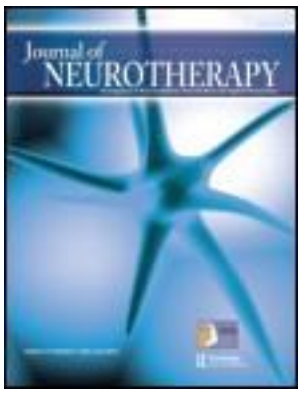

Journal of Neurotherapy: Investigations in Neuromodulation, Neurofeedback and Applied Neuroscience

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Published online: 18 Oct 2008.

To cite this article: Valdeane W. Brown PhD (1995) Neurofeedback and Lyme's Disease:, Journal of Neurotherapy: Investigations in Neuromodulation, Neurofeedback and Applied Neuroscience, 1:2, 60-73, DOI: 10.1300/J184v01n02_05

To link to this article: http://dx.doi.org/10.1300/J184v01n02_05

Neurofeedback and Lyme's Disease: A Clinical Application of the Five Phase Model of CNS Functional Transformation and Integration

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This article presents a Five Phase Model of CNS Functional Transformation which has been developed through my work with the multiple modalities of neurofeedback treatment across a wide range of disorders. The rationale of this approach is described as well as its application to working with a particular individual suffering from Lyme's dis - ease. In addition some ideas will be presented regarding how the overall framework of the five phases can be used to triage and treat a range of disorders including ADD, anxiety, depression, substance abuse, PTSD, and peak performance.

Introduction

Neurofeedback has generated enormous interest recently, especially in regards to ameliorating the effects of immune system involved disorders like Lyme's Disease. Although neurofeedback itself does not mitigate the disease processes that are responsible for immune system involved disorders, it can be quite helpful at restoring functional levels in affected individuals. In particular, sleep disturbance, mood disturbance, and increased fatigue, as well as poor concentration and diminished attentional abilities, all show remarkable restoration with effective neurofeedback. However, neurofeedback with immune system disorders is an even more recent development than neurofeedback with other more "traditional" disorders such as attention deficit disorder, post traumatic stress disorder, and substance abuse.

One of the major difficulties in the rapidly emerging field of neurofeedback is the wealth of unintegrated clinical and research findings. This plethora of intriguing data currently lacks a systematic approach that will allow neurofeedback clinicians to apply the power of this technology with precision across a range of diverse disorders. At present, intriguing bits of clinical wisdom float about while practitioners have little sense of how to integrate these various nuggets into a comprehensive approach to restoring and optimizing CNS function. Having been engaged in the provision of neurofeedback across a wide variety of disorders, it became apparent to me that a comprehensive framework is necessary so that we can treat the person who has the disorder, and not chase the tail of the disorder that has the person. Fortunately, with a rigorous enough examination of the clinical wisdom that abounds in the literature currently, such a comprehensive and integrated framework suggests itself naturally. The present article will discuss this central idea as well as several main conclusions that flow from it, including the following.

1. A single, overarching Five Phase Model of CNS Functional Transformation exists which can integrate the various current neurofeedback protocols into a singular and comprehensive approach. This comprehensive framework can be used regardless of the particular disorder being treated. All clients begin with the same protocol and progress through each phase at their own pace, as determined by changes in functional status, as well as in more quantifiable shifts in E.E.G., especially as seen in spectral analysis.

2. A single, referential sensor placement

at Cz is used for the majority of treatments, except for the last phase in which a four channel, global synchrony setup is necessary. This simple approach demonstrates equal or better clinical efficacy when compared to more diverse and varied hook ups.

3. The older terms of Alpha, Theta, and Beta are no longer precise enough to guide clinical work and need to be replaced with more specific frequency-based descriptors.

4. The functional limitations associated with immune systems involved disorders like Lyme's Disease, CFIDS, and PMS respond well to the Five Phase Model of CNS Functional Transformation.

This article presents a Five Phase Model of CNS Functional Transformation which has been developed through my work with the multiple modalities of neurofeedback treatment across a wide range of disorders. The rationale of this approach is described, as well as its application to working with a particular individual suffering from Lyme's disease. In addition, some ideas will be presented regarding how the overall framework of the five phases can be used to triage and treat a range of disorders including ADD, anxiety, depression, substance abuse, PTSD, and peak performance.

A Brief History of Neurofeedback

Neurofeedback has a long and somewhat controversial background due to the fact that, in the early 1970s, technology was not quite up to the demands of clinicians, the scrutiny of researchers, and the criticism of the skeptical. Initially, clinicians focused on the use of Alpha augmentation across a wide range of disorders, with early clinical demonstrations leading to elation when many subjects were able to learn to produce deep states of relaxation, seemingly at will. However, these initial results soon led to disappointment when other studies produced equivocal or even paradoxical results. Due to the variability in the findings from these early clinical efforts, the orientation of the field shifted to focused research projects concerning several specific disorders, most notably epilepsy and attention deficit disorder. The pioneering work of Lubar (1984) and others led to the recognition that precisely applied neurofeedback could effect change in many intractable disorders and that those changes were frequently long lasting. Concurrent with these research efforts, there was an explosion in the quality, computational power, and availability of micro computer technology. This allowed many more practitioners and researchers to have access to these approaches, and to use them with increasing precision and aplomb across a wide range of clinical complaints and disorders.

