed fully, all nervous systems at risk need to be trained.

KEY POINTS

The rapidity, comprehensiveness, and completeness of recovery from PTSD with neurofeedback demonstrates that PTSD is primarily a disorder of regulatory systems.

The similarity in recovery curves across disparate symptom categories implies that the disregulation is governed principally by one parameter.

It is proposed that the dominant parameter governing regulatory integrity is the functional connectivity of resting state networks, in particular the Default Mode Network.

The neurofeedback functions as a subtle challenge to the regulatory systems, thus effecting their renormalization.

Since PTSD symptom severity is cumulative with exposure, the use of neurofeedback in stress inoculation should be considered.

DISCUSSION

Some common reactions to hearing about the effectiveness of EEG feedback in the remediation of PTSD are the following:

1. *The results appear to exceed all prior findings for PTSD. Could they be a fluke?*

2. *EEG neurofeedback is not yet an evidence-based treatment for PTSD.*

3. *This method needs to be evaluated in formal research before it is offered to service persons or veterans.*

These results exceed prior findings. Could they be a fluke?

First of all, it needs to be pointed out that these results come from a variety of sources within the clinical community. So we are not dealing here with an isolated success. Secondly, the number of client histories involved here is quite large, sufficient to reflect the natural variability that prevails in outcomes. The fact that these cases are gathered from naturalistic settings introduces additional sources of variance into the data. This strengthens rather than weakens the overall thrust of the findings.

If the findings nevertheless look too good to be true, then it is likely that the observer does not have a working model in terms of which the data make sense. As Einstein said, "It is the theory that tells us what we may believe." Neurofeedback belongs in the domain of Behavioral Medicine (from the medical perspective), or in the domain of Applied Psychophysiology (in the perspective of psychology). This is a new frontier for most professionals, even though it also has a well-established research history. Since it falls between the classical domains of medicine and of psychology, it has to date been relatively neglected by both.

Neurofeedback addresses the physiological basis of behavior, the aspects that are accessible to us by virtue of our innate brain plasticity. With the appropriate set of tools, one then observes what can be accomplished in a training paradigm. Neurofeedback can be considered physical therapy for the brain. By and large, the symptoms being tracked have a prior history of responding to neurofeedback specifically or to biofeedback generally, but in PTSD we confront a more complex and daunting symptom presentation than is common otherwise in clinical practice. For that reason we ourselves were startled initially to see just how responsive PTSD cases could be to the neurofeedback training, in particular the regularity with which rapid results were being obtained. How then do we understand the profound disregulation that is so prevalent in PTSD?

The essential feature of PTSD that results from shock or event trauma is that the traumatic memory involves the mind and the body as a unitary entity. The event is encoded as a body memory a well as an explicit historical memory. This merely requires that explicit event memory is coupled to state memory, i.e. memory of the physiological state at the time. Such coupling is commonplace, but is usually associated with emotionally meaningful events. In a trauma situation, the valence of all such memory is heightened, and the memory is encoded as a unitary experience involving both sensory and visceral systems. In a kind of one-shot learning, the body-mind then alters its response to threat from that time forward. It remains in a threat posture at some level, and this exacts a cost in terms of our normal regulatory function. When we are confronted with a threat to our existence, or something similar, our physiology defaults to more basic mechanisms of response that are in our biological inventory for such eventualities. We then lose top-down cortical control because sub-cortical and brainstem-related mechanisms have taken charge. Once that occurs, it may be difficult to re-install the original more subtle, more complex, and more integrated cortical control over our critical regulatory functions.

Addressing this as a problem of the mind is often inadequate, quite simply because talking to cortex has limited influence over the state of affairs. As long as the brainstem is left in emergency mode, it is driven by its own internal mechanisms and is not paying as much attention to cortex. And when such methods do succeed, it is because the physiological response was also changed during the process. After all, the brain's self-recovery processes can be mobilized in a variety

of ways. We can, however, also take advantage of the opportunity to retrain our physiological response directly, bypassing the suffering and ailing mind. Either way, our physiology is the real target in recovery from PTSD. It should not surprise us that this strategy actually works most of the time.

EEG neurofeedback is not yet an evidence-based treatment for PTSD.

This statement is merely an indication of unfamiliarity with the whole field of Applied Psychophysiology. The evidence now in hand supports the claim that physiological function in PTSD can be re-normalized with a direct approach of training such function. Neurofeedback is then one strategy among several that are available under the general umbrella of the rehabilitation of brain function. By analogy to physical therapy, it would be odd to select one particular approach in physical therapy and argue that it is not evidence-based. In rehabilitation, propositions are not either true or false. It is rather a question of whether they are useful or not useful. Various techniques are tried, and either kept in the mix or abandoned on the basis of actual efficacy in the event. And on the basis of existing data, EEG neurofeedback is clearly useful. Indeed, it may be more 'useful' than any other available technique, even in the limited perspective of the data we already have in our possession.

We can state quite emphatically that all the evidence necessary to prove efficacy of neurofeedback in application to PTSD already exists. In fact, an authoritative Navy psychiatrist was moved to say, after surveying the data, that more data now exist to support the efficacy of EEG neurofeedback for PTSD than we have for all of the conventional techniques put together.

Let us survey briefly, then, what we already know about techniques of physiological normalization in application to PTSD. First of all, it is well known that PTSD sufferers tend to be hyper-reactive to traumatic stimuli, and that is directly reflected in elevated phasic responses of the autonomic nervous system. This can register in heart rate, blood pressure, skin conductance response, electromyographic response, and in more pronounced startle response. Biofeedback techniques have been in routine use for over fifty years to address such autonomic disregulation, and are considered evidence-based. In an individual case, one biofeedback approach may, however, be much more effective than another, so clinical assessment, and clinical judgment, are called for.

What is the effectiveness of such biofeedback methods in application to the particular autonomic dysregulation we encounter in PTSD? In a recent publication, long-term practitioner John Carmichael estimates that using his methods he observes remission in PTSD symptoms among police and military veterans in some 90% of cases (Carmichael, 2010, p.10). Now these methods include CBT and other techniques along with biofeedback, but he points out that "Sometimes clients are unable to take full advantage of CBT until autonomic and/or central nervous systems become properly regulated." (p.25) There is a natural flow to optimized therapy for PTSD that puts physiological normalization up front as the primary intervention, to be followed by psychotherapeutic methods as appropriate.

In the last several years we have seen increasing interest expressed in using Heart Rate Variability (HRV) training to improve the regulation of the autonomic nervous system (ANS). This technique was originally developed in Russia, where it has a long and well-established history of use with cosmonauts and Olympic athletes, as well as with clinical conditions. After the method was introduced in the US some years ago, initial positive findings were in application to asthma and myofascial pain. Since autonomic nervous system dysregulation is such a prominent feature in PTSD, extension of the work to this condition was obvious.

In HRV training the breath is used as a forcing function to subtly challenge the interaction between the sympathetic and parasympathetic arms of the ANS. With breath pacing at a fixed frequency (nominally 0.1 Hz), a well regulated system will then show a strong spectral peak for HRV at that same frequency, as heart rate tracks the breath with a moderate phase delay. The HRV measure, then, gives us a direct indication of the success being achieved in training based on the fraction of total spectral power that is contained within this peak. Jay Ginsberg et al. have done a pilot study in which improvement in autonomic regulation was shown not only in terms of the HRV spectral properties, but also through improvements in executive function. A formal study is planned.

Another physiologically based approach to PTSD utilizes Cortical Electrical Stimulation (CES). A commercial device, the Alpha-Stim, has been used most prominently in this application, having found a home in some 75 VA facilities and at

some 20 military bases. The primary applications are to anxiety, insomnia, headache, chronic pain, and depression. With such devices, a significant change of state, for example toward greater calmness in the face of anxiety, can be induced within a typical training period of 20-60 minutes. Although full resolution of the clinical syndrome may take many such sessions, this does demonstrate that resolution of such clinical symptoms can be achieved with a purely physiological, non-pharmacological approach.

Techniques have also been developed in which tapping on the body can serve to disrupt a state of anxiety or of phobia. Here talk therapy is also involved, but the essence of the method is the disruption of a persistent state of distress of the body-mind. Psychiatrist Daniel Kuhn has successfully used verbal techniques to disrupt the re-engagement with discrete traumatic memories. Although the method is entirely verbal, it has greater kinship with the tapping method than with standard psychotherapy. Both are physiologically mediated. Finally, there is EMDR, in which a periodic stimulation or excitation of the left and right hemispheres at a relatively low frequency of around two Hertz serves to stimulate traumatic recall. Although talk therapy is involved, the method rests on a physiological mechanism, namely the encoding of traumatic memories in delta-dominant states, which sets the stage for state-dependent recall.

On the basis of the above, the utility of using psychophysiological techniques to remediate symptoms of PTSD is already established. The outstanding questions regarding neurofeedback then concern how it compares to existing psychophysiological approaches and how it might best be integrated into a comprehensive treatment program for PTSD.

This method needs to be evaluated in formal research before it is offered to service persons or veterans.

One of the immediate reactions from research professionals upon hearing about the efficacy of neurofeedback for PTSD is that the technique should be evaluated in formal research. That is indeed to be welcomed, but since the technique is already in broad clinical use, proof of efficacy is already in hand, as the previous data survey demonstrates. The questions for research should instead deal with ways that the clinical approach can be further improved, and with trying to reach a deeper understanding of mechanisms.

Formal research designs to establish efficacy handicap a technique like neurofeedback because they typically require reduction to a single fixed protocol, and because they evaluate a technique in isolation. Past neurofeedback studies related to the PTSD application have typically tested neurofeedback as an adjunct to conventional treatment rather than as a stand-alone treatment. This accords with the way in which neurofeedback will typically be used, and that should inform any research agenda as well. It would not make sense, for example, to take apart the cocktail of drugs used in anti-viral treatment of HIV for individual testing of efficacy. Treatment efficacy depends upon the independent contributions of the various constituents. Similarly, it was recently found that a combination of trace nutrients was helpful with cognitive function, whereas prior tests with individual nutritional factors were less positive. Again, synergistic effects contributed to efficacy. By the same token, neurofeedback should be part of an organic, multi-modal treatment program for PTSD, where the positive contribution of each aspect of the therapy is maximized. Complex conditions should not be addressed simple-mindedly or single-mindedly. For this reason among others, neurofeedback should not be tested for efficacy as a stand-alone procedure.

Resources

Carmichael, J. (2010). *Multi-Component Treatment for Post-Traumatic Stress Disorder*, A publication of the International Society for Neurofeedback and Research

Ginsberg, J.P. (2010). Autonomic Control of Heart Rate and Heart Rate Variability: Influences on Orienting and Information Processing in Combat Veterans with PTSD. D.A. Powell, (Ed.), *Central Nervous System Control of Learned Autonomic Adjustments*. Research Signposts: Kerala, India (pp. 79 - 114).

Ginsberg, J.P., Berry, M.E., & Powell, D.A. (2010). Cardiac coherence and PTSD in combat veterans. *Alternative Therapies in Health and Medicine*,16(4), 52-60.

KEY POINTS

Multiple, independent corroboration of these results for neurofeedback argue against the supposition that the results may represent outliers, or results that may not be easily replicable.

Shock trauma mobilizes the threat response system, which may 'permanently' alter autonomic nervous system ambient setpoints. The resulting disregulation affects other regulatory functions.

The above model for PTSD makes it reasonable that neurofeedback can effect comprehensive resolution.

Biofeedback is evidence-based in application to trauma formations. All of biofeedback aims at the restoration of functional balance of the autonomic nervous system, which is the primary dysfunction in PTSD.

Some success has been demonstrated for several biofeedback techniques, when they are embedded in a multi-modal treatment setting.

If the EEG is used as a training vehicle, the same objectives can be accomplished.

Given the prior history with biofeedback, this merely requires an existence proof, which is provided by the evidence in hand.

Efficacy is usually established for therapies on a stand-alone basis. In application to PTSD, neurofeedback has always been used as one element of a multi-modal treatment program.

Hence it should be tested that way, and that is best accomplished in the actual therapeutic setting.

The research agenda should engage with questions of mechanisms, which may lay the basis for further advances in therapeutic effectiveness.

CLINICAL FINDINGS

Clinical Methods of Neurofeedback

by Siegfried Othmer, PhD

The Method of Infra-Low Frequency Neurofeedback

Neurofeedback utilizes the EEG as an index to physiological activation. Group activity of neuronal populations is tightly constrained. It reflects the instantaneous level of neuronal activation, which in turn is governed by central mechanisms of regulation. The EEG signal can be picked off readily at the scalp, and is then extensively digitally processed to select specific frequency components that have been found empirically to be most clinically relevant. This signal is then reflected back to the individual in the form of a pleasing visual, auditory, and tactile feedback signal.

The neurofeedback process depends upon the brain's recognition of the salience of the presented signal. Once the brain makes the connection between the signal and its own internal processes, it then naturally takes control of that signal, in the same manner that the brain takes automatic responsibility for the steering wheel in the car one is driving. It is the ongoing attempt to control the signal that exercises the brain's control mechanisms and brings about improved self-regulation over the longer term.

In working with impacted populations over the years, it became clear that the strongest clinical effects were being observed at the lowest EEG frequencies. Over time, the work was extended to the infra-low frequency region of less than 0.1 Hz. This region is referred to as the slow cortical potential; it is customarily excluded from conventional EEG recordings. It is this extension to low frequencies that led to the breakthrough in working with PTSD that is being reported here. Hence the method is referred to as Infra-Low Frequency (ILF) Training.

The first observable effect of the training is state change. The person shifts in state of arousal and activation. This change is not at all random, but rather systematically takes the person toward calmer states. However, since the work is being conducted with highly disregulated clients, the outcome is not categorically predictable. Optimum state management turns out to be highly dependent on the specifics of the feedback. Hence the process must be closely monitored by competent clinical personnel.

The training is also highly dependent on placement on the scalp, because at different sites one is able to engage preferentially with certain specific regulatory processes. Optimization of the training requires appropriate site prioritization, which is yet another reason that the process requires competent professional guidance. The training utilizes a single channel of EEG signal, in order to focus the brain's attentions on a single trajectory through state space. The placement is bipolar, in order to bring to the fore site-to-site relationships, which are the most time-critical---the most dynamic---processes actively regulated by the brain. Bipolar montage also suppresses any common-mode activity which may affect the low-frequency EEG signal without yielding clinically relevant information.

The efficacy of this kind of EEG training may be understood in the context of recent findings in neurophysiology. Over the last decade an understanding has emerged of the central role of resting state networks in underpinning brain function. The brain expends the vast majority of its energetic resources organizing itself, and this activity is largely independent of external demands. It is also largely independent of whether the brain is in a waking state, a sleep state, or under anesthesia. This activity is organized into a number of resting state networks that are associated with particular functional domains. Among the resting state networks, the first among equals is the Default Mode Network, which describes the core brain state in the absence of external demands.

Resting state networks were first identified in functional magnetic resonance imaging through their persistent patterns of functional connectivity. Such functional connectivity is the defining characteristic of the functional integrity of the resting state networks. It can be readily argued that the ILF neurofeedback training impinges directly on the functional connectivity of the resting state networks and thus restores their operational utility. Since the connectivity relationships in the unchallenged state are persistent over long time scales, they are expected to correlate with infra-low frequency components of the slow cortical potential. It is likewise easy to defend the proposition that the central causal mechanism of PTSD is

the disruption of the functional connectivity of resting state networks. Once a nervous system has been severely traumatized, its ability to return to appropriate resting states has been compromised.

The failure mechanism being postulated lies substantially in the functional domain, and hence should be subject in principle to rather complete remediation. Moreover, since the status of resting state network integrity underpins all of observable brain function, it is not surprising that the ILF training should have such a broad clinical footprint.

The Method of Alpha-Theta Training

A second aspect of the neurofeedback training program is the use of what has become known as Alpha-Theta training. The training is done under eyes-closed conditions with auditory feedback indexing alpha or theta dominance in the EEG. This promotes a shift toward states of lower arousal and toward states of internal engagement. The trainee may experience the state as a zone of safety, of safe harbor. Executive control is diminished for the duration; the internal censor is silenced to an extent; and the mind is freer to explore its internal terrain. Often the trainee experiences a degree of internal peace and calm that is beyond the person's prior experience, and that is quite welcome. At other times or in other cases, the mind mobilizes to engage the prior traumas. However, because the trainee finds himself in a state of low arousal, abreactions are not triggered. The training effects a decoupling of the historical memory from the physiological response to that memory. Re-experiencing will have been averted. The trauma is experienced in what has been called a 'witness state.' This process is usually quite benign and proceeds without drama. Once the decoupling of physiological responding has been accomplished with a particular traumatic memory, it is unlikely to ever become an issue again. Hence, Alpha-Theta training is an effective physiologically based method of de-fusing specific traumatic memories.

More generally, Alpha-Theta training can be helpful in restoring integrity to the wounded Self. This is traceable perhaps to the subjective sense of wholeness and of wellbeing that may accompany the Alpha-Theta experience. Reactivity may be profoundly diminished. Fractured relationships can be repaired, sometimes in very short order. The trainee may emerge with a more positive and confident outlook. This aspect of the training is nicely complementary to the ILF training discussed above.

