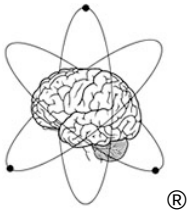

Ultra-Low Frequency Bipolar Neurofeedback Protocol Guide

or
How to perform (a therapeutic trial of) neurofeedback in the absence of a quantitative electroencephalogram (QEEG).

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"*From the brain and the brain alone arise our pleasures, joys, laughter and jests, as well as our sorrows, pains and griefs*" – Hippocrates

"*Archie, the brain has a mind of its own!*" – Edith Bunker

The average client does not need expensive laboratory tests, genetic profiling, and biopsies in order to eat, exercise, and live better. A therapeutic trial of healthy lifestyle and self-regulation usually shows whether the effort was worth it or not. If good results are not forthcoming, it is prudent to find the most accurate and comprehensive evaluation possible. In the realm of neural dysregulation and sub-optimum performance, this evaluation may begin with the quantitative electroencephalogram (QEEG).

Only recently has the QEEG become so affordable, available, and accurate as to be nearly routine in the evaluation of human cerebral performance. Nevertheless, it may still be inconvenient or unattainable for some.

Before QEEGs were even feasible, neurofeedback pioneers successfully and routinely ameliorated disturbances such as epilepsy, attention deficit disorder, addictions, migraine, post traumatic stress disorder, and many others. The techniques were often deceptively simple. Only now, in the 21st century, are we beginning to understand that the awareness and self-regulation of neurophysiological states through neurofeedback shares crucial neurological circuitry with the mindfulness meditation practiced for millennia throughout the world. Neurofeedback also ties in with the forces that guide the neurological development in a child's brain under the influence of secure social attachment.

This brief text is dedicated to all of you who would use any means possible to relieve human suffering.

Table of Contents

1. Introduction

The Technology

This manual describes the use of single-channel neurofeedback. Such a setup can be used to do traditional amplitude training. One example would be placing the ground on the right ear, the black reference electrode on the left ear, and the red exploratory electrode over the region where the amplitude training is desired. The above example is best referred to as "single-channel amplitude training (with one exploratory electrode)." Amplitude training, in most cases, will train to increase or decrease the amplitude of a particular target frequency, such as alpha or SMR.

This manual describes a different setup for single-channel neurofeedback, which is best described as "single-channel bipolar neurofeedback." In this setup, the ground remains in a convenient location while both the black and red electrodes are placed on the head. The black and red placement may be inter-hemispheric or intra-hemispheric. When using bipolar neurofeedback in this fashion, many practitioners have found that the reward frequency can be varied over a wide range, even in a single session, in an effort to find the optimal client response.

An increasing number of neurofeedback practitioners are finding exceptional results training in the low frequencies, even in the infra-slow frequencies such as 0.01 – 1.0 Hz. Some practitioners have an aversion to training at a low delta frequency that is traditionally associated with sleep or head injury. What must be remembered is that this is *not* amplitude training. With traditional amplitude training, your black electrode is on an EEG-silent area such as the ear. Thus, the only activity that is measured and rewarded is the amplitude under the single exploratory electrode.

With bipolar training, say with black at T3 and red at T4, you are automatically rewarding the difference in amplitudes between the two sites. Literally, the amplifier is subtracting the amplitude at T3 from the amplitude at T4. The reward bar graph on your screen rewards the *difference* between the two sites. If at two sites, say T3 and T4, the EEG activity is very similar, then when they are subtracted (by the amplifier), they cancel each other out and your reward bar shows a low "difference" amplitude. If the brain spontaneously shifts the phase or timing of the EEG activity at T3 and/or T4 so that they become less similar, then they will not cancel out as much and your reward instrument will show an increased "difference" amplitude. This is a technique for reducing coherence between two sites.

The Rationale

This bipolar low frequency technique strives to enable the two sites to have more independence and autonomy at whatever frequency you are training. This is generally a good thing. This is a powerful technique for training increased robustness in the client's neural networks.[1]

In The Journal of Neuroscience, August 2008, Monto, et al wrote: [2]

> "We examined the dynamics of human behavioral performance and its correlation with infraslow (0.01–0.1 Hz) fluctuations in ongoing brain activity. …The subjects' ability to detect the sensory stimuli was strongly correlated with the phase, but not with the amplitude of the infraslow EEG fluctuations. These data thus reveal a direct electrophysiological correlate for the slow fluctuations in human psychophysical performance. We then examined the correlation between the phase of infraslow EEG fluctuations and the amplitude of 1–40 Hz neuronal oscillations in six frequency bands. Like the behavioral performance, the amplitudes in these frequency bands were robustly correlated with the phase of the infraslow fluctuations. These data hence suggest that the infraslow fluctuations reflect the excitability

[1] Othmer SE & Othmer S. Interhemispheric EEG Training: Clinical Experience and Conceptual Models. In Evans JR (Ed) - Handbook of Neurofeedback. Haworth Press, NY, 200, p. 109-136.
[2] Monto S, et al Very Slow EEG Fluctuations Predict the Dynamics of Stimulus Detection and Oscillation Amplitudes in Humans The Journal of Neuroscience, August 13, 2008, 28(33):8268-8272.

dynamics of cortical networks. We conclude that ongoing 0.01–0.1 Hz EEG fluctuations are prominent and functionally significant during execution of cognitive tasks."

This new research done in Finland gives additional support to the efforts of pioneers like Siegfried and Sue Othmer, John Anderson, and others, who explore and harness these newly discovered powerful rhythms for the benefit of their clients. It has only been in the last several years that affordable neurofeedback amplifiers and software have been capable of functioning reliably at the infra-slow frequencies.