As the success of neurofeedback in working with individuals suffering from attention deficit disorder and epilepsy was beginning to be widely documented, a variety of different approaches to the actual treatment of these and other discrete disorders started to emerge. A little later, interest in neurofeedback burgeoned with the publication of Peninston's (1990) landmark article regarding treating Chronic Substance Abuse using the Alpha-Theta protocol. This novel and intensive approach was successfully applied to PTSD as well, and led to a concurrent increase in excitement in the neurotherapy field because of the potential of that protocol for facilitating transpersonal transformation.

At this point, a previously latent dialectic began to crystallize into a focused debate concerning the role of diagnosis and symptomatology in neurofeedback. Many in the field started to consider the question of whether to initiate neurofeedback by attempting to optimize function and, thereby, precipitate transpersonal change or to focus on restoring functional deficit by decreasing specific symptoms. In other words, should preference be given to Alpha-Theta augmentation and its potential for facilitating transpersonal renewal and integration, or to some specific version of either SMR or Beta augmentation with concurrent Theta suppression depending on the precise problem the client is experiencing?

This question has been addressed in various practical ways, the most typical involving the issue of attaining and formulating an accurate and precise diagnosis of the condition or disorder that is afflicting the client. Thus, a client suffering from ADD would be treated via an ADD-oriented protocol such as Lubar's (1984), whereas a client with a substance abuse problem would engage in a Peninston (1990) style protocol. In my experience, this kind of approach is problematic because clients rarely suffer from a singular problem. In fact, most suffer from several treatable conditions, which usually require divergent and even antithetical neurofeedback protocols. For example, research shows that 40% or more of adult alcohol abuse may be directly related to untreated ADD. Thus, an adult diagnosed with a substance abuse disorder may very well also have a concurrent attentional difficulty. Does one begin with the alcohol abuse protocol, and perhaps worsen the ADD-based symptoms, or does one begin with the ADD protocol, and precipitate increased alcohol consumption? There has been no clear answer to this kind of question, beyond those offered by a practitioner's own clinical wisdom.

The use of precise diagnoses to prescribe divergent treatments presupposes that clinical conditions are discrete and differentiable, however, the growing comprehension of the immune system involved disorders undermines the validity of that assumption and calls for a new perspective on the role of differential diagnosis of discrete disorders. Immune system involved disorders evoke a wide range of disturbances in neuropsychological and psychophysiological function, rather than a simple, linear unfolding of a discrete disease process. Human functioning involves the systemic, syncopated, chaotic integration of multiply self-referenced psychophysiologic processes rather than the linear, mechanistic combination of separate body parts. Accordingly, we need now to comprehend functional limitation within a new paradigm that is at once simpler, and more complex, than those allowed by our older world view, especially if we are to develop effective responses to the devastating challenge posed by immune system involved disorders. This article proposes just such a Copernican revolution in understanding neurofeedback.

Copernicus, Elegance, and the Origin of the Five Phase Model

Before Copernicus changed our view of the world and our place in it, Ptolemaic astronomy ruled the heavens. According to Ptolemy, the earth was placed as the fixed center of the universe because of man's central role in God's plan. From that basis, Ptolemy developed a way to calculate the movements of the known heavenly bodies that was exceedingly accurate, but incredibly complicated to use. Planets had to move backwards (as in "Mars is in retrograde") and in a variety of smaller orbits (or epicycles) in order to be seen as moving around the earth. Copernicus, however, had a new vision: instead of the earth, it was the sun that occupied the central spot in the universe. Although this meant that man was no longer so central in the divine plan as was once thought, it greatly simplified the task of calculating the movement of the heavenly bodies. With the sun at the center, every other heavenly body moved in some version of an ellipse. Now there was no longer a need for complicated machinations because all heavenly bodies moved in essentially the same fashion, but at their own rates and at their own distance from the sun. A simpler explanatory framework of equal predictive power replaced an older, more cumbersome perspective. Copernicus had come up with a revolutionary orientation that was elegant in the mathematical sense: it was both conceptually simple and enormously powerful in its ability to explain and predict events. I believe that there is a similarly elegant way to reconceptualize neurofeedback practice and integrate the various protocols into one comprehensive framework.

We can begin to catch glimpses of this new perspective by considering in some depth the diverse protocols that emerged

during the early, formative era of research into neurofeedback. During that time many practitioners used "pre-training" periods involving various techniques including Autogenics, thermal training, guided visualizations, and diaphragmatic breathing, among others. Even though it was seen as essential for clinical success, this critical "pre-training" portion of the various protocols was considered to be an entirely separate phase from the neurofeedback proper. The past few years has seen a virtual explosion of treatment protocols—especially in regards to immune system involved disorders—with many practitioners attempting to copyright and trademark their approaches. Many still use a "pre-training" period of some sort, that is necessary for, but distinct from, the actual neurofeedback.

Throughout my early work with neurofeedback, as well as other biofeedback modalities, I began to notice a systematic process unfolding as various forms of disorder were initially impacted through successful application of the various technologies and approaches used during these "pre-training" periods. In particular, I began to notice how several key indicators of Circadian Rhythm appeared to renormalize to some fairly significant degree. Although this effect was particularly clear regarding sleep-wake cycles, the amount of change in any particular indicators conformed to the Law of Initial Values.