CAMP PENDLETON'S DEPLOYMENT HEALTH CLINIC

Clinical Practice and Observations of Infra-Low Neurofeedback as an Adjunctive Treatment

April 26, 2011

Presentation by: Maj. Michael Villanueva, MSC, USA(Ret.), Ph.D.;
Anna Benson, Ph.D.; Tamsen LaDou, GS, Ph.D.

The following information, presented at the COSC Conference 2011, by clinical psychologists from Camp Pendleton detailed results of their work in neurofeedback with over 350 active duty service members.

The first part of the presentation, by Michael Villanueva, described the neurofeedback method being employed and the Default Mode Network. This was followed by a description of how neurofeedback is incorporated within the overall program at the Deployment Health Clinic, by Anna Benson. Two case reports were then presented by Tamsen LaDou. Finally, Michael Villanueva showed videos documenting rapid recovery from PTSD and TBI in a soldier at Fort Hood. These videos are available on-line at youtube.com/homecoming4vets. Subsequently, he showed results of a preliminary analysis of the cumulative tracking data that have been gathered at Camp Pendleton.

Description of Neurofeedback and the Default Mode Network

Michael Villanueva, Ph.D.

We wanted to be here today to share our experience working with Neurofeedback to treat active duty service members. We feel this is a relevant story and we wanted to share some suggestive trends from our work. We hope you will agree there is something here worth exploring

Neurofeedback is a specialty form of biofeedback. It started in the 60s through 70s and into mid 80s with Barry Sterman at UCLA in studies on uncontrolled epilepsy. Alpha training started even earlier to reduce anxiety and matured into Alpha Theta.

Neurofeedback is conducted in the same manner. There are three approaches:

1. Targets known mechanisms of brain regulation at specific EEG frequencies.
2. Targets deviations from "normal" brain activity as discerned in quantitative EEG analysis (QEEG).
3. By analogy to traditional biofeedback, the brain witnesses its own activity at infra-low frequencies (ILF Training) and thus alters its own function.

The Quantitative Electroencephalogram was first introduced to neurofeedback in the 90s. The QEEG evaluates overall brainwave function and the resulting waveforms are statistically analyzed. Z scores are compared to a normative

database matched on age and gender. As Hammon (2006) notes: neurological and medical disorders have concomitant non-typical EEG patterns.

The Infra-Low Frequency (ILF) approach was introduced at the 2008 COSC conference by Siegfried Othmer, Ph.D. Here, he referenced the CRI-Help Study, based on Peniston protocols. Infra-Low is a different approach from QEEG, and more relevant to our population, where state changes required active clinical monitoring and clinical response. As in CBT, ILF is clinician-based training, as opposed to a treatment. This training is rooted in bipolar placement, where three electrodes are used. The amplifier subtracts the activity of one site from the other and feeds the difference back to the patient.

What are we physically doing? We select two sites, place three electrodes and subtract one signal from the other, while feeding the difference back to the brain real time. The clinician monitors state changes. The task the patient is doing during Infra-Low neurofeedback is simply to watch movement and hear sounds from a screen. The brain has the task of relating what it experiences to its own internal processes.

THIS is the singular most important key to Infra-Low neurofeedback.

Infra-Low Neurofeedback
Why are so many of our patients highly attentive to repetitive (and frankly boring) movement, and sound keyed in real time to their EEG? Clinical work supports Marcus E. Raichle's argument against a reflexive brain model:
"The function of the brain is fundamentally intrinsic, involving information processing for interpreting, responding to and predicting environmental demands."

The brain loves to see its influence in the world and is always asking: Did I cause that? The brain's fundamental currency is information.

Default Mode Network (DMN)
Low frequencies may affect a series of interconnected large networks / regions which increase activity when the brain is in a resting state and decrease its activity transitioning from a resting state during goal-directed tasks. This network is called the Default Mode Network (DMN).

Reference: Marcus E. Raichle (Mar 2010) Two views of Brain Function

DMN represents the brain's internal state in the absence of active engagement with the outside world. DMN appears preparatory - it facilitates a smooth transition to more engaged states. We are "tilting" the brain's DMN and it uses its regulatory resources to react.

Unknown Causal Mechanisms
Why is the frequency so important? We absolutely have not the slightest idea. We do know that the lower the frequency, the faster symptoms resolve and the more a person's state will shift in session. Thus, the clinician must be finely tuned to the patient.

Clinical Implementation: Neurofeedback within Deployment Health

Anna Benson, Ph.D.

In our Standard Intake Process, an entering service member (SM) is given an education on COSC and on PTSD, and is presented with treatment options. Referral is made to COS groups and psychiatric care as needed. Evidence-based treatments are offered. Adjunctive therapies of biofeedback and neurofeedback are offered if appropriate.

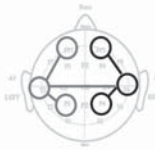
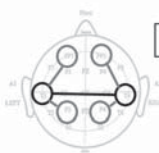
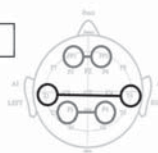
Appropriateness is judged on several criteria. The SM must be able to commit to 20 sessions of training. Neurofeedback

is particularly recommended if the SM refuses medication, or if there is resistance to the therapeutic process. Also it is recommended in the event of cultural or language barriers. Finally, it is recommended in the case of severe insomnia, of symptoms of hyper-arousal, or if alexithymia is identified.

The positive aspects of Neurofeedback include a high retention rate in SM's receiving Neurofeedback. Unrecognized mTBI symptoms are treated through this therapy. Overall cognitive functions are enhanced and it appears to assist in the overall regulatory regime. Also, it is non-invasive.

Symptoms are reviewed at the first session, and the SM is oriented to the instrumentation and the process. All SMs begin with the same initial starting conditions with respect to protocol (.0001 Hz). If unpleasant sensations arise, the protocol is altered accordingly. In this manner, the training becomes individually optimized for the SM. The majority of trainees is comfortable with the starting protocol and are given a homework sheet.

Basic Neurofeedback Sites and Infra-Low Reward Frequencies

For People with:	Starting Sites	Add Next	Add Other Basic Sites	Reward Frequency Rules
Early Development or Attachment Issues Autism, CP Attachment disorders Personality disorders Addictions, PTSD				**Start T4-P4** 0.0001Hz and go up only as needed **Add next T4-Fp2** with RF same as T4P4 **Add other basic sites as needed** T3-T4 RF same as R-side L-side RF = 2 x R-side RF*
Instabilities (And No Attachment Issues) Migraines, vertigo, seizures, panic, asthma, mood swings, irritable bowel, hypoglycemia, traumatic brain injury, etc.		 OR		**Start T3-T4** 0.0001Hz and go up only as needed **Add other L and R-side basic sites as needed** Or- **Add inter-hemispheric sites** for more stabilizing effect Fp1-Fp2 RF = T3-T4 RF / 2 P3-P4 RF = T3-T4 RF/ 4
Other Issues (And No Instabilities or Attachment Issues) Physical calming Emotional calming Mental calming				**Start T3-T4** 0.0001Hz and go up only as needed **Move next to T4-P4 and T3-Fp1** T4-P4 RF same as T3-T4 T3-Fp1 RF = 2 x R-side RF* **Add other L and R-side basic sites as needed**

For all groups: Add other placements as needed for specific symptoms. Some people need reward frequency = 0.0001 Hz at all sites.*

EEG Institute 7/2011

The current state of the SM is established in the first training session, on the basis of response to the reinforcement. This is referred to as 'awake-state' training, to contrast it with respect to the Alpha-Theta training to follow. Session duration is 30 minutes, irrespective of the number of placements trained (ranging from one up to four or even five). Sessions 10-20 combine the awake-state training with Alpha-Theta. Physiological state is monitored throughout the session, as the SM is prompted to share information about ongoing state shifts. Alertness and drowsiness are monitored throughout. Although immediate clinical results are not expected, they are often observed. The SM is charged with reporting on changes in symptoms, behavior, and level of function from session to session. The SM is thoroughly debriefed at every session.

The provider plays an integral part in the clinical administration of infra-low frequency neurofeedback. With respect to the actual training, the provider selects the target frequency and decides upon appropriate electrode placement. Both target frequency and placement may be changed within the session and from session to session as needed.

Neurofeedback training results in self-regulation. Although not a cure, it helps the CNS to re-regulate. We suspect that we are building resilience as the brain is exercised. This is a training, not a treatment. As we experiment with the optimal number of sessions and alternative electrode placement, our method is continually being refined.

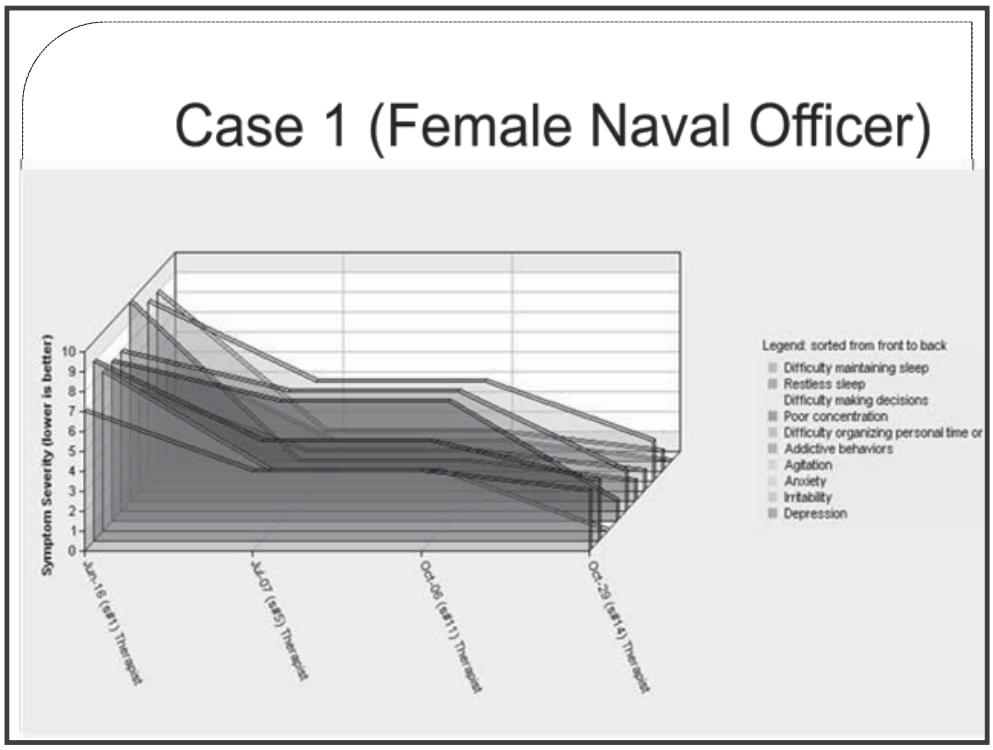
Two Case Presentations

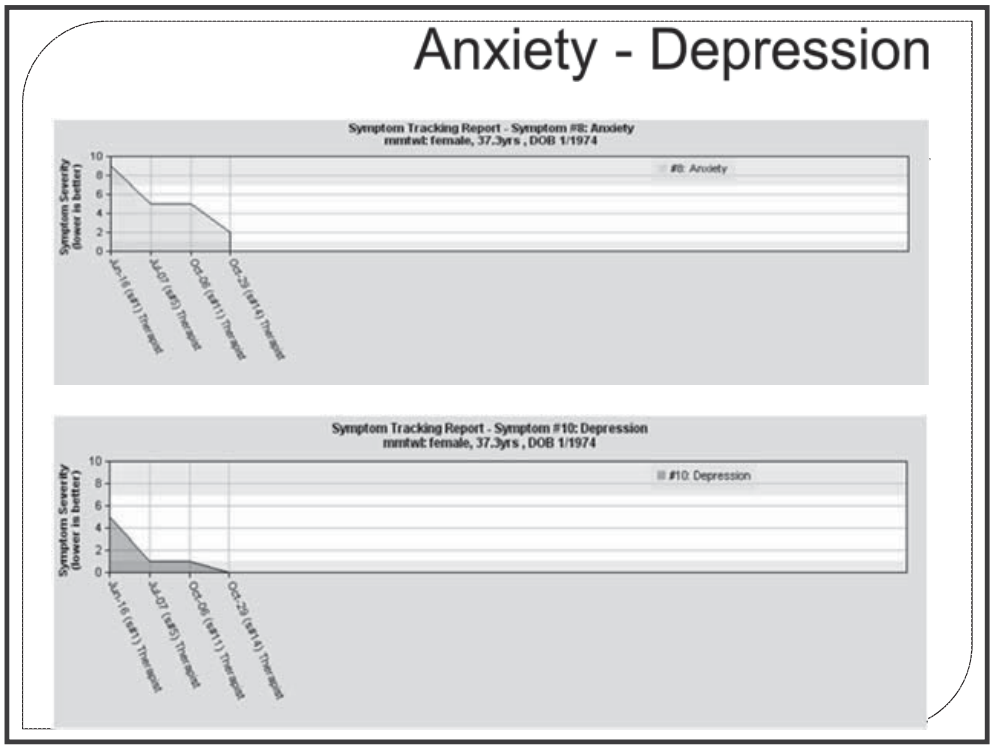
Tamsen LaDou, Ph.D.

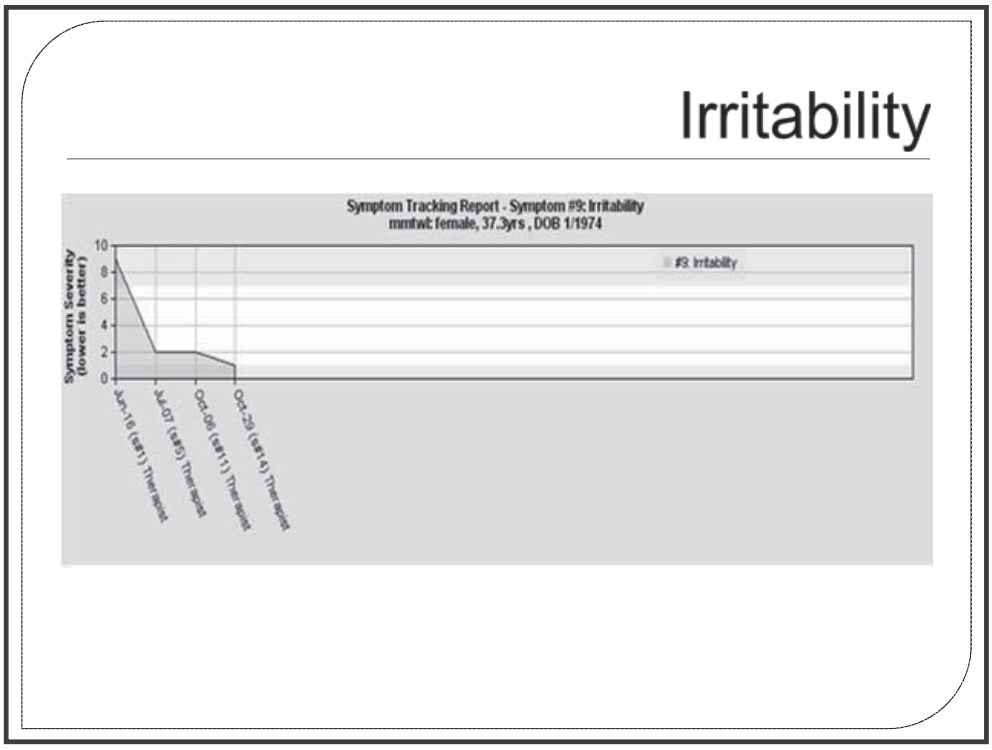
Case 1 (Female Naval Officer)

2 deployments in Iraq, most recent in 2008
Worked in STP's with little difficulty prior
Critical incident: Family member at home while deployed
Sx presented on deployment: panic, anxiety, depression and irritability
Medications:

SSRI
Ambien prn for sleep
Xanax prescribed prn for panic attacks.







Medical History Case 2 (M)

Post-deployment from Iraq 2007 experienced a fall from a vehicle that resulted in a frontal lobe injury and depression fracture - Surgical repair of fracture

Two weeks later experienced severe H/A 4-5x/wk that became chronic over next several yrs.

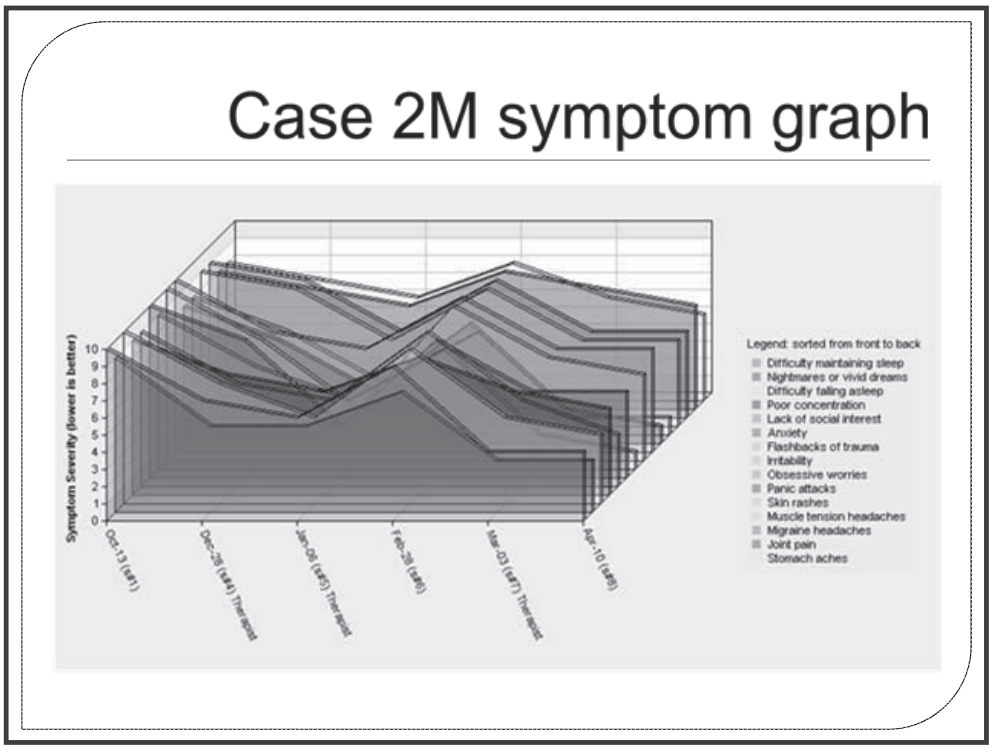
Presented at DHC with chief complaint: irritability

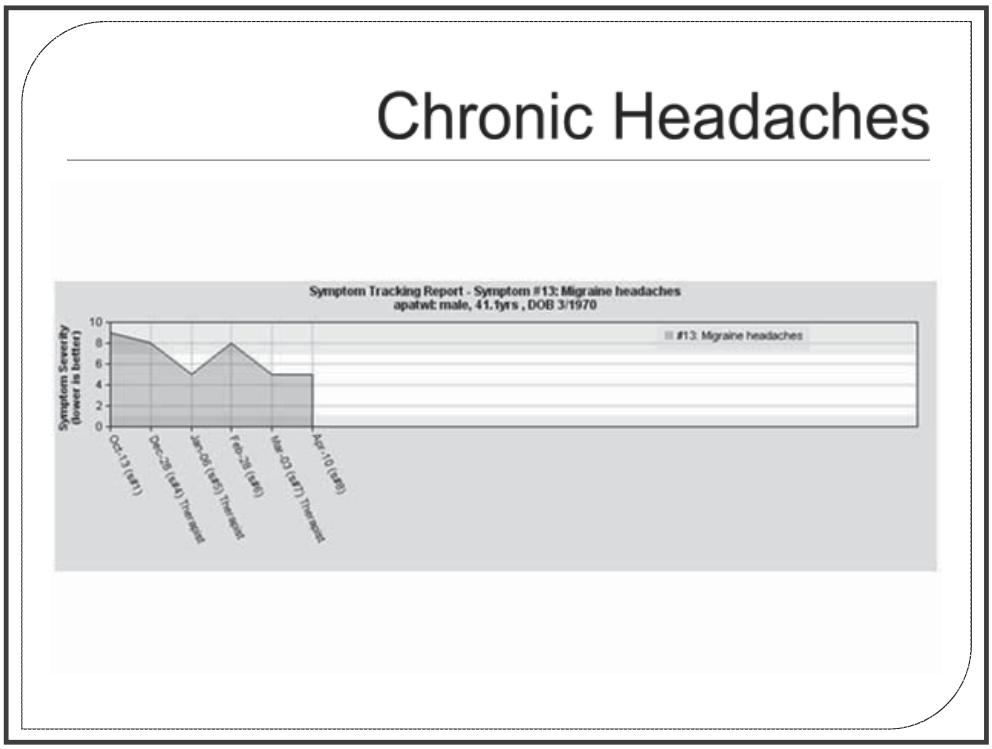
MEDICATIONS: (current)

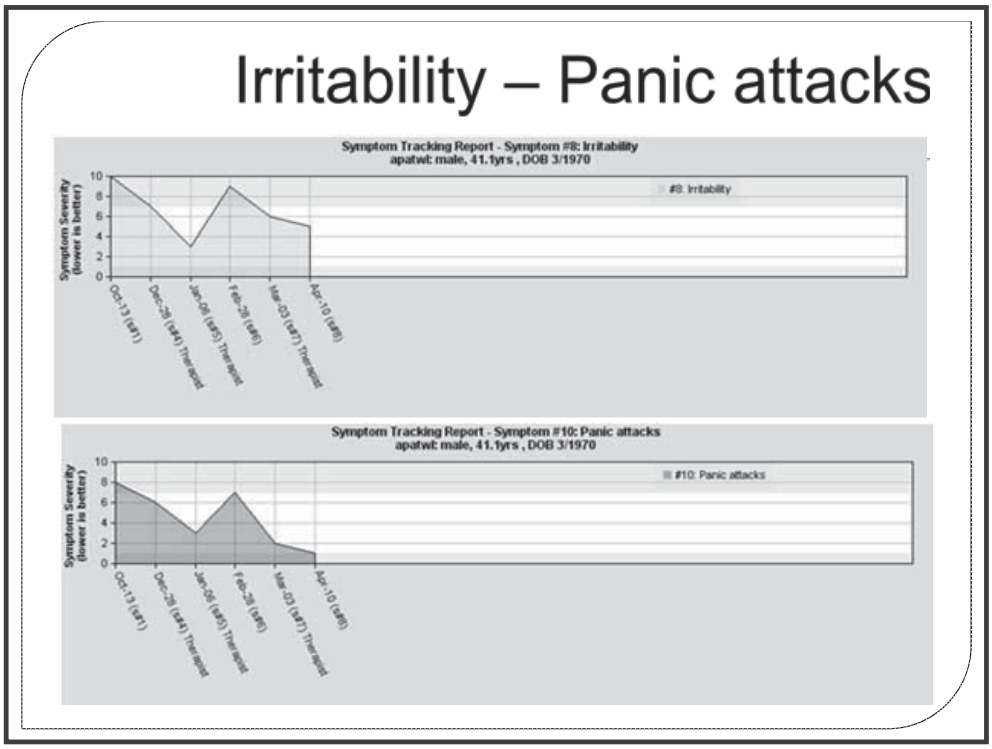
Amitriptyline

Trazedone for sleep

Medication for treatment of migraine headaches



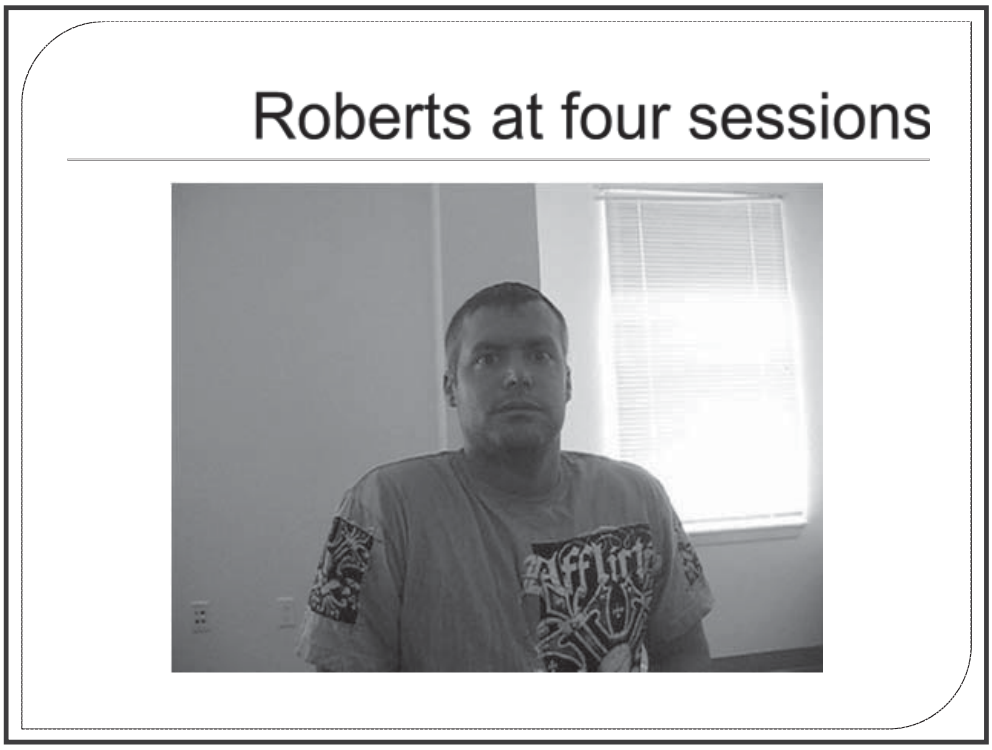


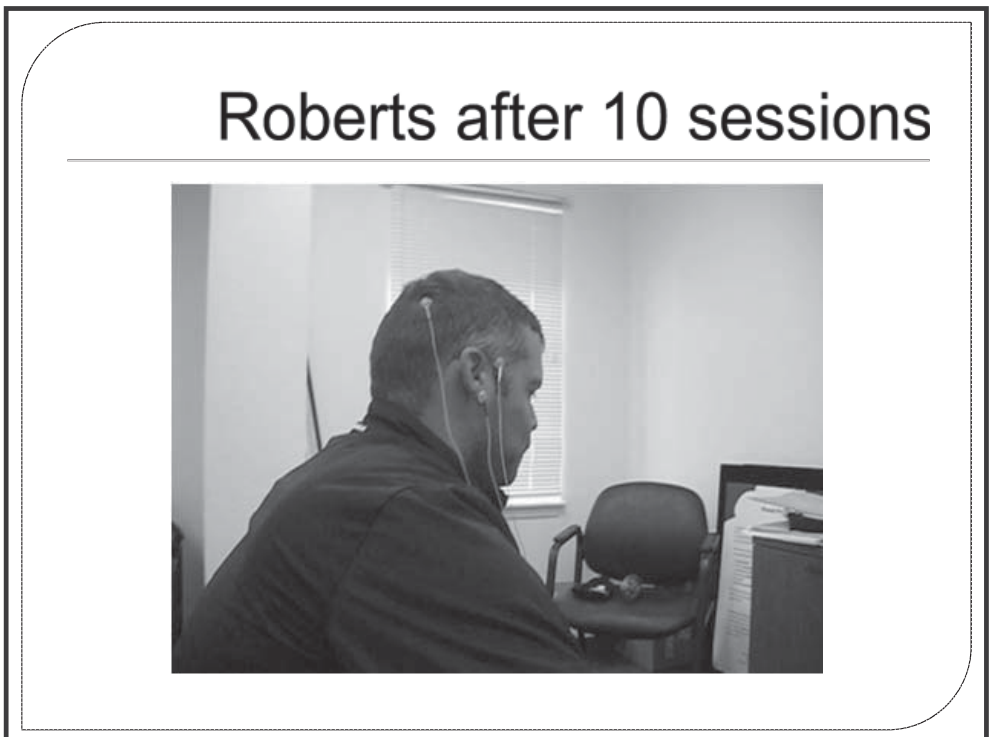


Fort Hood - Sergeant Roberts Videos
Michael Villaneuva, Ph.D.

Put a face on infra-low neurofeedback
Two videos, both about 2 minutes long
None were pre-planned
First shot after 4 sessions

Second shot at the end of the 10th session immediately after patient had watched his first video
Fluidity of movement?
Prosody / tonal quality in voice?
How many facial expressions?
How attractive is he?
Scale of 1-10 rate his humanity: 1= Zombie 10 = Someone you would hang with





Michael Villaneuva: "I don't think there is any assessment tool that we have in psychology that can capture the emergence of that humanity."

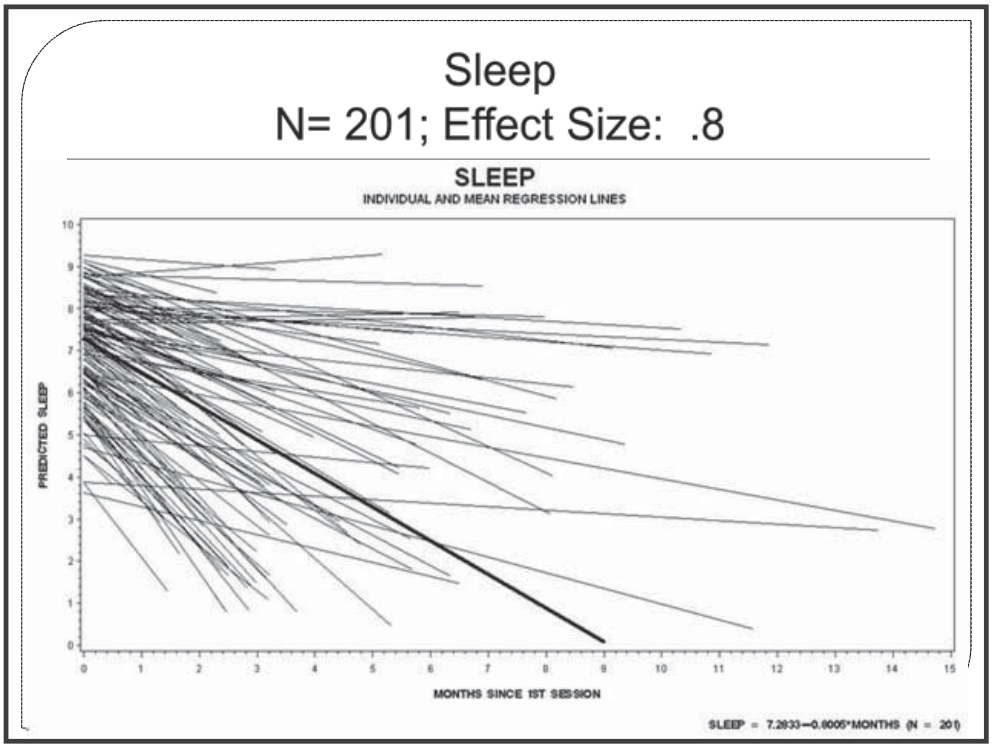
Qualitative and Quantitative Observations of Infra-low Neurofeedback

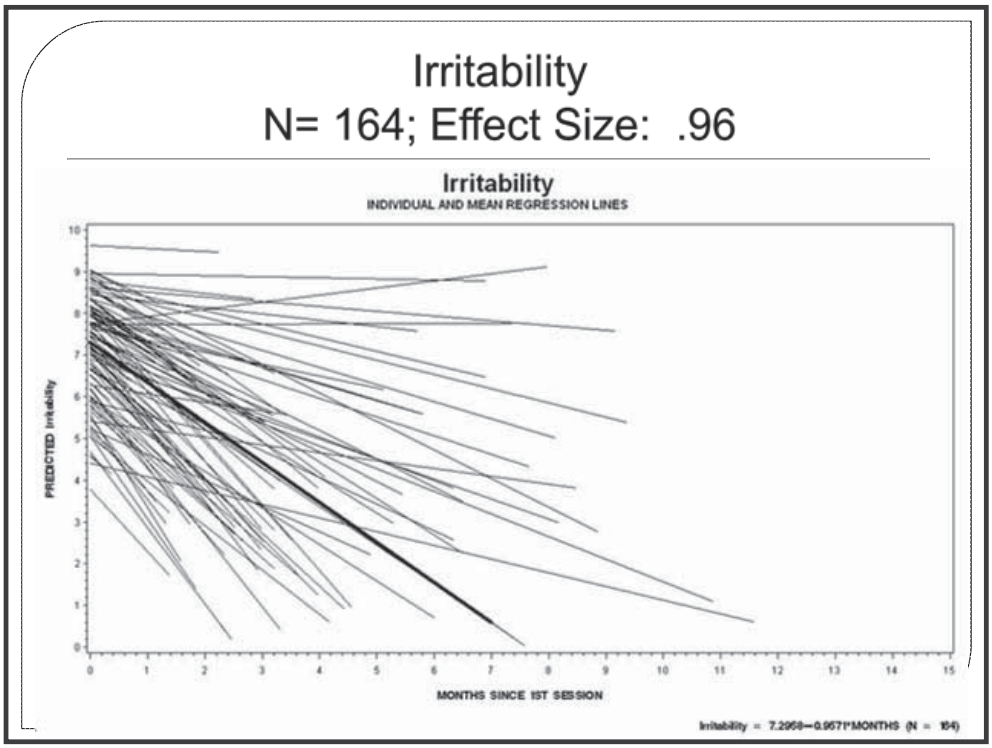
We never set out to do research but what we saw caused consistent wonder and disbelief. We played with a few numbers to see if the trends suggested a rigorous clinical study.

The structure of the Symptom Tracker and manner in which symptoms were selected for inclusion proved problematical to do a traditional analysis. Therefore, we reviewed trends for approximately 350 cases.