As I explored the specifics of this "pre-training" phase in more detail through my work with various disorders, it became clear to me that there are several functional tasks which are important to the resolution of this critical portion of treatment. In particular across a wide range of disorders, it is important to be able to achieve any one or all of the following: digital temperature training to criteria of 94 degrees sustained for twenty minutes, autogenic use of relaxation for the same time period, sustained use of Vipassana-style meditation for twenty minutes, or ten minutes of sustained amplitude augmentation at 14 Hz with consequent diminishing of slow wave amplitude, particularly in the range of 3 to 5 Hz.

With the recognition of this initial "pre-training" starting point, I began a course of clinical treatment involving progression of virtually all clients through the same approach to fulfill one or more of these criteria, before initiating any other more specific neurofeedback protocol. The clinical results of this shift in practice were profound and robust, with other forms of treatment being greatly facilitated regardless of the identified focus of treatment. This result led me to hypothesize that this initial "pre-treatment" phase is essential to effective therapy across the entire range of disorders treated by neurofeedback. From my perspective, the most critical criteria for this phase is augmentation of 14-Hz amplitude with slow wave amplitudes between 3 and 5 Hz being suppressed concurrently. My clinical work indicates that this same concurrent shift of augmenting 14 Hz while suppressing 3-5 Hz is the net effect of training in the other modalities used in various "pre-training" approaches. Accordingly, what I refer to as Phase I consists of 14-Hz augmentation with concurrent suppression of 3 and 5 Hz (for further details, refer to the appendix).

Theta, theta everywhere, but not a stop to think

Historically, the term Theta referred to any activity that occurs in the range of 4-7 Hz, regardless of its clinical significance. Various practitioners have considered that there may be "bad" and "good" Theta. Barry Sterman (1994) has raised the idea that "bad" Theta originates extrathalamically, in various cortical regions, whereas "good" Theta originates centrally, in the thalamus. Others, like Tansey (1994) report that the frequency of the Theta activity is what is important because surges at different frequencies are tied directly to distinct states of consciousness. I believe that both are correct, such that what clinicians call "bad" Theta involves extrathalamic, or cortically originated, surges in 3- and 5-Hz activity, whereas "good" Theta involves surges in thalamically originated 7-Hz activity.

The essence of Phase I clinical work is the suppression of "bad" Theta, i.e., 3- and 5-Hz activity, simultaneous with augmenting 14-Hz activity. Many times this involves a progressive restriction of the range of Theta activity being suppressed until an actual diminishment in amplitude can be achieved and sustained. Once such suppression occurs at the lowest end of this range (viz. at 3 Hz); suppression is sequentially expanded back upwards to include suppression of 5-Hz activity. Surges at 3 Hz seem to be directly involved in reexperiencing the intrusive, catastrophic emotional activity of psychologically traumatic events. Thus, 3-Hz activity is suppressed so that the client will not be overwhelmed by such emotional states, and be retraumatized. Surges at 5 Hz seem to be directly tied to physical trauma and/or structural changes in the CNS, especially to cortical regions that are frequently damaged in Traumatic Brain Injury (TBI) and immune system involved disorders. In analogy to the 3-Hz surges, these 5-Hz surges are suppressed as a way to diminish the cognitive distortions (such as short-term memory impairment) introduced by such structural changes. Theta activity in the 7-Hz range is not suppressed, in general, because 7 Hz is the precise frequency that appears to be directly associated with profound visualization and the transpersonal processes that are fundamental to the Alpha-Theta protocol. Although there are some exceptions, surges at 7 Hz usually serve as a creative resource for clients, and do not precipitate increased symptoms.

During Phase I, filters are set to augment amplitude at 14 Hz while also suppressing 2- to 6-Hz surges using real-time, in vivo thresholds. The CapScan C80 single channel system or CapScan Prism 5 system both allow for easy manipulation of band widths, inhibit and reward filters, thresholds, and other clinically important parameters, while also providing for real time spectral analysis of E.E.G. activity. However, since systems differ in how they set and modify these parameters, this article will only indicate the cogent changes for the various phases of the model. Each clinician will need to review the appropriate system documentation or contact the equipment supplier to be able to implement such fine-grained adjustments on a particular system.

Phase I Details

The work in this phase is usually quite involved with clients suffering from immune system disorders. In general, if clinically significant change has not occurred within three sessions, the frequency range of the suppress filter is "notched down" in various ways, while the 14-Hz setting of the augment filter is maintained. Typically, the initial setting of 2-6 Hz is switched to 2-4 Hz, in order to decrease emotional reactivity and increase tolerance for and acceptance of sitting still. If this does not lead to clinically significant change, the range is then switched to 4 to 6 Hz, in order to minimize current cognitive impairments, which may be limiting the client's conscious involvement in self regulatory strategies.