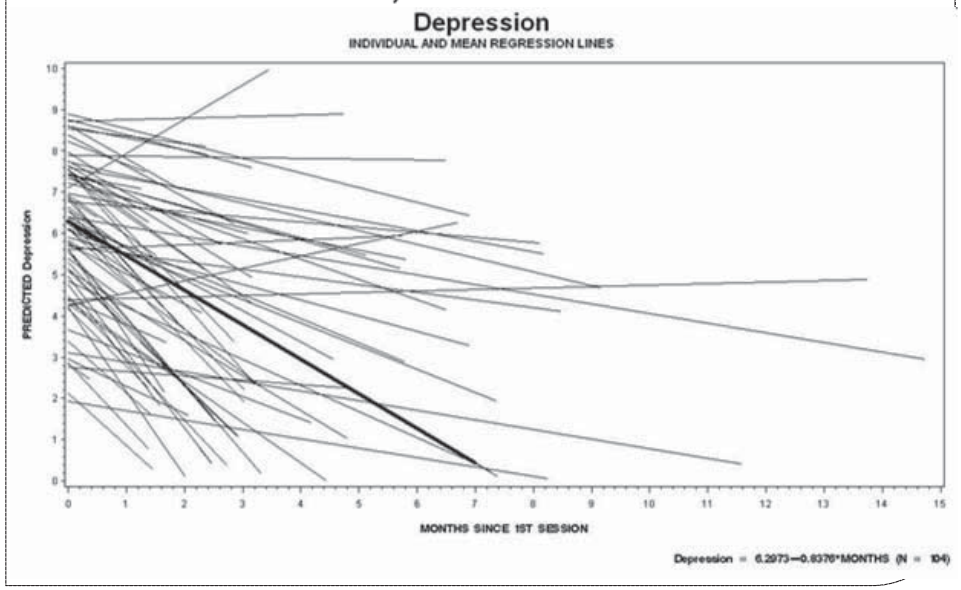
Hierarchical Random Coefficient Model

Linear mixed models handle data where observations are not independent and correctly model correlated errors.The random coefficient model mashes everyone's data. It estimates each person's regression line as a random deviation from the mean and finds the average regression line using ALL data points.

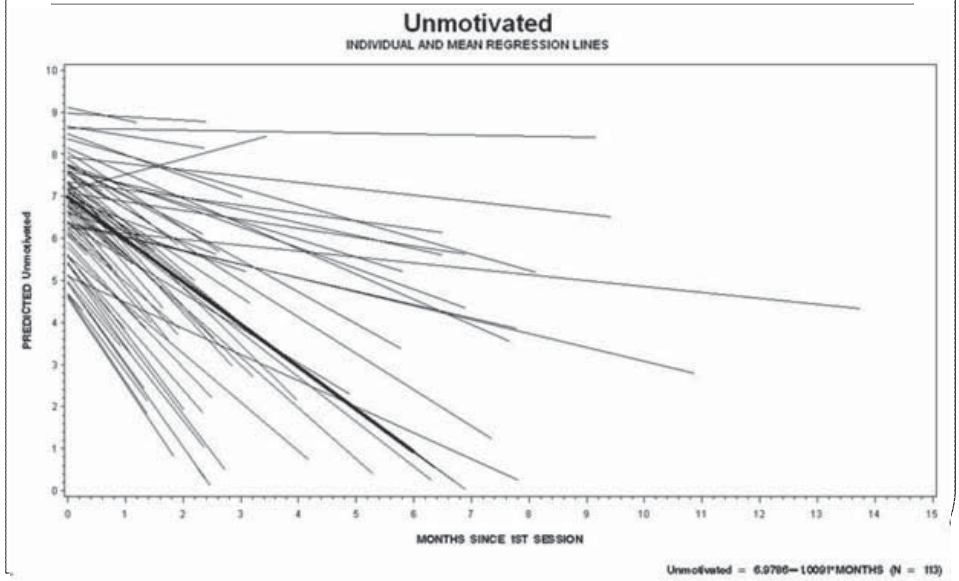




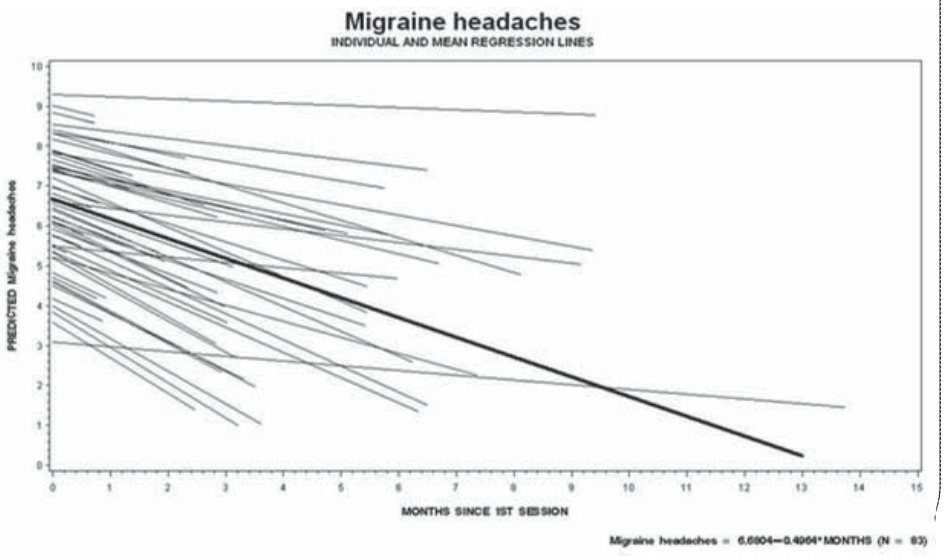
Depression
N= 104; Effect Size: .84



Unmotivated
N= 113; Effect Size: 1



Migraine Headaches
N= 83; Effect Size: .5



Regression Effects Across a Few Variables

PENDLETON MIXED MODEL SUMMARY

DV	Effect	Estimate	StdErr	DF	tValue	Probt
Difficulty maintaining sleep	Intercept	7.2931	0.1711	156	42.62	<.0001
Difficulty maintaining sleep	MONTHS	-0.9526	0.116	105	-8.21	<.0001
Nightmares or vivid dreams	Intercept	6.9288	0.2024	105	34.23	<.0001
Nightmares or vivid dreams	MONTHS	-0.971	0.1372	72	-7.08	<.0001
Night sweats	Intercept	5.9065	0.3315	44	17.82	<.0001
Night sweats	MONTHS	-1.0092	0.1856	32	-5.44	<.0001
Poor short-term memory	Intercept	7.2958	0.167	141	43.7	<.0001
Poor short-term memory	MONTHS	-0.5765	0.08474	99	-6.8	<.0001
Unmotivated	Intercept	6.9786	0.1943	112	35.91	<.0001
Unmotivated	MONTHS	-1.0091	0.136	76	-7.42	<.0001
Irritability	Intercept	7.2958	0.1567	163	46.56	<.0001
Irritability	MONTHS	-0.9571	0.1001	110	-9.56	<.0001
Agitation	Intercept	6.7656	0.2122	91	31.88	<.0001
Agitation	MONTHS	-0.6074	0.1102	57	-5.51	<.0001
Depression	Intercept	6.2973	0.2412	104	26.11	<.0001
Depression	MONTHS	-0.8376	0.1289	82	-6.5	<.0001
Flashbacks of Trauma	Intercept	6.4916	0.2683	59	24.19	<.0001
Flashbacks of Trauma	MONTHS	-0.5092	0.1366	40	-3.73	0.0006
Migraine Headaches	Intercept	6.6804	0.2528	82	26.43	<.0001
Migraine Headaches	MONTHS	-0.4964	0.09372	56	-5.3	<.0001

Multiple Caveats and Substansive Trends
These results are despite multiple dataset weaknesses, despite self-selected sample, and despite the argument about regression to the mean. Nearly all regression slopes show exceptionally powerful and provocative trends, with effect sizes across 45 symptoms averaging about .8.

In Sum: What We See We are Doing
We show the brain its own activity and it responds! It self regulates.As it regulates, it calms itself. As it calms itself, sleep deepens and is more restful. As sleep deepens, mood & cognition improves, anger and irritation subside, motivation returns, energy levels increase, and the cognitive fog clears.

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KEY POINTS

Over 350 cases of PTSD with or without TBI were tracked through neurofeedback training.

Over 60 symptom categories were tracked.

The video of Sergeant Roberts demonstrates quick training effects for PTSD/TBI combination.

45 symptom categories were analyzed quantitatively.

Average effect size of 0.80 was found for the 45 symptom categories.

This is a large effect size.

RECOVERY FROM PTSD: A VIETNAM VETERAN

by Siegfried Othmer, Ph.D.

February 19, 2009

We have just experienced a remarkably quick recovery from PTSD symptoms in a Vietnam veteran. The case is illustrative of the more rapid pace of recovery that is achievable with the latest neurofeedback techniques that encompass the infra-low range of EEG frequencies. The veteran has had a forty-year history of PTSD, and was rescued from homelessness by the Salvation Army here in Los Angeles. He came to our offices for intensive neurofeedback training through the auspices of the Salvation Army. In exchange for our providing services at no cost, the veteran has allowed us to make his case history available for the benefit of other clinicians.

For scientific purposes, the veteran has agreed to undergo pre-post quantitative EEG analysis (courtesy of QMetrx) and SPECT imaging (courtesy of the Amen Clinics). As the training is still on-going, these pre-post comparisons are not yet available. However, we do have initial symptom-tracking data that already tell quite a story. Symptoms are assessed on the basis of self-report at typically three-session intervals. Severity is rated on a ten-point scale. Results for the first eighteen training sessions are shown in Figure 1. Overall symptom reduction reached 50% by session ten, and was more than 80% by session eighteen. The symptom list was broadly inclusive, and covered a number of areas not considered to be classically associated with PTSD. Eleven out of the twenty major symptoms were rated at zero by session 18. None were rated higher than 4 out of ten by session 18. The picture is one of broad improvement in self-regulatory capacity.

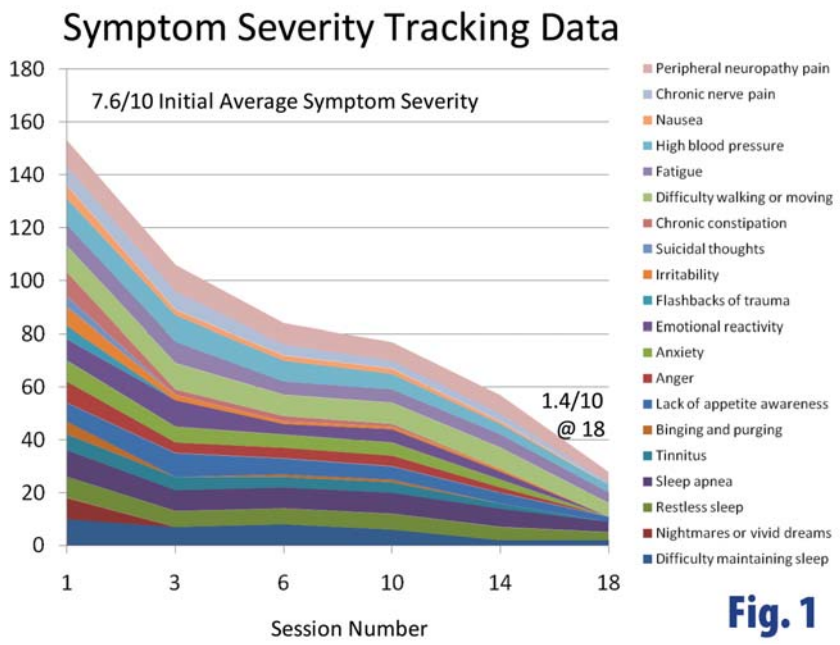


Fig. 1

The picture is actually even more dramatic when data are segregated for the symptoms commonly associated with PTSD. These are shown in Figure 2. With regard to PTSD symptoms, overall improvement reached 50% within three sessions, and reached 93% in 18 sessions. Even more significantly, nightmares, flashbacks, suicidal thoughts, and binging and purging were all eliminated within three sessions. These were the most troublesome PTSD-related symptoms. The most persistent symptoms related to the quality of sleep. At the first QEEG session it became obvious that the veteran was suffering from sleep apnea. He was unable to stay awake for the QEEG assessment. This was a problem during the early neurofeedback sessions as well. By session 18, he was getting through entire alpha-theta sessions without falling asleep. Other persistent symptoms relate to motor function and mobility. Currently the veteran remains confined to a wheelchair. The improvement in hypertension is not entirely attributable to neurofeedback: as a result of the training, the veteran was motivated to be more consistent in taking his blood pressure medication.

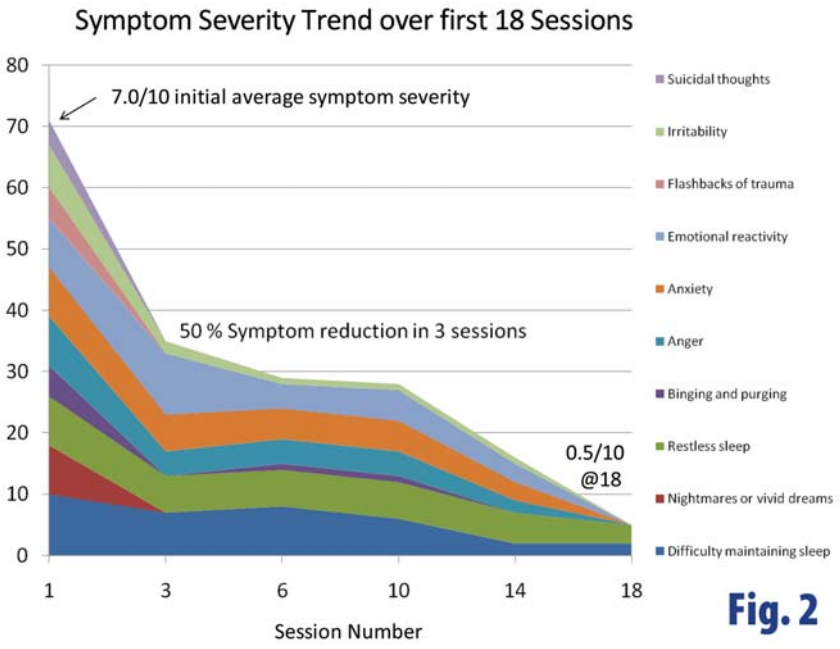


Fig. 2

Ratings for a military standard PTSD checklist are also available, and are shown in Figure 3 for comparison of pre-training values with those after session 19.

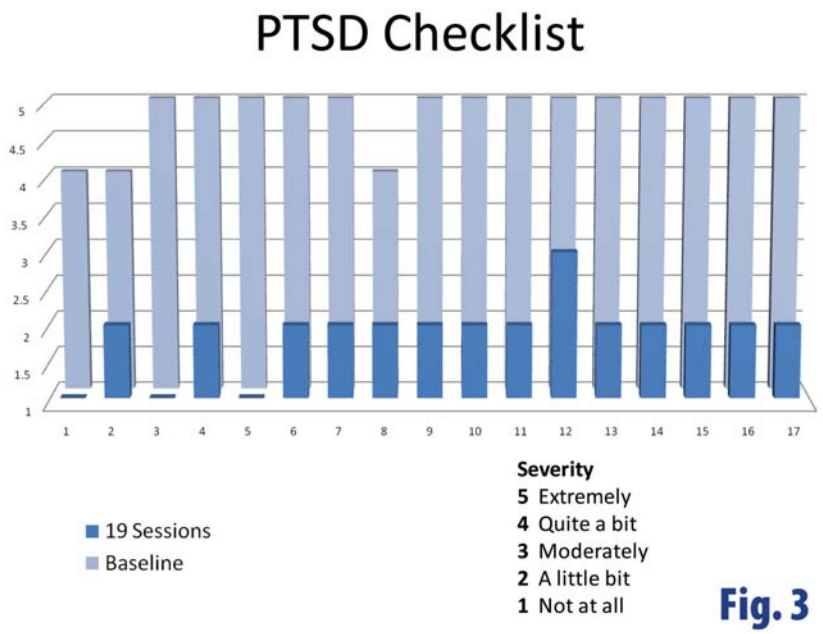


Fig. 3

EEG training is continuing, but the focus is shifting toward alpha-theta training in order to allow the veteran to come to terms with the extraordinary life changes that he is now undergoing. He remains in a fragile state, full of ambiguity regarding his future. The remaining symptoms no doubt call for longer-term training: sleep quality; mobility and motor control; peripheral neuropathy pain (secondary to diabetes). But the focus will increasingly shift toward functional augmentation and away from symptom reduction.

The veteran was trained with our standard set of single-channel bipolar protocols, using reinforcement at the optimum reward frequency (ORF), combined with multiple inhibits.

The migration to infra-low frequencies is not an arbitrary choice on our part but rather is dictated by the response to the reinforcements. However, in nearly all cases of PTSD the ORF appears to fall within the infra-low range of frequencies, i.e. below 0.1 Hz. The selection of the optimum reward frequency is critical to success in this process, and even seasoned neurofeedback clinicians are strongly cautioned not to undertake this training casually or without proper professional training in this particular method.

Legend for PTSD Checklist:

How much have you been bothered by each problem in the last month?

1. Repeated, disturbing memories, thoughts, or images of a stressful military experience?
2. Repeated, disturbing dreams of a stressful military experience?
3. Suddenly acting or feeling as if a stressful military experience were happening again (as if you were reliving it)?
4. Feeling very upset when something reminded you of a stressful military experience?
5. Having physical reactions (e.g. heart pounding, trouble breathing, or sweating) when something reminded you of a stressful military experience?
6. Avoid thinking about or talking about a stressful military experience or avoid having feelings related to it?
7. Avoid activities or situations because they remind you of a stressful military experience?
8. Trouble remembering important parts of a stressful military experience?
9. Loss of interest in things that you used to enjoy?
10. Feeling distant or cut off from other people?
11. Feeling emotionally numb or being unable to have loving feelings for those close to you?
12. Feeling as if your future will somehow be cut short?
13. Trouble falling or staying asleep?
14. Feeling irritable or having angry outbursts?
15. Having difficulty concentrating?
16. Being "super alert" or watchful on guard?
17. Feeling jumpy or easily startled?

The rapid response of PTSD to this straight-forward neurophysiologically-based technique supports the case for neurofeedback as a primary intervention for PTSD, leaving the cognitively-based and psychodynamic therapies for a later role as the person attempts to reconstruct his or her life. When this case is placed in the context of similar such cases in our clinical experience, we have a demonstration here of a benign alternative to exposure-based therapies and other labor-intensive, extended therapies to effect recovery from the symptoms of PTSD. Recovery is also much more comprehensive than would be expected with any psychologically-based technique, including EMDR. The report also demonstrates that the duration of symptoms (40-some years in this case) does not stand in the way of effecting substantial recovery, nor does the extremity of initial symptom severity. This case, among others, holds out significant hope for the large number of Vietnam veterans who still suffer from PTSD to this day.

It is particularly heartening that with this training the suicidal ideation ceased almost immediately. We have just recently crossed the threshold at which more Vietnam veterans have been lost to suicide since the war than we had war casualties in theatre. The potential for improving the quality of life of our remaining Vietnam veterans through neurofeedback is immense.

In this regard, it is also significant that we are coming to this task with an entirely new approach. By now the typical Vietnam veteran is quite settled in terms of expectations for his future, and no doubt brings a healthy skepticism to any invitation to further "therapies." Neurofeedback can be successfully promoted to such a skeptical audience because the focus is entirely on enhancing function. The elimination of symptoms is a side effect of the process of restoring functionality and wholeness. Although clinicians would obviously like to have a full picture of what they are up against, it is not even necessary for the vet to disclose all of what bothers him. The project can succeed entirely with a focus on enhancing the brain's functional scope. No failures or shortcomings need to be acknowledged to qualify for neurofeedback. No personality issues need to be bored into. No blame needs to be placed or responsibility assigned. One simply trains the central nervous system to self-regulate, and the brain to perform better, in a manner that is unique to each nervous system.

With neurofeedback we can counter the hidden fear of many long-term disabled veterans that their symptoms are their indispensable lifeline to continued disability compensation. The realistic prospect of fully restored functionality must be in prospect, not mere symptom relief. With this veteran, we have passed only the first milestone. The second one remains.

To view a short documentary on this case study go to:
youtube.com/homecoming4vets

KEY POINTS

40-year history of PTSD post-Vietnam.

Living in Salvation Army homeless shelter.

20 PTSD-related symptoms tracked through training process.

4 major symptom categories eliminated in three sessions.

50% reduction in severity of classic PTSD symptoms within three sessions.

90% reduction in symptom severity in 18 sessions.

Global symptom picture: >80% reduction in severity in 18 sessions.

Gains continued to accrue post-training.

Now living independently.

NEUROFEEDBACK RESEARCH

Relevant Research Papers Substance Abuse, and Minor Traumatic Brain Injury

Trauma reactions and substance abuse often go together. In the following, we list the research on substance abuse first because historically it led into the work with Post-Traumatic Stress Disorder. The ground-breaking research was performed by Eugene Peniston, a psychologist working at the VA with Vietnam veterans. Much early work led up to his studies, but his were the first to combine the relevant techniques in a formal controlled design. His studies were also the first to achieve such outstanding results.

ADDICTIONS & POST-TRAUMATIC STRESS DISORDER:

In the following ground-breaking study, Peniston and Kulkosky demonstrated enhanced relapse prevention in a group of chronically relapsing Vietnam veteran alcoholics with the addition of Alpha-Theta Neurofeedback. All ten experimentals were able to sustain prevention of relapse (in two cases only after brief relapse), while all ten controls relapsed over an eighteen-month period. All had had a minimum 20-year history of alcoholism, and a record of at least four (average 5.4) treatment failures. Subsequent tracking of the experimentals showed abstinence to be maintained over ten years (one succumbed to cirrhosis of the liver in that timeframe).

Alpha-Theta Brainwave Training and Beta-Endorphin Levels in Alcoholics
by Peniston EG and Kulkosky PJ
Alcoholism: Clinical and Experimental Results, **13(2)***, 271-279(1989)*

From the Abstract: An Alpha-Theta brainwave biofeedback training program was applied as a novel treatment technique for chronic alcoholics. Following a temperature biofeedback pre-training phase, experimental subjects completed fifteen 30-min sessions of Alpha-Theta biofeedback training...These experimentally treated alcoholics showed sharp reduction in self-assessed depression...13-month follow-up data indicate sustained prevention of relapse in alcoholics that completed Alpha-Theta training.

A second publication followed a year later in which Peniston and Kulkosky presented data documenting the personality changes in the experimentals vis-à-vis the controls:

Alcoholic Personality and Alpha-Theta Brainwave Training
by Peniston EG and Kulkosky PJ
Medical Psychotherapy: An International Journal, 3, pp.37-55 (1990)

From the Abstract: The Millon Clinical Multiaxial Inventory (MCMI) and the Sixteen Personality Factor questionnaire (16PF) were employed to assess personality differences and changes among chronic alcoholics and non-alcoholic controls prior to and after either traditional medical treatment or Alpha-Theta brainwave treatment of the alcoholics...Administration of EEG Alpha-Theta brainwave treatment was accompanied by significant decreases in MCMI scales labeled schizoid, avoidant, passive-aggression, schizotypal, borderline, paranoid, anxiety, somatoform, dysthymia, alcohol abuse, psychotic thinking, psychotic depression, and psychotic delusion. Alcoholics receiving standard medical treatment showed significant decreases only in two MCMI scales, avoidant and psychotic thinking, and an increase in one scale, compulsive. On the 16 PF...EEG Alpha-Theta treatment corresponded to significant increases in warmth, abstract thinking, stability, conscientiousness, boldness, imaginativeness, and self-control. These personality differences and changes in alcoholics...provide confirmatory evidence that the application of Alpha-Theta brainwave treatment produces fundamental changes in alcoholic personality variables. These changes may underlie the sustained prevention of relapse...

Peniston recognized that recovery from alcoholism in his veterans really amounted to recovery from their Post-Traumatic Stress Disorder, so his two follow-up studies treated PTSD as the primary focus rather than the alcoholism. But they were in fact intimately related in this population, and the therapeutic approach was identical.

Alpha-Theta Brainwave Neurofeedback Therapy for Vietnam Veterans with Combat-Related Post-Traumatic Stress Disorder
by Peniston EG, and Kulkosky PJ
Medical Psychotherapy, 4, 47-60 (1991)

From the Abstract: The Minnesota Multiphasic Personality Inventory (MMPI) was used to assess personality changes in Vietnam combat veterans with Post-Traumatic Stress Disorder, after either traditional medical treatment or Alpha-Theta neurofeedback brainwave therapy. Application of brainwave training for thirty 30-minute sessions resulted in decreases in MMPI T-scores on clinical scales labeled hypochondriasis, depression, hysteria, psychopathic deviate, masculinity-femininity, paranoia, psychasthenia, schizophrenia, hypomania, and social introversion-extroversion. The traditional medical control group showed decreases only in the schizophrenia scale...A thirty-month follow-up study showed that all fourteen control patients had relapsed, in contrast to only three of fifteen brainwave training patients.

In the above study, the PTSD subscale of the MMPI decreased 50% for the experimentals, and not at all for the controls. In a subsequent study, Peniston evaluated an Alpha-Theta training instrument that offered four-channel synchrony training in an outcome study on dual diagnosis Vietnam combat veterans.

EEG Alpha-Theta Brainwave Synchronization in Vietnam Theater Veterans with Combat-Related Post-Traumatic Stress Disorder and Alcohol Abuse
by Peniston, E.G., Marrinan, D.A., Deming, W.A., & Kulkosky, P.J.
Medical Psychotherapy, 6, 37-50 (1993)

From the Abstract: An experimental group of 20 male Vietnam combat veterans with a diagnosis of Post-Traumatic Stress Disorder and alcohol abuse were treated with Alpha-Theta brainwave neurofeedback therapy. Alpha-Theta brainwave therapy produced significant increases in the percentage of synchrony in brain channel pairs in the frontal and parieto-occipital lobes of the cerebral cortex.

Twenty-six month follow-up with these veterans found that four of the twenty had shown a recurrence of PTSD symptoms, whereas sixteen remained in symptom-free status. A summary of the Peniston-Kulkosky method, along with references to the antecedent work and the subsequent replications, can be found in the following:

The Peniston-Kulkosky Brainwave Neurofeedback Therapeutic Protocol:
The Future Psychotherapy for Alcoholism/PTSD/Behavioral Medicine
by Peniston EO Ed.D., A.B.M.P.P., B.C.E.T.S., F.A.A.E.T.S.

Electroencephalographic (EEG) biofeedback has been in use since the early 1970's for treatment of anxiety disorders and a variety of psychosomatic disorders. Early work conducted by researchers such as Kamiya and Kliterman (1970) focused on alpha wave biofeedback. Much of this initial research associated changes in EEG state with different states of consciousness (Basmajian, 1989)...

The second major controlled study to evaluate Alpha-Theta training for substance dependency was co-sponsored by our group and by CRI-Help, a residential treatment center in North Hollywood in the 1995 timeframe. The objective was to do the first study with a large subject pool, and to provide the service with the existing staff in a real-world setting. The addition of EEG feedback to conventional treatment improved relapse prevention by a factor of 3.3. Relapse prevention was sustained among the experimentals, as documented in three-year follow-up. Additionally, the experimentals demonstrated better attentional functioning and improved mental health status as indexed by the MMPI.

Effects of an EEG Biofeedback Protocol on a Mixed Substance Abusing Population

by Scott WC, Kaiser DA, Othmer S, Sideroff SI

The American Journal of Drug and Alcohol Abuse, 31:455-469, 2005

From the Abstract: This study examined whether an EEG biofeedback protocol could improve outcome measures for a mixed substance-abusing population. 121 volunteers were randomly assigned to the EEG feedback or control group. EEG biofeedback included training in beta and SMR to address attentional variables, followed by an Alpha-Theta protocol... Experimental subjects stayed in treatment significantly longer than the control group. Of the experimental subjects completing the protocol, 77% were abstinent at 12 months, versus 44% of the controls. Experimental subjects demonstrated significant improvement on the TOVA (Test of Variables of Attention). Following Alpha-Theta training, significant improvements were noted on five of the ten MMPI-2 scales. This protocol enhanced treatment retention, attentional variables, and abstinence rates one year following treatment.

When the relapse data were calculated with respect to entry into the program, where the two populations were matched, the outcomes favored the neurofeedback group even more strongly: 81% of the controls had relapsed by the one-year point, whereas 62% of the experimental subjects were maintaining relapse-free status. That's a ratio of 3.3 in success rate. Three-year follow-up (unpublished data) showed the experimentals to be holding their gains, whereas the controls continued to attrition into recurring dependency.

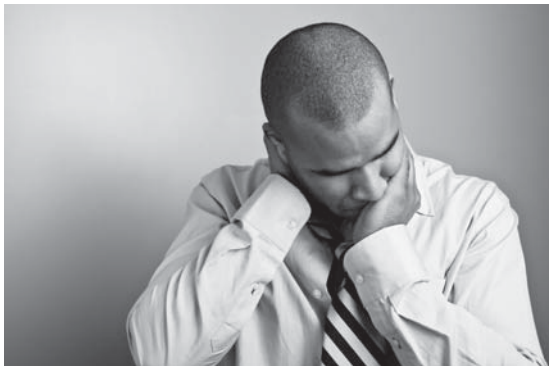
One of the principal replication studies is the following:

Alpha-Theta Brainwave Neurofeedback Training: An Effective Treatment for Male and Female Alcoholics with Depressive Symptoms

by Saxby E and Peniston EG

This was an experimental study of 14 alcoholic outpatients using the Peniston and Kulkosky (1989, 1991) brainwave treatment protocol for alcohol abuse. After temperature biofeedback pre-training, experimental subjects completed twenty 40-minute sessions of Alpha-Theta brainwave Neurofeedback training. Experimentally treated alcoholics with depressive syndrome showed sharp reductions in self-assessed depression (Beck's Depression Inventory). On the Millon Clinical Multiaxial Inventory-I, the experimental subjects showed significant decreases on the BR scores: schizoid, avoidant, dependent, histrionic, passive-aggression, schizotypal, borderline, anxiety, somatoform, hypomanic, dysthmic, alcohol abuse, drug abuse, psychotic thinking, and psychotic depression. Twenty-one-month follow-up data indicated sustained prevention of relapse in alcoholics who completed BWNT. *(Note: Only one of the fourteen was recorded as having relapsed.)*

Numerous other small-scale replications have been published over the years.



ANXIETY AND STRESS:

Biofeedback is of course known for its role in stress management and in the remediation of anxiety disorders. So when EEG biofeedback came along years later, it was not thought necessary to prove the case all over again with regard to EEG as a measure. But in fact EEG feedback may hold an advantage even for anxiety and stress management by addressing brain regulating networks more directly. This may be because the anxiety is more deeply rooted in trauma histories, or it may be that the anxiety is secondary to other dysregulations in brain networks. In any event, EEG feedback should be considered along with traditional biofeedback in the management of anxiety disorders. The response may be very quick (i.e., single-session response), as demonstrated in the following study of Army Reservists involved in a combat stress exercise.

The Effects of Brief, Eyes-Open Alpha Brain Wave Training with Audio and Video Relaxation Induction on the EEG of 77 Army Reservists
by Putman J M.A.

It was found that eyes-open alpha enhancement training resulted in substantial increases in activity in the feedback band (alpha) with smaller increases in low beta and decreases in theta. This is quite a different result than one would expect from general “relaxation” training that is usually accomplished with eyes-closed and yields substantial increases in both alpha and theta...

BRAIN TRAUMA:

When it comes to traumatic brain injury, we face the double difficulty that many of the deficits of which victims complain do not show up on the classical imaging techniques that reveal structural injury in the brain. These deficits only show up in the more recent, and more expensive, functional brain imaging that is rarely ordered when victims first present with minor head injury. So victims often go undiagnosed, yet their deficits are debilitating and may linger indefinitely.

These deficits are traceable to the kind of dysregulation in the cerebral networks that is responsive to EEG Neurofeedback training, as documented by the following reports:

Impact of qEEG-Guided Coherence Training for Patients with a Mild Closed Head Injury
by Walker JE M.D., Norman CA, Weber RK
Journal of Neurotherapy, 6(2), 31-43 (2002)

Recovery from mild closed head injury (of >50%) was noted in 88% of the patients (mean recovery, 72.7%). All patients reported that they were able to return to work following the treatment, if they had been employed prior to the injury. On average, 19 sessions were required, less than the average of 38 sessions required using power training of Cz-Beta in our previous unpublished study.

Conclusions: In this uncontrolled open trial of QEEG-guided coherence training, the majority of patients with mild closed head injury experienced substantial and rapid symptomatic improvement, including return to work. Further study with controls and additional outcomes measures is warranted.

The following report reviews prior Neurofeedback work with minor traumatic brain injury, compares outcomes for various therapeutic approaches, and makes the case for the author's own approach to EEG Neurofeedback for brain injury. Individual case histories are presented rather than group data, in view of the heterogeneity of clinical presentations in TBI. The effect sizes are much larger with neurofeedback than for any other intervention.

Electroencephalogram Biofeedback for Reading Disability and Traumatic Brain Injury
by Thornton KE Ph.D. and Carmody DP Ph.D.
Child and Adolescent Psychiatric Clinics of North America, 14, 137-162 (2005)

From the Summary: Our society has spent billions of dollars on efforts to remediate the cognitive and behavioral dysfunction in individuals with learning disabilities and TBI through various cognitive-based strategies. The evidence accumulated to date indicates that few of these intervention efforts demonstrate efficacy. When change is measured for the more traditional approaches, the change scores typically result in improvements in the 0.0 SD to +0.5 SD range, often after lengthy intervention periods. Research completed to date and clinical reports show greater improvements with EEG biofeedback with these two groups.

The following study shows that EEG feedback can also improve the regulation of autonomic measures. Effects are not restricted to cognitive and executive function, emotional regulation and pain control. This is one of a series of four papers covering in detail the recovery of 27 TBI patients using Neurofeedback.

EEG NeuroBioFeedback Treatment of Patients with Brain Injury: Part 3: Cardiac Parameters and Finger Temperature Changes Associated with Rehabilitation
by Laibow RE M.D., Stubblebine AN MSc, Sandground MB DSc

Twenty-seven patients with brain injury were treated by computer-assisted electroencephalographic NeuroBioFeedback (EEG-NBF).

From the Summary: Neurobiofeedback in patients with brain injury results in beneficial physiological regulation in addition to initially targed improvements in brain function.

KEY POINTS

Three successive studies by Peniston and Kulkosky on dual diagnosis Alcoholism and PTSD first established evidence base for biofeedback plus Alpha-Theta training in remediation.