At this time, clinical practice indicates a roughly trimodal distribution in terms of clinical response to Phase I. One group of clients succeeds directly with the 2-6 Hz range within approximately 6 sessions. A second group benefits from a shift to 2-4 Hz after the third session, followed by a return to 2-6 Hz after succeeding in the 2-4 range. Whereas the third group benefits from a shift to 4-6 Hz after the third session, followed by a return to the original 2-6 Hz range. Not only must the Delta-Theta range filter be "notched down" in a sequential fashion, but it then must be expanded back upwards in a step-wise and measured fashion, with frequent returns to the 2 to 6 filter settings to maintain the baseline of effective functioning.

Regardless of which of the three basic patterns emerges, subtle shifts in frequency range regarding slow wave activity are employed, along with continual modification of amplitude based threshold, until clinically significant results are obtained. These functional shifts may be documented both in

terms of changes in EEG spectra as well as in terms of reduction in relevant symptoms. Usually the first functional improvement involves restoration of normal sleep-wake cycles as well as an increased general level of energy. This result is particularly striking in the case of the immune system involved disorders, such as Lyme's disease, where the sleep-wake disturbance leads to enormous energy depletion as well as affective instability and mood disorder.

With immune system disorders I do not consider Phase I to be completed successfully until three to four sessions can be navigated at the same level of achievement when the filters are set to suppress 2-6 Hz while augmenting 14-Hz activity. Due to the importance of the achievement of this initial phase, I almost always recommend that the immune system involved patients begin a daily practice of meditation of the Vipassana or Zen style. These styles are used, along with specific focused breathing instruction, because they do not involve systematic or spontaneous imagery. I believe that it is very important to initially decrease the amount of ambient and operant imagery in immune system involved persons, because these images may induce unwanted and unanticipated negative responses, including panic and reexperiencing of prior trauma. Eventually, however, systematic use of archetypal imagery develops during Phase IV and becomes a critical resource for working with immune system involved individuals. Similarly, the use of certain ocean wave sound tracks during sleep (viz. those that are produced using harmonics of slow, synchronous Theta) may also be helpful in establishing or stabilizing this level of proficiency. Frequently, these kinds of tapes are very useful as a sleep aid, especially with clients suffering from immune system involved disorders.

The verbal cue for this phase is, "Just let go," which helps to orient clients to an important psychological task: to let go (cognitively, emotionally, neuromuscularly, and existentially) of the suffering that is directly tied to the 3- and 5-Hz surges as described above. Of course, clients will frequently develop their own idiosyncratic verbal cue, or not even use one. What counts is what works for the client, not what someone else thinks should work. When clients can "let go" and remain present-focused, then they are ready to move on to Phase II.

Phase II Details

Once Phase I has been achieved with a reasonable degree of success, it is possible to move on to Phase II. The prototype focus of Phase II is attention deficit disorder. The primary task of Phase II is to maintain suppression of 3- and 5-Hz activity while augmenting specific frequencies within the Beta range. My experience in working with attention deficit disorder, as well as in progressing immune system involved individuals through this phase, is that it frequently involves two sub-phases. The first sub-phase involves augmenting low Beta (i.e., 15-18 Hz), whereas the second sub-phase involves augmenting high-range Beta (i.e., 20 Hz and above). Again, these are very general guidelines which are modified with individual clients based on their clinical response.

Phase II work is typically brief with the immune system involved disorders; nonetheless, special attention must be paid to maintain suppression of 2-6 Hz activity because even minute upward modulations in that range can exert a profound effect, frequently with a marked return of symptoms. If this seems to be occurring when Beta augmentation is attempted, a return to Phase I for additional 14-Hz augmentation is probably indicated, especially if this effect occurs equally with both low and high Beta augmentation. Individual sessions may also be structured in the same way and be bracketed at the beginning or end with a brief period of Phase I training. Phase I bracketing is a very effective way to make sure that clients do not leave a session "in trance" because it orients them directly to the task of openness to sensory input, with diminished emotional reactivity.

Despite its typical brevity, Phase II is vitally important to working effectively with immune system involved disorders because those individuals almost always have strikingly diminished attention, concentration, and memory skills. The ability to maintain a high level of Beta production concurrently with 2-6 Hz suppression is enormously refreshing for these individuals, and leads to a sense of empowerment and human possibility that many of those individuals feared was forever gone from their lives. It is during this phase that many individuals report the ability to either return to work or to increase their participation in home maintenance and other tasks, including activities of daily living, which had previously been impossible for them.

The catch phrase for this phase is, "Just focus," which helps clients orient to the central task of augmenting attentional acuity and ability.

Phase III Details

Phase III involves Alpha augmentation with the typical focus involving increased access to states of relaxation and the pursuit of what has been called the meditation model. Until Phase I has been accomplished, it is usually not advisable to begin Phase II training. Until Phase II training has been successfully achieved, it is usually not recommended to initiate Phase III. In other words, do not attempt a phase of intervention that requires a degree of neurocognitive or psychophysiological stability that is beyond what has been accomplished in previous levels. Such efforts will most likely lead to an increase in symptoms and an enormously profound sense of disappointment and insurmountable difficulty in participating in neurofeedback. For instance, attempting to teach relaxation skills to a child who is actively involved in the behavioral sequelae of attention deficit disorder is likely to produce an increase in the hyperactivity and/or impulsivity, as well as an increase in irritability and affective instability. Until the Phase II goal of increased Beta production with concurrent 2-6 Hz suppression is achieved, it is simply not possible to produce enough sustained Alpha amplitude for a sufficient length of time to proactively relax while also maintaining clinical and functional stability.