Scott, Kaiser, Othmer, and Sideroff replicated Peniston with large-scale study with three-year follow-up. Used EEG biofeedback exclusively in place of biofeedback.

Saxby and Peniston added yet another replication of the original Peniston studies.

Jointly these studies support the claim that neurofeedback is evidence-based for the remediation of PTSD.

Several studies document recovery from TBI.

PUBLICATIONS

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SPECIAL ISSUE

Post Traumatic Stress Disorder—The Neurofeedback Remedy

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Keywords: post-traumatic stress disorder, neurofeedback, low frequency training, arousal regulation, attachment

The application of neurofeedback to post traumatic stress disorder (PTSD) in returning veterans is described herein and is illustrated with two case histories. Initially, frequency-based electroencephalogram training was employed to promote functional recovery, in the manner of the traditional sensorimotor rhythm/beta approach. An optimization procedure was employed in which the reinforcement frequency is tailored to the client on the basis of symptom response, with particular regard for the regulation of arousal. Low frequencies, down to .01 Hz, have been found especially useful in the remediation of post-traumatic stress disorder. This training was complemented with traditional alpha-theta work as pioneered at the Menninger Foundation and by Peniston. The objective here is experiential, because prior traumas typically are revisited in a nonforced, nontraumatic manner. The benign witnessing of traumas consolidates the experience of safety for which the prior training laid the groundwork. Collectively, this approach has been found to be much better tolerated than traditional exposure therapies. In addition, it is helpful in the shedding of substance dependencies that are common in treatment-resistant PTSD

Introduction

Neurofeedback protocols have continued to evolve in clinical practice to cover domains of function that were not originally envisioned in the application of sensorimotor rhythm/beta (SMR/Beta) training to seizure management and attention-deficit/hyperactivity disorder. The breadth of applications is now such that our thinking with respect to neurofeedback should not be organized around specific clinical conditions at all. It may be argued that neurofeedback impinges on entire regulatory systems, and these now include not only the domain of cognitive and executive function but of emotional control, autonomic regulation, and interoception as well. This opens the door to the remediation of conditions such as post-traumatic stress disorder (PTSD) that involve rather global dysregulations in the "body-mind."

The human regulatory regime can be modeled as a network, quite irrespective of whether we are speaking of the neural networks specifically. And if we impinge upon the functional organization of our neural networks through feedback, then the effects are communicated to the entire regulatory network through both synaptic and nonsynaptic interactions. Advantage is taken of the high level of functional integration of our regulatory regime. Hence, neurofeedback is a candidate approach even if matters concern primarily autonomic dysregulations that, to date, have been the domain of the standard peripheral biofeedback approaches. A choice between them must be made on the basis of relative clinical efficiency rather than of mere efficacy.

The most characteristic and troublesome symptom of PTSD is that of reexperiencing, and this involves an evocation of the original system response to the trauma in all its particulars. By virtue of the salience of the original trauma, the entire event is registered in the body-mind as a unitary memory. (There is survival value in the trauma being remembered permanently, so in that sense the system is working as it should.) Subsequent recall of the event then involves the whole memory, including not only the specific, explicit "event memory" but also the accompanying implicit "state memory" that is diffusely registered throughout the body. With a concatenation of traumatic events, the body-mind eventually accommodates to a perpetual state of anticipating threat, at great cost to the person's well-being and functionality. Unsurprisingly, this state of readiness typically defies therapeutic attempts to effect its extinction because it is grounded in our most basic survival mechanisms.

The remedy lies in giving the body-mind the visceral experience of calmness to which it no longer has access, and in reinforcing that state to the point where the body can once again live there in the steady state. Cognitively based methods don't accomplish this task very well. A psychophysiological approach is called for. Neurofeedback is one such approach, and in the following we report on our experience using this method.

Models for Neurofeedback Intervention

Neurofeedback lends itself to this task for several reasons. First of all, it is a ready means for shifting the arousal level of the trainee in a controlled fashion. Second, in contrast to biofeedback techniques, the control is bidirectional—one can move the person up or down in arousal level arbitrarily. Third, with neurofeedback one is operating in a much larger variable space than is the case with peripheral biofeedback. The whole frequency range of the electroencephalograph (EEG) is available, as well as all scalp locations. This provides the opportunity for both specificity in the pursuit of training objectives and the fine-tuning of the particulars. That allows the process to be implemented with a finesse that simply is not available with other methods.

Inevitably, of course, the availability of a large variable space has resulted in the proliferation of clinical methods to exploit the new feedback possibilities that have opened up. An attempt to categorize all of the major approaches has just been published in a book chapter (S. Othmer, 2008). For present purposes, however, a different classification is appropriate. Broadly speaking, neurofeedback approaches either target specific dysfunctions that are observable in the EEG or they promote function more generally. In practice, these disparate approaches are often combined.

These two basic approaches each have their relative strengths. The specific targeting has its advantages for conditions with a strong cortical representation, such as specific learning disabilities. The more general mechanisms-based targeting is appropriate for the deeper, more diffuse, more thorough-going, and nonspecific dysregulations that characterize many of the mental health issues that have been hitherto intractable. PTSD falls in the latter category.

In our application of mechanisms-based training, we orient primarily to the person's state of arousal. Reference here is to tonic rather than phasic arousal, and even though our immediate observations indicate arousal state, we are really interested in trait arousal. The neurofeedback challenge gently moves the person in level of arousal to permit exploration of his or her "state space." The immediate objective is to find the person's comfort zone, the point at which the challenge of neurofeedback can be best tolerated going forward. This comfort zone is highly individual, and indexes for us the person's intrinsic trait arousal level (Othmer & Othmer, 2007).

The analogy to "still-point" training in movement therapy may be helpful here. Feldenkrais (1949) found that small excursions around the point of ease served to reorganize the control of movement in a gentle and unforced manner. What Feldenkrais accomplished externally we are accomplishing in top-down fashion via the EEG. In both instances, the exercise serves to improve regulatory capacities more generally. Motor function is the observable for Feldenkrais; arousal regulation is the observable for us.

Arousal, as we use the term, can be thought of as a composite of many specific activations, for example, cognitive arousal; autonomic arousal and balance; excitability of our sensory systems; set-point of motor system excitability; and activation of the executive control system. The most basic of all of these systems, and perhaps for that reason the most obscure, is the state of our emotional ambient, related to our intrinsic sense of safety in the world. The strongest inputs to our brainstem arousal regulation mechanisms are from the limbic system.

Systemic Approaches: Alert State Training

With every potent neurofeedback challenge we affect the state of arousal in general, and by means of specific electrode placements we can bias the training toward certain system activations. In the case of PTSD, for example, we bias the EEG feedback training toward the right hemisphere, which is dominant for the organization of our affective domain. Physical calming is achieved by targeting the right parietal region; emotional calming and stability are targeted with right prefrontal training. Other placements may be included for other aspects of dysfunction. All right-side trainings employ T4 as a common reference in bipolar montage, and all left-side trainings employ T3 as a common reference. Overall system stability is promoted with the interhemispheric bipolar placement T3-T4.

The reward frequency is adjusted during the first session to the state in which the person is maximally calm, alert, and as euthymic as the nervous system is capable of being at that moment. The fine-tuning is done on the basis of client report on their own status. This approach is often referred to as optimum reward frequency (ORF) training. The reward frequency can be anywhere in the EEG frequency range below nominally 45 Hz, but it tends to be very low in PTSD, extending down to as low as .01 Hz. The use of rewards set at such low frequencies is a relatively new emphasis in our approach to neurofeedback, discussed in greater detail in S. Othmer (2008).

At such low frequencies, one may well ask whether we are still targeting the EEG or whether we are interacting with peripheral physiology. Operationally, of course, it does not matter. All that can be said at this point is that the behavior we observe is on a complete continuum with what we observe at higher EEG frequencies. In particular, the narrowness of the optimum frequency range can be

quite striking in both domains. A person who responds well to .02 Hz reinforcement may respond less well to .04 Hz and .01Hz. At higher frequencies, a person who responds well to 14 Hz reinforcement may respond less well to 13.5 and 14.5 Hz. We therefore appear to be interacting with a resonant system (which is how the EEG is organized) in both domains. Additionally, a recent publication speaks of the EEG rhythmicity being observable down to .01 Hz (Kelly, Uddin, Biswall, Castellanos, & Milham, 2008).

A very practical issue arises of how one gives good feedback on such low-frequency signals. The utility of the low-frequency training actually was uncovered with the same instrumentation that is used at higher reward frequencies. In both cases, the client is only given information on short-term changes in the EEG signal. The brain is biased in favor of the detection of change, and thus to the highest frequency components of the reward signal. In order to make the brain sensitive to the slower components of the EEG, the higher frequency components have to be masked. As in heart rate variability training, attention focuses on the moment, but ultimately, the entire low-frequency waveform is affected by the experience.

Systemic Approaches: Deep State Training

The second phase of our approach to PTSD is essentially the alpha-theta training pioneered at the Menninger Foundation and first formally investigated for PTSD by Eugene Peniston (Peniston & Kulkosky, 1999). In our implementation we employ two-channel sum training at P3 and P4 to promote global synchrony in the parietal and occipital region. The nominal theta band is centered on 7 Hz and the alpha band is centered on 10 Hz for most individuals.

The principal objective here is experiential. Alpha and theta synchrony moves the person to deactivated states and promotes disengagement, particularly under the eyes-closed conditions in which the session transpires. The state silences the inner verbal censor and it expands the dimensions of self-awareness. The state is experienced nonlexically, that is, in terms of imagery. Trauma-related imagery that arises in this context typically does so without evoking the usual physiological response. The benign experience of the trauma event essentially reprograms the memory as a merely historical one. The success of this strategy, as well as the relative absence of abreactions, is attributable to the fact that the ground has been prepared by the prior alert-state training to acclimate the nervous system to living in calm states. The training program is illustrated by the following two case histories.

Two Cases of PTSD

We are providing neurofeedback to veterans with PTSD at no cost as part of our nationwide program of participating neurotherapists, Homecoming for Veterans. In return, some veterans are giving us the right to talk about their cases in detail. One allowed his entire training experience to be videotaped for the benefit of other neurofeedback professionals. This case is presented briefly below in order to illustrate the flow of the work.

Case One: "K."

K. is a Canadian veteran of the Bosnian conflict. He had been through 10 years of various conventional therapies for PTSD, but in the course of these his deepest traumas could never be touched. His wife initially discouraged his participation in neurofeedback, fearing yet another disappointment. The early history of this person disclosed that he was born prematurely and spent the first 3 weeks in an incubator, with possible implications for early attachment. Later in life he experienced a concussion in an automobile accident, which is likely to have been a psychological trauma as well as a physical one. Both of these may have served as priming events for the subsequent trauma formation.

The initial evaluation disclosed the following primary symptoms: flashbacks, panic attacks, phobias, daily headaches, hypervigilance, mood swings, anxiety and depression, fatigue, anger, chronic body pain, tinnitus, bruxism, irritable bowel, asthma, hand tremor, nail biting, poor memory and concentration, and a tendency to bump into things while walking. He complained of fitful sleep (3 hours at a time), nightmares, and night sweats. He reported out-of-body experiences. There was also a problem of binge drinking, and K. exhibited a lack of appetite awareness. He scored four standard deviations below norms on omission errors, and two standard deviations below norms on variability of reaction time. Medications included Remeron for depression; Zopiclone for sleep; Clonazepam for anxiety; Flovent for asthma; and Tramacet for pain. Ongoing therapies included massage and chiropractic.

The burden of the first neurofeedback session is to characterize the response of the nervous system and find the optimal training conditions. K. came into the session with a headache and with body tension in the back and hands. He complained of back pain and fatigue. These symptoms are used to judge the quality of the training. The initial placement of T3-T4 is commonly used to establish the optimum reward frequency. The first trial reward frequency was 9.5 Hz. After 3 minutes K. reported reduced tension in the jaw. His headache had moved and decreased in severity.

He felt calmer and more awake. After 3 additional minutes at 8.5 Hz his headache was mostly gone; his hands felt less tense; and he felt more calm and relaxed. After 3 additional minutes at 7.5 Hz, K. felt that back tension was reduced, and he continued to feel more awake. After 3 minutes at 6.5 and 5.5 Hz the back was no longer tense, although it was still sore. After 3 minutes at 4.5 Hz, K. felt some anxiety in the chest and throat. This was possibly better after 3 minutes at 3.5 Hz and nearly gone after 3 minutes at 2.5 Hz. However, now K. complained of eyestrain. This was reduced after 3 minutes at 1.5 Hz. After 3 minutes at 1 Hz, K. reported increased salivation, and after 3 minutes at .5 Hz, then at .25 Hz, and then at .1 Hz, he felt positively hungry. He had not eaten all day. The final training epoch took place at .05 Hz, after which K. felt very relaxed, lighter physically and mentally, and his eyes betrayed the hint of a smile.

On the basis of this initial training experience, subsequent training sessions focused on the very low frequency range. Significant training milestones included the following: After this first session he was able to go to the grocery store, where he was previously troubled by spatial disorientation. His headache did not return, but he came to the second session with neck pain. This was eliminated with 10 minutes of training in the parietal region (P4-T4). No pain was reported after the second session; no need for a nap; tremor was reduced; no nightmares or night sweats—very unusual. After the third session, the sight of garbage bags in the building elevator triggered a flashback. After Session 5 the same scene elicited no reaction.

Alpha-theta (A/T) training was introduced at Session 8. He felt "strangely calm" after the session, and pronounced it "awesome. I can't wait to do it again." Memories came up for him without emotional reaction. He saw the images dissolve in water. He was very energized after the A/T session. He boldly took a trip to Walmart, which went fine until beeping at the checkout counter reminded him of mine detectors. K. went deeper in the second A/T session, reporting a visit from his deceased grandfather. The session reactivated a pain in his right leg. After this session he slept through the night for the first time since beginning the training. The next A/T session was accompanied by muscle pain everywhere. New memories were coming up and being processed.

Seeing the homeless people around the office begging for food triggered a flashback. And seeing a car accident on a mountain highway took him back to Bosnia. After Session 11 he reported smoking less—out of habit more than felt need. He started to feel a need to be creative. After Session 13 he reported feeling "like a million bucks." He planned to go to a movie theater that evening for the first time since he had his first panic attack in a movie theater.

The subsequent pattern was to train alternately with A/T and the alert-state training. At Session 14 he was able to talk about the war. K. also reported less obsessive-compulsive disorder–type checking and rechecking. Alpha-Stim™ Cranial Electrotherapy Stimulation treatment was added between sessions for increased calming. At Session 18, K. reported "craving" a return to neurofeedback after the weekend off. He also was craving the A/T training. As the training drew to a close with Sessions 24 and 25, K. experienced the return of some anxiety about the return home. A pre-post symptom comparison is shown in the Table.

Essentially, all of the symptoms of which K. complained at the outset are robustly on the path toward resolution. The Continuous Performance Test was completely normalized. We would like to have had 40 sessions, but already after 25 sessions K. was moved to tell us: "Thank you for my new life." He had mastered traumas that he could never even broach during earlier therapies, and they had largely left the stage effortlessly. K.'s training is ongoing on a home-training basis to further consolidate his gains.

Case Study: "A."

The second veteran was more challenging, a Marine with a tough outer shell—a warrior's warrior. He came into the program drinking excessively and with no intention of altering his behavior. Normally we would not take such a person, because we cannot provide the complementary services of a residential treatment program, but we had committed to accepting all comers among veterans. This man had gone into Iraq with the initial assault, and he lost most of his buddies either in that campaign or later back home.

During the training his wife continued to support A. in his drinking habits because she found him nicer to be around. The perceived short-term benefits of drugs and alcohol are a reality to which we must accommodate. The initial burden of training is to take the nervous system to such a place of stability, functionality, and ease that the benefits of taking drugs are no longer seen as compelling. This objective was only beginning to be met for A. when his initial set of training sessions drew to a close. The schedule was inflexible because A. was traveling a significant distance for the treatment.

Initial complaints included hypervigilance, nightmares (3 per week), panic (1 per week), flashbacks, anger, mood swings, anxiety/depression, visual sensitivity, tinnitus, episodic hypertension, poor appetite awareness, and headaches with

Table. Pre-post comparisons of symptom severity for veteran K. before and after 24 sessions of neurofeedback	
Pretraining	**Posttraining**
Flashbacks commonplace	Flashbacks less often, less severe, shorter
Nightmares commonplace	Only one nightmare since training began
Night sweats commonplace	Only two night sweats since training began
Tunnel vision leading to panic	Less risk of panic; some precursor symptoms
Hypervigilance	Largely subsided
Sleep period of 3 hours	Sleeping through the night; reduced meds
Out-of-body experiences	No further reports
Bruxism	No longer using mouth guard
Binge drinking	No urge to get drunk
Depression	Depression much improved; still on meds
Tinnitus	No report of tinnitus
Hand tremor	Tremor only apparent when stressed
Irritable bowel syndrome (IBS)	IBS much improved; eating in restaurants
Asthma	Forgetting asthma meds without penalty
Obsessive-compulsive disorder	Only “checking” once a day at bedtime
Appetite awareness	No longer an issue
Headaches commonplace	No headaches after optimization of training
Body pain obtrusive	Body pain much reduced
Nail biting	Nail biting has ceased
Poor physical coordination	Less clumsy
Fatigue	No complaints of low energy
Mood swings	Remediated
Memory and concentration	Improved

exertion. At 24 sessions, the nightmares were resolved and flashbacks were receding as an issue. He felt more optimistic about life. However, many symptoms remained, and he agreed to additional training. The ORF was .05 Hz.

This case remains of particular interest because it illustrates the substantial resolution of core symptoms of PTSD even in the context of continuing abuse of alcohol. In the case of Peniston's work, the finding was typically of the joint resolution of PTSD and of alcoholism. In this case, the progress in training was documented with pre-post single photon emission computed tomography (SPECT) scans, which were done at the Amen Clinic in Newport Beach, California. These are shown in the Figure. The most obvious changes in the SPECT consisted of reduced overactivation of the anterior cingulate, the basal ganglia, and the cerebellum. Overactivation remains at the thalamus, which could indicate a residual propensity to depression.

In a subsequent training sequence, conducted after the post-SPECT were taken, A. was much more future oriented, and he was beginning to acknowledge his drinking habit as a problem. Again, however, the training epoch was limited in time, and more training is needed.

Discussion

Both of the above cases illustrate the essential features of our approach to resolving PTSD. The immediate target is a general improvement in self-regulatory capacity, using protocols to which every nervous system responds.

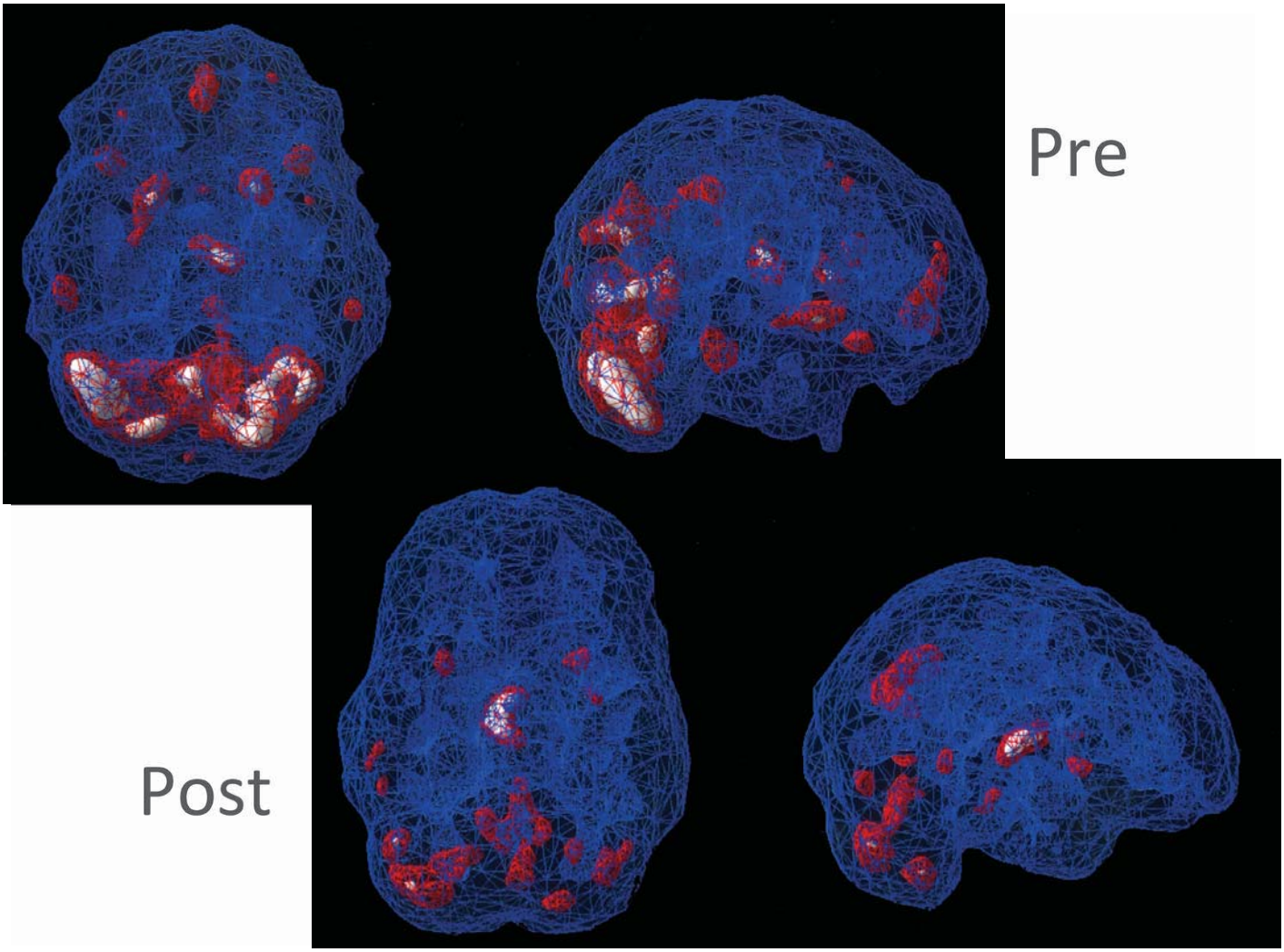

Figure. Pre-post single photo emission computed tomography scan data are shown for veteran no. 2, comparing pretraining conditions with those prevailing after 24 sessions. Classic signs associated with post traumatic stress disorder include elevations in activity at the anterior cingulate, the basal ganglia, and the thalamus. In posttraining data, the activity level at the anterior cingulate and basal ganglia are reduced. Additionally, the high activation of the cerebellum has been reduced. A color version of this figure can be found at http://www.aapb.org/magazine.html.

The guiding philosophy is that better function displaces dysfunction. Symptoms are merely the guideposts of progress; they determine the training procedures only in a very general way. One can think of this as a kind of "zone defense" approach to neurofeedback, in which certain functional domains are targeted in training rather than specific symptoms. Of course symptoms are relied upon to judge training priorities, and finally, outcomes, in addition to the guiding of optimization procedures in the moment.

In the initial thrust toward functional optimization, three or four basic protocols cover the ground and a subset of these is used with nearly everyone. The implication is that successful neurofeedback impinges upon the quality of communication of our neuronal networks in a very general, almost universal fashion. The brain is subtly challenged in its organization of timing and frequency, and the whole system of synaptic information transport is affected in consequence by virtue of its tight integration (S. Othmer, 2007). We get to observe the outcome of this process through explicit functional testing and the subsidence of symptoms.

The use of protocol-based approaches in neurofeedback has been well established since the very origins of the field. The principal novelty that has recently been brought to this approach is twofold: (a) individual optimization of reinforcement parameters; and (b) the extension of the work to very low EEG frequencies. The optimization strategy is its own justification. At nearly every session, an A/B comparison is made in which adjacent reward frequencies are compared in their effects on the trainee within the session, and different placements are evaluated as to their differential effects as well. This sequential and progressive optimization strategy brings the discipline of an internally controlled design into every neurofeedback training.

The extension of the work to low EEG frequencies simply follows from the first, an extension of the optimization procedure to wherever it might lead. The high "productivity" of the low-frequency challenge in neurofeedback, whenever such training is appropriate, is quite striking and begs for an explanation. One has the sense that the low frequencies may be foundational in the organization of the frequency relationships in the EEG. It is only at the low frequencies that we can even talk about persistent states. Organizing the continuity of states is one of the fundamental challenges for the brain. Much of psychopathology can be framed in terms of an inability of the brain to maintain continuity of function. And on the other end of the functional continuum, working memory capacity can similarly be modeled in terms of maintaining continuity of state under a challenge.

When it comes to the deepest and most thorough dysregulations of cerebral function, the disorder takes us right to these foundational frequencies upon which our cerebral symphony is constructed. Tracking symptoms is a sure way of directing our attention to the part of the frequency domain that is most in need of our attentions. It should come as no surprise that attention to how the nervous system actually responds to our intervention in the moment could lead us to the most effective training strategies.

If this picture is valid, then what we have found to be true for PTSD should have much broader clinical validity, and that is indeed the case. PTSD is at the extreme end of a continuum of responses to trauma. Dissociative identity disorder, borderline personality disorder, and reactive attachment disorder are other extreme manifestations of the same phenomenon. If early attachment does not develop as nature intended, the adverse consequences involve not only our emotional regulation but also the arousal regulation system, and from thence autonomic regulation and the whole orchestration of cerebral function. Unsurprisingly, this will manifest most obviously in those EEG frequencies that are the first to organize in the infant brain, those that underlie our persistent states.

If the brain is not able to maintain functional continuity at these low frequencies, the individual is much more vulnerable to subsequent insult, whether that be minor traumatic brain injury or psychological trauma. The statistics emerging from our clinical practice and that of others using these methods is that more than half of typical clinical populations optimize at the very low frequencies. The hypothesis should therefore be entertained that we are seeing the fallout of a combination of poor early childhood attachment bonding and of the prevalence of traumatic experiences (physical and/or psychological) in our lives. It is perhaps the very ubiquity of trauma even in ordinary lives that has prevented us from seeing the centrality of the trauma response in our understanding of mental dysfunction. Fortunately, we now have a very promising, humane, and comprehensive remedy.

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KEY POINTS

Two Cases of recovery from PTSD are described.

The actual work dates back to 2008, early in the development of the Infra-Low Frequency (ILF) Neurofeedback approach.

Limiting target frequency was 0.01 Hz due to then-existing software limitations.

Work was done on outpatient basis.

Alpha-Theta training was also offered as part of the program.

Case 1 involved a Canadian veteran who had been in treatment for PTSD for over ten years, ever since his deployment to the Bosnian conflict.

Recovery from PTSD was demonstrated in 24 sessions.

Traumas were resolved in Alpha-Theta that he had not been able to even bring up in prior therapy.

Client continued on home-training basis for continued improvement.

Case 2 involved an alcohol-abusing veteran of the Vietnam era.

He was determined to continue drinking, seeing it as a remedy rather than as a problem.

Demonstrated substantial recovery from PTSD symptoms even with ongoing resort to alcohol.

Subsequent to this report, additional training was done and the trainee turned his life around with respect to reliance on alcohol and started planning positively for his future.

On the CRI-Help Study

Effects of an EEG Biofeedback Protocol on a Mixed Substance Abusing Population

August 2005

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Siegfried Othmer, Ph.D.,[3] and Stephen I. Sideroff, Ph.D.[4]

by Siegfried Othmer, Ph.D.

The full paper is available on-line, at the following link: ***www.eeginfo.com/research/articles/Biofeedback-Protocol.pdf***

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For even larger context, see the following reference: EEG Biofeedback (Neurofeedback) as a modality for treating addictions, by Siegfried Othmer and Mark Steinberg. http://www.eeginfo.com/research/pdfs/Addictions.pdf

The CRI-Help Study was undertaken explicitly as a replication of Eugene Peniston's studies on alcoholism and PTSD some years earlier. One common critique of the Peniston studies early on was that they were individually small. This was more than compensated for by the fact that the effect size was very large, so statistical significance was high despite the small group size. But the critique took on a life of its own, and finally just needed to be answered with a larger-scale study. Another criticism directed at Peniston was that his findings related to alcoholism that was secondary to PTSD, and that success in his treatment should be seen more explicitly as remediation of PTSD rather than of alcoholism per se. Peniston was quite prepared to agree, and his subsequent study featured recovery from PTSD rather than alcoholism.

The distinction here was in the framing of the issues rather than the underlying reality. In all cases Peniston was working with the same population, and with the same methods. Hence all three of his studies can be taken together to make the case that the Peniston protocol is evidence-based in application to PTSD-mediated alcoholism. Peniston's work was never given that recognition, and hence another motivation for the CRI-Help study was to augment the scientific underpinnings of the Peniston approach. In the event, the CRI-Help study not only corroborated Peniston but generalized the findings to drug addiction in general, irrespective of the drug of choice. Originally the focus of the study had been on alcoholism, but that was no longer representative of the current treatment population. So the acceptance criteria were broadened. The distribution in drugs of choice is shown in **Figure 1**.

There were two primary aspects to the Peniston approach. The first involved conventional hand temperature biofeedback for a direct experience of training in self-regulation, and to train the person toward calmer states. The second aspect was Alpha-Theta EEG training, which allows the trainee to access deeper states where traumas may be benignly resolved. The operative hypothesis was that if the traumas are re-accessed while the person resides in low-arousal states then re-experiencing will not be kindled. By and large, that was found to be true. In the CRI-Help study, the temperature training component was replaced with the SMR-beta training protocols that had been developed for the training of attention, arousal regulation, and of executive function and working memory. The Alpha-Theta component largely carried over, with only minor parameter adjustments to reduce further the likelihood of inducing abreactions.

SMR-beta training involves reinforcement in the mid-range of EEG frequencies of 12-19 Hz. This training is largely done on the sensorimotor strip of cortex. SMR refers to the sensorimotor rhythm, a specific EEG rhythm (nominally 13 Hz) that indexes a resting state of the motor system. Promoting such resting states repeatedly over several sessions adjusts the set-point of arousal regulation in both autonomic and central arousal. Additionally, however, there are benefits for executive function that in turn facilitate functional recovery in PTSD and promote resilience in the face of challenges.

The EEG training was offered as part of a standard state-of-the-art (as of 1995) Minnesota Model 12-step based treatment program involving individual and group psychotherapy. The program was conducted entirely at CRI-Help, a residential treatment center in Los Angeles, utilizing staff that had been trained in the neurofeedback method. The control group received only the standard treatment. The experimental group additionally received the EEG training. Therapy hours were matched between groups. Testing was done blindly.

The EEG training was done in two stages. The first involved the then-standard SMR-beta training, conducted at the rate of two sessions per day. Progress in training was assessed with the T.O.V.A.®, a continuous performance test. The first retest was performed after ten sessions, and if the scores were not yet normalized at that point, the trainee was given another five or ten sessions. The average number of sessions of SMR-beta training overall was 13, which means that the majority of trainees had normalized their scores by ten sessions (although some may have tested in the normal range at the outset, in which case they still got ten training sessions). Trainees were transitioned to the Alpha-Theta portion of the EEG training protocol after at most 20 sessions of SMR-beta training.

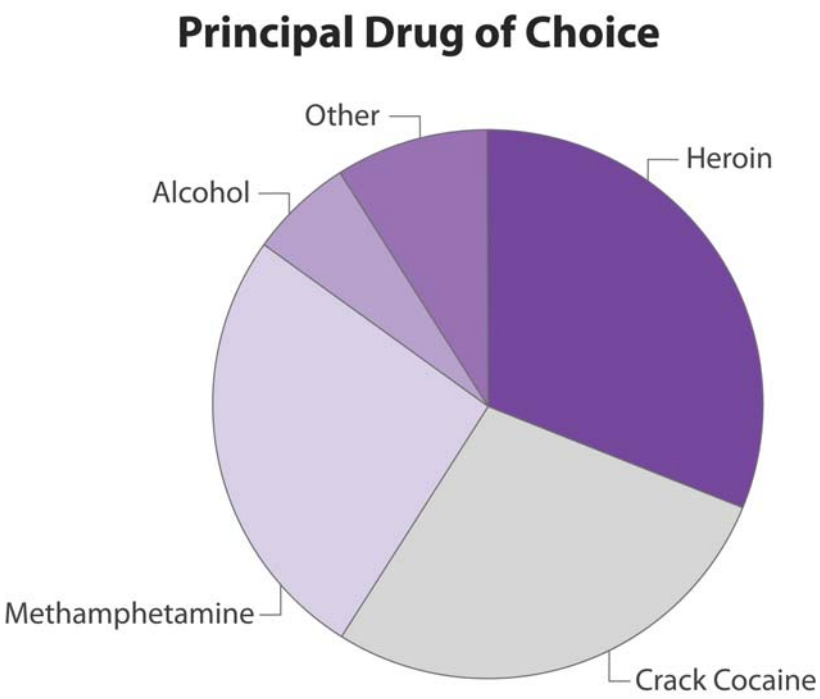


Figure 1 - Principal drugs of choice of study participants. The category 'other' largely refers to polydrug users.

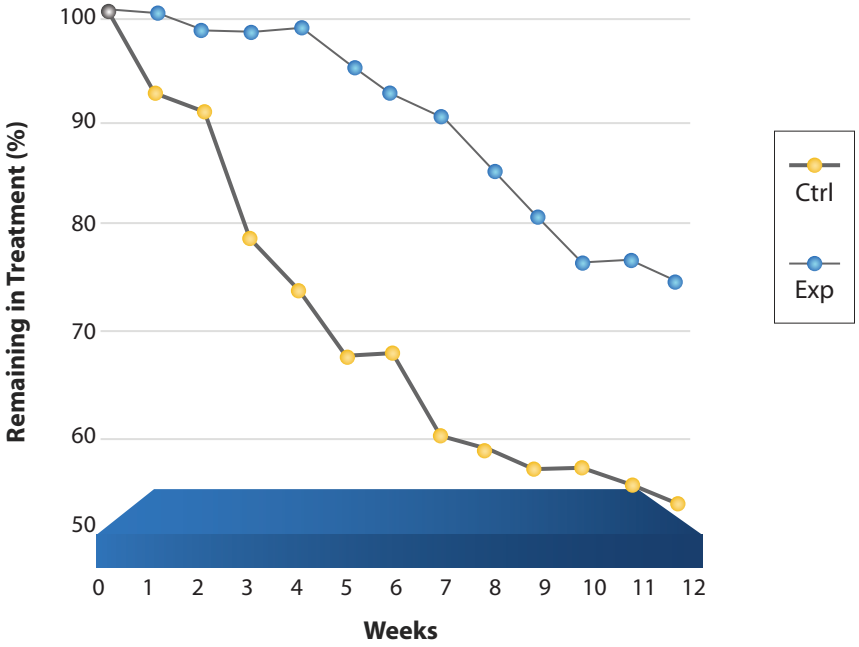


Figure 2 - Effect of the EEG biofeedback protocol on patient retention for control (n=61) and experimental (n=60) subjects.