The typical clients engaged in this phase are oriented towards mastering stress management skills because they have recognized that their life style, thinking patterns, and health-related behaviors contribute to their ongoing level of dissatisfaction and irritability. This phase can also be difficult for those suffering from immune system involved disorders because it is so easy for them to bypass the challenges of self-initiated daily meditation practices in favor of pursuing the relatively easily attained pleasure of the augmented Alpha state which occurs during neurofeedback sessions. For this reason, Phase III training may include occasional sessions in which both Phase I and Phase II tasks are reinstituted periodically as opening or closing "brackets"—especially when working with individuals suffering from immune system involved disorders.

Phase III training has been accomplished when sustained, high-amplitude Alpha can be produced by the client for a sufficient length of time to trigger what Benson (1976) has called "the relaxation response." This can be measured and documented in a number of physiological modalities; however, clients will also tell you that they can accomplish the task. The catch phrase for this phase is, "Just relax," which is self- explanatory. When a client has progressed through both Phase I & II, and can produce a sustained ridge of Alpha at 3 or 4 times the amplitude they began with, then it is time to move on to Phase IV.

Phase IV Details

Phase IV involves the core of the Alpha-Theta protocol delineated by Peninston (1990). During this phase, continued production of high-amplitude Alpha waves leads to what has been called an Alpha-Theta "crossover" in which Alpha amplitude decreases in conjunction with a time-linked

Theta surge over the level of Alpha amplitude. This increased Theta is what many clinicians have wanted to call "good" Theta. It manifests a different level of coherence and generality than is seen in the ambient chaos and local recruitment of elevated 3- and 5-Hz activity noted during the initiation of Phase 1 intervention. Accordingly, it is vitally important in this phase to make sure that surging of such emotionally and cognitively chaotic Phase I activity does not recur (viz. spikes in the range of 2 to 6 Hz). Particular attention needs to be paid during this time to noticing the signs of returning symptomatology in the immune system involved client. In particular, renewed sleep-wake cycle disturbance, increased feelings of fatigue, or flu-like symptoms indicate the advisability of returning to Phase I tasks in order to reestablish an effective baseline of functional stability. This is the same kind of caution that has been observed in the classical use of Alpha-Theta protocols with individuals suffering from substance abuse and post-traumatic stress disorder.

The prototypical disorders of Phase IV are substance abuse, post-traumatic stress disorder, and multiple personality disorder. This phase is frequently marked by the emergence of highly-charged hypnogogic imagery which can lead to either reexperiencing or integrating old childhood and traumatic memories, which of those possibilities occurs reflects, of course, the existential choice of the client as it is supported by the facilitation of an effective psychotherapist. These periods of integration can be particularly challenging for immune system involved individuals; therefore, most of the sessions where this highly emotional work occurs need to be completed with a return to either Phase I or II interventions in order to ascertain that the baseline of functional stability has been maintained. By bracketing the training in this way, you can verify that clients will not be leaving the session "in trance" or in danger of reexperiencing the traumatic event later on their own. This is a general precaution for all Phase IV work because the psychological material that usually surfaces during this phase can be quite powerful and lead to secondary disturbances that may mimic and even mask the original clinical presentation. When Phase IV has been successfully completed, a characteristic sense of well being (which resembles a sub-clinical hypomania) may result and this is usually quite pleasing and attractive to the individual.

Interestingly, when addictive behaviors are also present in the immune system involved individual, they tend to diminish in intensity or resolve completely during this phase. This process occurs in analogy to the resolution of alcohol addiction documented by Peninston (1990). If they have not already removed caffeine, sugar, high levels of salt, food additives, and alcohol from their diet at this point, almost all immune system involved patients do so. They find that they simply do not have the urge to consume these substances anymore, rather, they experience an increased orientation to maintain the behaviors that have promoted their reestablished equilibrium, health, and sense of well-being. This includes not only increased walking or other forms of exercise such as yoga, as well as their continued pursuit of and deepening of the meditative experience, but also a frequent reemergence of spirituality or contemplative reflection as a central concern of their daily lives. The catch phrase for this phase is, "Just be free and watch." When clients can do that, regardless of the content that arises, then they are definitely prepared for Phase V and training in global synchrony.

Phase V Details

Proliferation of global synchrony is both the primary goal of Phase V, as well as the primary means to achieve that goal. There has been a debate regarding synchrony for a number of years, which I believe is based on a differential use of that term by various scientists, practitioners, authors, and researchers. Neurologists use the term synchronous to refer to the locally emergent and coherent EEG phenomena that appear

before, during, and just after an epileptic seizure, as well as other similar focal events. This is not what I would call synchrony, rather, I would refer to that phenomena as local recruitment. In local recruitment a particular cortical site produces an upsurge of 3- or 5-Hz activity which induces a similar upsurge in the immediately adjacent cortex in the same frequency range. The effect is localized and partitioned off from being functionally integrated with what is occurring throughout the rest of the CNS, that is why seizures and related focal events are so disruptive of generalized secondary and tertiary neuropsychological functioning. Once ignited, the flames of seizure activity spread to adjacent sites like a brush fire engulfing a dried-up prairie.

In distinction to this, global synchrony refers to a different kind of coherence that unfolds at a distance rather than in a localized or focal fashion. Global synchrony occurs when EEG activity is synchronous or coherent across widely separated regions of the CNS, for instance, when the same dominant frequency occurs in both left and right occiput. Real-time information regarding the presence, amount, and frequency range of this synchronicity is relayed to the client so that a feedback loop is instituted. Of course, there are several closely related yet distinct algorithms for determining degree of synchrony present, but the details regarding those differences are not so critical at this time. What is more important at this point is to really understand the difference between local recruitment and global synchrony. Perhaps a few analogies will help clarify this distinction.

Focal seizure activity is like a black hole. Black holes form where a star has burned out and collapsed inwards to a single point. They are considered to be "black" because they cannot be seen; not even light can escape from their enormously powerful gravity well. The only way we can tell a black hole is present is because we see its functional impact on the space around it, the singularity at its center sucks in (i.e., recruits) everything in the neighboring space and disrupts the local space-time continuum. Similarly, we can frequently discern the onset of seizure activity by how it disrupts and precludes neuropsychological function. This is catastrophic, local recruitment.

On the other hand, global synchrony is more like experiencing nightfall: a gradual diminishing of energy induces a growing darkness that leads to an overall quieting of mind and body and, then, an increased perceptual ability as we slowly accommodate to our new environment. We gaze at the stars at night because of their beauty, and the sense of awe, permanence, and peace we experience in that gaze. We find revealed to us patterns and images in those points of light that we had not seen before. This is the creative tranquillity of global synchrony. The constellations first emerge for us when we allow them to enter our awareness in a very precise way that rarely, if ever, happens when we look for a restaurant sign in the neon jungles that surround our interstate highways, unless, of course, we have experienced the kind of profound transpersonal transformation that occurs via proliferation of global synchronicity.

The use of the CapScan Prism 5 has been central to my success in Phase V training because it is able to effectively validate in real-time to the client that global synchrony is occurring, using both visual and auditory feedback. In addition, four separate channels of EEG data, as well as their degree of synchrony, are recorded to disk so that a permanent record can be made, which can be reviewed by the clinician at a later time. This is a real asset in fine tuning the work in Phase V. Again, clinicians are referred to the documentation that came with their system, as well as to their suppliers for details about how to implement real-time global synchrony using four channels of data on their own equipment.

Completion of Phase V Synchrony training allows for crystallization of the CNS mechanisms that will foster long-term

autopoetic maintenance of all of the previously established functional gains. Thus, it is important to progress all clients through Synchrony training, especially with individuals suffering from immune system involved disorders, as this is the final level of CNS functional integration. However, many clients decide to opt out of training at this point because they are not yet prepared for the kinds of life-changing experiences that come from Phase V. Apparently many people only want to resolve their immediate problem and when that occurs, they decide that they have changed enough. The catch phrase for this phase is, "Just be," which is also self-explanatory.

A prototypical focus of treatment for this phase is Peak Performance. Many athletes are very interested in Phase V training in order to augment their sense of athletic ability and neuromuscular integration while decreasing performance anxiety and overcoming their fear of injury so that they can take a quantum leap beyond the previously experienced limits of their performance. Similarly, many executives, as well as others who initially began neurofeedback due to an interest in stress management, find that the progression into Phase V Synchrony training is a natural extension of their pursuit of a sense of greater ease, accomplishment, and joy in the work environment.

The primary site for placement of the active sensor in all of the prior phases is Cz with a single channel of EEG-based feedback being utilized, while reference and ground sensors are typically attached to the ears. Although there are many other sites that could be used for the active sensor, the single referential Cz placement is used for two primary reasons: 1) it is an easy site to find, 2) it is the site that I have found to be the most effective across the first four phases. The appendix contains specific information regarding when and how this fundamental placement may be modified within a specific phase due to clinical response. It is important to remember, though, that even when the placement is modified, a Cz placement is again reinstituted to ascertain that specific functional goals have not only been attained, but can be maintained by the client. In order to implement the synchrony training of Phase V, however, a four channel hook-up involving placements at O1, O2, F7, and F8 is used instead of a single channel placement at Cz.

Synchrony usually occurs first in the Alpha band, with progression down into the upper regions of Theta and ultimately down into the lower regions of Theta, and even into what has been traditionally referred to as Delta (viz. 2 to 4 Hz). It is interesting to notice the change in the client's physiognomy and symptomatology as Synchrony is achieved and sustained, especially in the lower Theta and Delta range. The result is particularly striking for the immune system involved individuals, who report experiencing a sense of lightness and joy which has been absent for years, if they can even remember it ever being present in their lives. Ultimately, it is most transformative for Synchrony to be achieved through the lowest Theta and then Delta ranges with eyes open. However, this requires a considerable amount of dedicated effort, and clients frequently discontinue treatment prior to this point due to their sense of accomplishment and satisfaction with clinical results. Another factor is the expense of ongoing sessions, which is mostly not reimbursable by third party payers once the client's clinical situation has been ameliorated. In particular, ADD-diagnosed children frequently terminate at the end of Phase II, however, when they become adolescents it is likely that we will see them again if they have not completed Phase V.