It became obvious early in the training that retention in program was higher for the EEG training cohort. Since statistical significance was attained within the first two weeks of training, a specific benefit of the SMR-beta training component was indicated. The retention curves are shown in **Figure 2**. The Alpha-Theta component was also conducted intensively, which meant that the entire EEG training phase reached completion at about week 5 into the program. Looking at Figure 1, a breakpoint in the retention curve is discernible for the experimental beyond week 5. It is conceivable that this change in slope of the retention curve

is related to the termination of the EEG training component of the program. As it was, the attrition rate was twice as large among the controls as among the experimentals (46% vs 24%). The 'median days in treatment' measure was over 140 days for the experimentals, versus less than 90 days for the controls.

The results of the T.O.V.A.® testing are shown in **Figure 3**. A statistically significant treatment interaction is noted for three of the four sub-tests. The fourth, reaction time, was not in deficit in either cohort. It is noteworthy that the experimental group ended up testing above norms in all categories after the training. Significantly, the participants here represent a tougher challenge than that confronted by Peniston. The group includes referrals from L.A. County, and significantly some 30% of trainees had done hard time in prison.

Since Peniston had used the MMPI as a change measure, subsequent replications followed suit, and that was the case here as well. Results of pre-post MMPI assessments are shown in **Figure 4 and 5** for the experimentals and controls, respectively. Statistically significant improvements of experimentals versus controls were shown for five of the ten MMPI subscales: Hypochondriasis, Depression, Conversion Hysteria, Schizophrenia, and Social Introversion ($p < 0.005$). Two other scales showed significant improvement, but no significant treatment interaction: Psychopathic deviate and Psychasthenia.

Relapse status was assessed one year after the end of the residential component of the treatment. (The group work that is part of the 12-step model continued on an informal basis, i.e. without the involvement of program personnel.) Results are shown in **Figure 6**. Brief relapse is commonly counted among the successes, and if that convention is followed here then the results indicate a successful outcome for

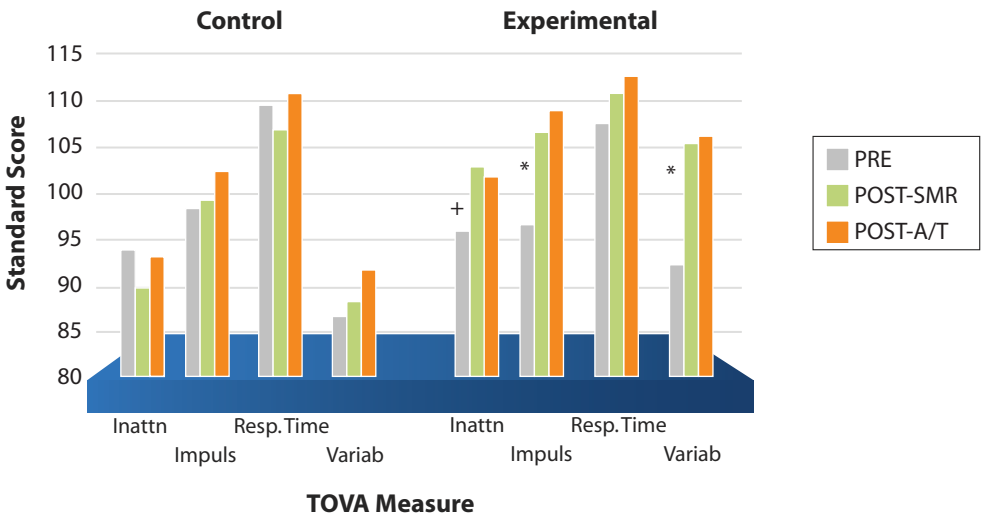
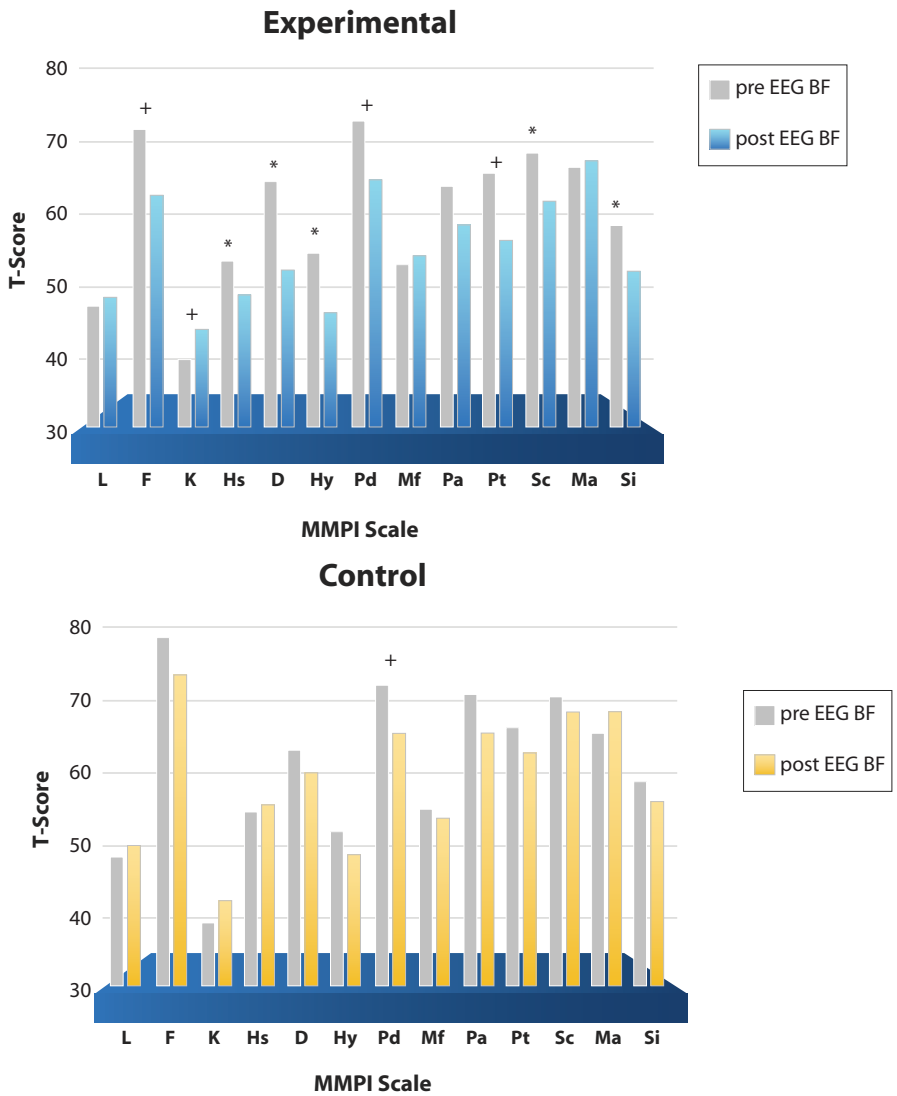


Figure 3 - TOVA standard scores for experimental and control groups for pretraining, post-SMR, and post-alpha-theta assessments (+ $p<.05$, *$p<.005$).



Figures 4 (top) & 5 - Change in 10 MMPI clinical scales and 3 validity scales for the experimental group (n=50) and the controls (n=33) (+ $p<.05$, *$p<.005$).

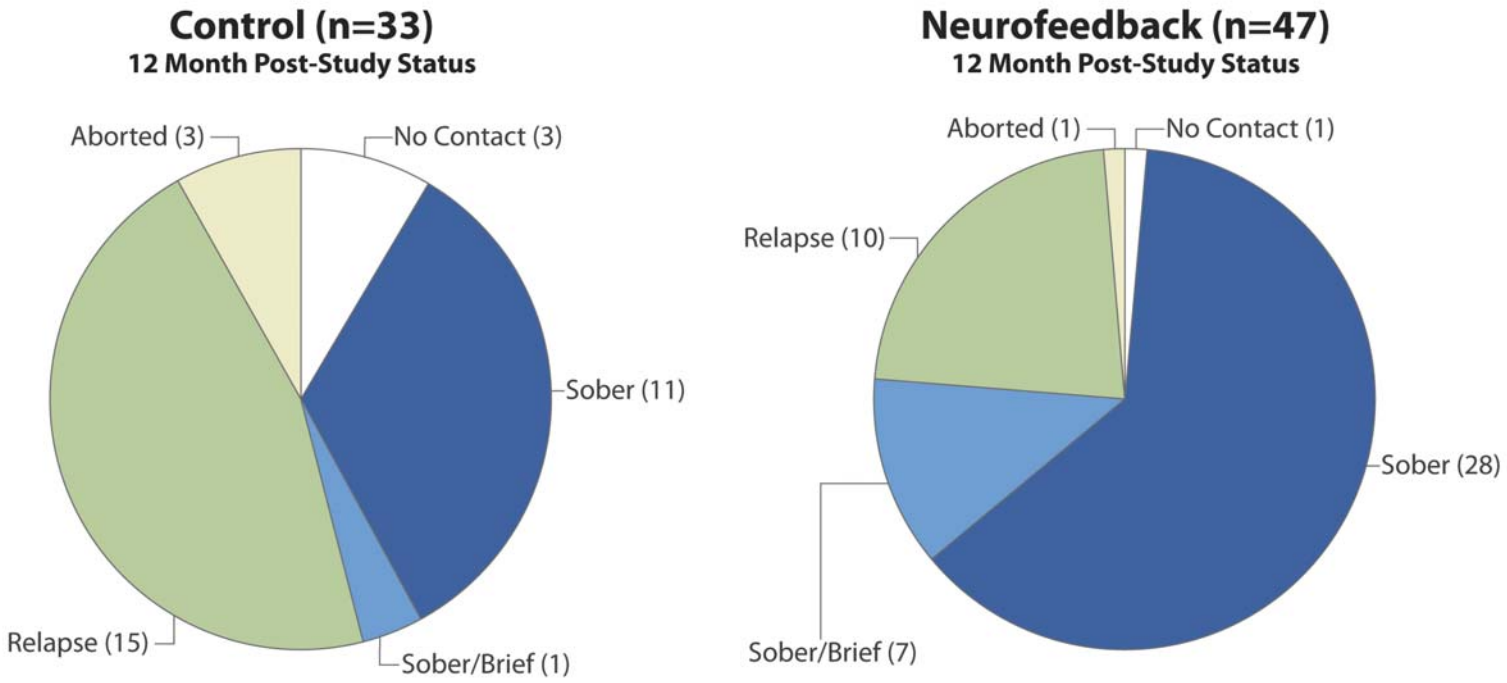


Figure 6 - Abstinence status of graduates one year after completion of the program. Success rate differed nominally by a factor of two. Referred back to entry into the program, it was a factor of three.

74% of the experimentals versus 36% of the controls. This outcome is obtained when reference is made to the end-point of the residential treatment portion. By that time, however, the groups are no longer matched in terms of Addiction Severity Index by virtue of the differential attrition rates during the program. If reference is made to the beginning of the program, the experimentals exhibited a three times higher success rate than the controls.

A second follow-up was done at three years after the residential treatment program, and the general observation was that the experimentals sustained their sobriety over the longer term. The controls, on the other hand, continued to attrition into relapse. These data were not included in the publication.

If we now critique this earlier work from our current perspective, one may say that we were able to address two fundamental aspects of the addiction problem. On the one hand, a we were able to help with the cognitive deficits, behavioral disinhibition, impulsivity, and to a certain extent the compulsive aspects of alcohol abuse. This was accomplished with the SMR-beta training. On the other had we were able to help with the psychological factors that sustained the addiction process, and this was accomplished with the Alpha-Theta training.

The subsequent development of our methods has given us a physiologically based approach to affect regulation. This is in principle similar to what we have been doing in the cognitive realm. The training of affect regulation permits direct access to what has become disregulated during early trauma formations. This has profound implications for addictions and for PTSD. With the combination of all three approaches, an even further improvement in outcomes is in prospect. In the 1995 time frame we were often confronted with cases in which craving for alcohol did not ever disappear. Hence the person had to rely on cognitive strategies, buttressed by the group experience, to sustain sobriety. In our recent experience, by contrast, it is more likely for clients to report that the craving for drugs had essentially disappeared during the course of training.

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CRI-Help Study

Effects of an EEG Biofeedback Protocol on a Mixed Substance Abusing Population

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Siegfried Othmer, Ph.D.,[3] and Stephen I. Sideroff, Ph.D.[4]

Abstract: This study examined whether an EEG biofeedback protocol could improve outcome measures for a mixed substance abusing inpatient population. *Method.* One hundred twenty-one volunteers undergoing an inpatient substance abuse program were randomly assigned to the EEG biofeedback or control group. EEG biofeedback included training in Beta and SMR to address attentional variables, followed by an alpha-theta protocol. Subjects received a total of 40 to 50 biofeedback sessions. The control group received additional time in treatment equivalent to experimental procedure time. The Test of Variables of Attention (TOVA), and MMPI, were administered with both tester and subject blind as to group placement to obtain unbiased baseline data. Treatment retention and abstinence rates as well as psychometric and cognitive measures were compared. *Results.* Experimental subjects remained in treatment significantly longer than the control group ($p<0.005$). Of the experimental subjects completing the protocol, 77% were abstinent at 12 months, compared to 44% for the controls. Experimental subjects demonstrated significant improvement on the TOVA ($p<.005$) after an average of 13 beta-SMR sessions. Following alpha-theta training, significant differences were noted on 5 of the 10 MMPI-2 scales at the $p<.005$ level. *Conclusions.* This protocol enhanced treatment retention, variables of attention, and abstinence rates one year following treatment.

Keywords: EEG, biofeedback, EEG biofeedback, addiction treatment, chemical dependency, alpha-theta, TOVA, MMPI

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KEY POINTS

This study played a key role in replicating the Peniston protocol for PTSD and associated alcoholism as a dual diagnosis.

Whereas this study did not address itself to PTSD directly, it did validate the Peniston studies that were exclusively involved with PTSD and alcoholism.

The study was large-scale, thus answering the key criticism of the Peniston studies that they were too small.

The study extended Peniston's findings to the principal drugs of abuse beyond alcohol.

The study also involved formal follow-up after one year, and informal follow-up after three years.

This follow-up documented the maintenance of abstinence among experimental participants over the long term.

By the three-year term, most of those who had received the conventional treatment had relapsed.

SUMMARY

Rapid remediation of PTSD with Neurofeedback is being documented in real-world settings

Rapidity of response argues for primacy of neurofeedback in the remediation

Deficits must lie largely in functional domain

Implies that a neurophysiological model of PTSD should be paramount

Brain training model fits with military physical and mental fitness paradigm

Entire focus of effort is toward optimal functioning

Dysfunction subsides in consequence of improved function

Training model gets buy-in from service personnel

Best compliance among available treatments for PTSD

The story is qualitatively similar for TBI

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HOMECOMING FOR VETERANS

Homecoming for Veterans, a non-profit initiative of The EEG Institute in Los Angeles, is dedicated to providing relief from the lingering mental hardship of war.

With a network of clinicians across the country willing to treat those in need at no cost, **Homecoming for Veterans** provides neurofeedback brain training for veterans and active duty service-people dealing with the effects of PTSD and TBI. Neurofeedback has been proven to greatly relieve the effects of PTSD and TBI through subtle brain training exercise that tunes the brain to function better. Stress, anxiety, addiction, sleep disorders, migraines and brain trauma are all greatly reduced through the neurofeedback training. Although positive results can all be generally experienced with the onset of treatment, resilience is further enhanced and optimal functioning promoted with more extended series of neurofeedback sessions under the direction of a trained clinician.

To increase the opportunities for those in need to receive this treatment, **Homecoming for Veterans** has launched pilot programs in neurofeedback at numerous facilities, shelters, clinics and military bases. Interested clinicians can be trained in neurofeedback by The EEG Institute, and provided with clinical systems, through a grant by HC4V. Health care providers from all medical and alternative health backgrounds are welcomed to learn about how neurofeedback can augment the work they are doing to support good mental functioning.

Through dedicated efforts, the organization is committed to raising awareness of the substantial self-recovery potential of the human brain with respect to PTSD and TBI, provided that the brain is allowed to witness its own functioning at the brain level. The organization is similarly committed to raising awareness about the seriousness of PTSD and TBI symptoms even for those who do not meet strict criteria of these conditions. Lives of veterans and of their families are adversely affected when such symptoms are allowed to persist.

Information on pilot programs, neurofeedback and a directory of participating clinicians can be found at hc4v.org, on Facebook, and on Twitter.