A Case Example Involving Lyme's Disease

Let's track an individual client through the course of neurofeedback to fully illustrate the use of the Five Phase Model of CNS Functional Transformation. Susan (her name has been changed for reasons of confidentiality) is a 39-year old mother of four. When neurofeedback began, three of

her children were diagnosed as suffering from ADD, two severely so. Susan had been diagnosed with Lyme's disease for five years at the time I first began treating her. She also reported her own history of untreated ADD and a history of profound affective instability, predating the emergence of her Lyme's disease, which had been treated pharmacologically with a variety of tricyclic anti-depressants (Elavil, Desyril, and others), SSRIs (including Zoloft, Effexor, and Prozac) and anxiolytics (including Valium, Xanax, and Ativan), all with minimal success. At the time that neurofeedback was initiated, Susan was unable to walk two blocks without needing to sleep for two hours immediately afterwards. She had been taking an average of two or more two-hour naps each day in addition to ten hours of continuous, but not restful, sleep throughout the night. She was experiencing frequent headaches, joint pain, and anhedonia, as well as a general sense of lethargy despite her hypersomnia. No matter how much she slept and rested, she never felt refreshed.

Initial EEG spectral analysis showed considerable 3- and 5-Hz elevation with a prominent spike profile, and minimal Alpha and Beta production. An initial 5-minute evaluation session of 14-Hz augmentation with 2-6 Hz suppression was attempted. Subsequent spectral analysis revealed clear differences in slow wave production relative to the initial readings such that the prominence of the spiking and ridging throughout the 3- and 5-Hz range was attenuated. Susan reported experiencing a sense of "calm and feeling prepared" after this initial session. A Phase I intervention strategy of twice a week 14-Hz augmentation with 2-6 Hz suppression was started.

At the end of her first two weeks of treatment, Susan reported that she was sleeping only seven hours a night with no naps during the day, and was feeling more rested than she had in years. In addition, she was walking slightly more than two miles a day, whereas only two weeks before she had been warned by her primary physician not to walk even two blocks. Although temperature was not used for biofeedback, contemporaneous recording of digital temperature was maintained throughout the initial sessions. Baseline digital temperature production was in the low 80's at best. After the initial two weeks of treatment, it was noted that digital temperature was 94 degrees sustained for 20 minutes during the feedback sessions with an ambient, pretreatment temperature of 91 degrees.

Susan continued with Phase I "notching down" for several more weeks until 2- to 4-Hz suppression was achieved concurrent with 14-Hz augmentation. At this point, the range of slow wave activity being suppressed was again expanded upwards, initially to 4-6 Hz and then to 2-6 Hz with functional stability being maintained. At that point, Phase II ensued with a few sessions of Beta augmentation in an attempt to ascertain that slow wave suppression and baseline autonomic functioning remained intact while she engaged in a neurofeedback task requiring focal attention. Two sessions each in both low and high Beta ranges were attempted with reasonable success. Each of these sessions were ended with five minutes of Phase I work using 14-Hz augmentation along with 2-6 Hz suppression mostly as a precaution since all functional gains were being maintained.

Phase III then was initiated with two weeks of Alpha training. During the initial week of Alpha training each session was ended with a brief Phase I "bracket" (as described above). At this point, sleep was still stable, energy levels were dramatically increased, while concentration and attention, as well as short term memory function, had returned to almost premorbid levels. Susan reported that most of her acquaintances were wondering what had happened to her because the change was so remarkable and dramatic.

In the third week, transition into Phase IV happened naturalistically such that Alpha-Theta crossover occurred sponta-

neously during an Alpha session along with concurrent production of hypnogogic quality imagery. Susan reported many archetypal images which helped her experience the integration of her own identity and sense of being a woman. During this time, her urge for coffee and chocolate decreased markedly, and eventually faded away completely. At her request, Phase IV training was maintained on a twice a week basis for three more weeks in order for her to pursue the archetypal images which she found to be enormously appealing and deeply affirming of her growing sense of peace and joy in the face of the multiple challenges of her life.

Phase V was then initiated with Synchrony training using a CapScan Prism 5. Originally Synchrony was achieved in the Alpha range with a quick progression downward through upper Theta and ultimately into the lower Theta-Delta range. Treatment was discontinued after four sessions of Synchrony training at Susan's request because, as she put it, "I feel like I'm done with all of that (meaning the Lyme's disease). I've moved beyond it." Upon follow-up, Susan has been virtually symptom-free with continued regularity of sleep-wake cycles, continued performance regarding attention, concentration, short-term memory, decrease of joint pain, and a sense of alertness and enjoyment in living which had been absent for years. She continues to meditate daily, walks two or more miles a day, and is consuming no caffeine, nicotine, or alcohol. Her overall level of health has increased so that she has been able to discontinue other pharmacologically-based interventions.

Summary

In summary, this article has outlined a Five Phase Model of CNS Functional Transformation. This model provides an effective and efficient framework for organizing the diversity of clinical wisdom regarding the application of EEG neurofeedback across a wide range of disorders and treatment foci. A systematic use of these five phases and the treatment protocols pertinent to each can help organize the use of biofeedback into a precision tool to dramatically increase its effectiveness.

Appendix: A Brief Guide To The Five Phases of CNS Functional Transformation

Cz is used as active site at the beginning and end of all phases except for Phase V, where a four channel hook-up involving O1, O2, F7, and F8 is required. Placement is varied within phases as necessary to obtain demonstrable clinical effect. Thus, Phase II work with depression may involve a temporal placement during the work of that phase, whereas in cases involving TBI, placement is frequently specified at or contralateral to site of injury. Once criteria is attained at the alternate site(s), then the original hook-up is reinstated until criteria can be attained at Cz. At that point, the work can progress into the next phase.

Phase I: SMR Augmentation (14 Hz) with Theta Suppression, especially of low end, high amplitude, spiked Theta (3 and 5 Hz). Begin here with everyone until they achieve criteria (e.g., via Temperature training > 94 for 20 min.; SMR amplitude doubled/20 minutes at sustained increase without frustration; amplitudes at 3 and 5 Hz decreased by 40%, especially with decrease in spiking and local recruitment). Also used as a 5-minute reorientation at the end of sessions in other phases. Frequently need to "notch down" the Theta range (e.g., 2-6, 2-4, 4-6) then follow with step-wise "notching up" (4-6, 2-4, 2-6, or other variations) especially with immune system involved disorders like Lyme's, CFIDS, and PMS. Primary task is to stabilize autonomic functioning, especially regarding sleep-wake cycle disturbance. If affective withdrawal, as in lack of empathy, especially with manipulative behavior-temper tantrums, poor body-part integration, and aggressive requests-demands for help-reduction in symptoms, then shift to C4. Notch down as above if necessary, then notch back up at C4, then shift back to Cz with notching down, then notching up as necessary in terms of symptom

changes. Catch phrase is, "Just let go."

Phase II: Beta Augmentation (> 14 Hz) with Theta Suppression (3 and 5 Hz). Begin with low Beta (15-18) initially, then shift to high Beta (20-24), however, if there is a poor clinical response to low Beta Augmentation with concurrent Theta Suppress at 2-6 Hz and continued criteria attainment for Phase I, then shift to high Beta Augmentation. If this is still ineffective and there is impulsivity, especially which seems manipulative, and poor spatial integration, including interpersonal spatial integration and high pain threshold (as if there is no body part integration), then return to Phase I work at C4. If Phase I criteria are no longer met after attempt at low Beta, then shift back to Phase I until criteria achieved. If emotional overlay (depressed or anxious) or ODD overlay (especially intermittent explosive type), then shift to C3 with low then high Beta in order to augment left hemisphere function, especially language mediation. If poor spatial integration, schizoid in the sense of affective withdrawal, but no psychotic symptoms, then C4 in order to augment right hemisphere functioning. The majority of the work with ADD occurs in this phase. Primary task is to increase the availability of and access to focal attention and concentration. Criteria for this phase are fulfilled when symptom relief occurs (especially as indicated by CPT and school-related behaviors in the case of ADD) with Phase I criteria continuing to be met. Many times ambient low and high Beta amplitudes show a doubling when this occurs, but just as frequently there is little overt, quantifiable change in Beta amplitudes or ratios to slow wave activity. Catch phrase is, "Just pay attention."

Phase III: Alpha Augmentation and the initiation of the Meditation Model. Sustained tripling (or even quadrupling) of Alpha amplitude for 20 minutes or more, ultimately with eyes open and Cz as placement. May need to begin at O1, then to O2, then to Oz, then progressing up the z line. Primary task is to reliably and demonstrably attain the Relaxation Response while maintaining the abilities of prior functional gains. The majority of the work with chronic stress related disorders, as well as many chronic pain disorders occurs in this phase. Catch phrase is, "Just relax."

Phase IV: Alpha-Theta protocol with continued production of sustained, high-amplitude Alpha which leads to a rapid, episodic decrease in Alpha amplitude with associated rapid 7-Hz surging (this is what has been referred to as the Alpha-Theta Crossover) while maintaining the abilities of prior functional gains (i.e. continued suppression of 2-6 Hz activity). The majority of the work with substance abuse and PTSD and its variants occurs in this phase. Catch phrase is, "Just be free and watch."

Phase V: Synchrony Training with increasing amounts of inter- and intra-hemispheric synchronization of dominant frequency. This usually occurs first in the Alpha range, with a natural progression through Theta and into Delta synchrony. Immune system involved disorders benefit greatly from Low Theta-High Delta synchrony as long as criteria for the earlier phases continue to be met. The majority of the work with peak performance occurs in this phase. Catch phrase is, "Just be."

For Further Reading

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Valdeane W. Brown, Ph.D. has more than a decade of experience in working with clients who have been identified as difficult or treatment resistant. Dr. Brown has been committed to developing a comprehensive approach to neurotherapy, including the use of home training instruments and other adjunctive techniques such as Yoga, mindfulness meditation, visualization, and breathing practices. He has developed the Five Phase Model of CNS Functional Transformation, which he has presented at international conferences. He has served as a national consultant on Total Quality Management, Outcome Measurement, and developing Multidisciplinary Practices. He is in private practice and the Director of Training for Health Training Seminars, which provides consultation, supervision and teaching services regarding neurotherapy and multimodality biofeedback.