Multiple Inhibit Bins

Another feature of the low frequency work, as originally implemented by the Othmers, is the use of multiple inhibit bins. In traditional amplitude training, it is common to have a "high inhibit" instrument to discourage excessive beta activity or EMG activity. Suppose you have a high inhibit which is set for the range of 18-30 Hz. You observe that your client has 20 Hz activity that is usually above 5 microvolts but occasionally above 10 microvolts. You could set an alarm threshold so that any signal above 10 microvolts between 18 and 30 Hz gives a warning signal. However, your client may also have a repeated 4 microvolt activity at some other frequency, say 28 Hz, that is more clinically significant. Unfortunately, it will not trigger the "high inhibit" because the high inhibit is set to 10 microvolts across the entire 18-30 Hz range. Unfortunately, in order to capture the 28 Hz 4 microvolt signal, you can't just lower the general 18-30 Hz threshold from 10 microvolts down to 4 microvolts because the 20 Hz signal is usually above 5 microvolts and would set off the alarm all the time.

One way to capture more rogue excursions is to have multiple inhibit bins, each spanning 4 Hz. For example, you could have an 18-22 Hz bin, a 22-26 Hz bin, and a 26-30 Hz bin. The 18-22 Hz bin could have a threshold of 10 microvolts to catch its rogue excursions, and the 26-30 Hz bin could have a threshold of 4 microvolts to catch its rogue excursions as well.

Bad Reactions and Side Effects

Remember the Finish study above that concluded: "the subjects' ability to detect the sensory stimuli was strongly correlated with the phase, but not with the amplitude of the infraslow EEG fluctuations". It is possible that, at a particular infra-slow frequency, your client might suddenly detect his or her own sensory stimuli more acutely. This could happen suddenly and distress your client. It is your job to watch your client carefully and alter your reward frequency as needed. Much of this booklet will help you do this.

Some incidences where people have claimed to have been harmed by low frequency bipolar training are ones where they were self training and did not orient to the development of altered arousal or sensation, which then became distressing. In other cases, the trainer may have not have been paying attention to subtle changes in client behavior (breathing, appearance, tone of voice, etc.). The inclusion of peripheral measures of autonomic stress, such as GSR or heart rate variability (HRV) power spectrum, can often provide advanced warning.

In general, most practitioners who have taken the time to understand the rationale and implementation of this technique expect to observe some sort of change in their clients within the first 1-3 visits. If positive change seems elusive, you might need to consider breathing, HRV, a closer look at diet (excitotoxins) and addictions, or the possibility of PTSD. You might consider alpha-theta "deep states" training to help with client integration and development of self-consciousness and narrative.

Always, if there has been a history of head trauma, epilepsy, brain surgery, stroke, or poor results with neurofeedback, you should have a QEEG done.

Conclusions

The author is unaffiliated with the Othmers and is solely responsible for the content of this book. I hope all your clients are ones you can help. Please contact me at mind@growing.com for more information.

2. The Relationship of Mindfulness Training to Biofeedback

It is possible that most of the books you have seen with the word “mindfulness” in the title have been books about meditation, often Christian or Buddhist in orientation. It may surprise you to know that the University of California in Los Angeles (UCLA) has a “Mindfulness Awareness Project”; and that the Massachusetts General Hospital has treated thousands of patients with its “Mindfulness Based Stress Reduction Project”.

Definition: Mindfulness refers to the self-regulation of the awareness of inner or mental states, often subtle, fleeting, and associated with the accurate perception of life as it is lived in the moment. Mindfulness Meditation or Training refers to a broad group of activities taught for many centuries in a wide variety of cultural and religious contexts. Basically, it is the self-regulation of the awareness of mental states accompanied by attitudes of appreciation, curiosity, openness, amusement and tolerance (ACOAT).

PBS’s Scientific American Frontiers with Alan Alda showed Tibetan monks trained in mindfulness meditation raising their body temperatures 15 degrees to dry wet and freezing sheets draped over their bodies. There is a similarity in the accomplishments of a woman or man who uses biofeedback to learn to control blood flow or brain waves in order to stop migraines or seizures.

The definition of mindfulness as “self-regulation of states of mind accompanied by attitudes of amusement, curiosity, openness, appreciation, and tolerance” could also describe the biofeedback process, wherein one learns to recognize and control various states of body and mind in a supportive and enjoyable environment.

3. Objectives of Neurofeedback Training

- Self-regulation of neurophysiological states
- Reduction or resolution of physiological and psychological issues
- Symptom reduction, enhanced functioning and improved quality of life

Three broad categories of neurofeedback are:

1) Protocol and system-symptom driven neurofeedback,
2) QEEG driven neurofeedback and EEG phenotype driven neurofeedback
3) Deep (twilight) state training.

QEEG and EEG phenotype driven neurofeedback will not be discussed in this manual.

In the protocol and system-symptom driven neurofeedback described in this guide, the trainer is guided by knowledge of neurophysiology, and especially by the reactions of the client during the training. As practitioners of this category of neurofeedback, we work to improve physiological awareness and self-regulation. In deep-state training, we strive to achieve integration and resolution of conflicted states and memories.

4. Neurofeedback Assessment

- Does not require or lead to a medico-legal label
- Describes client states of 1) over-arousal, 2) under-arousal, 3) instability, 4) localized dysfunction, and 5) addictive or post-traumatic behaviors
- Attempts to explain mechanisms of dysregulation and symptom production
- Suggests protocols for training for improving self-regulation
- May include reports of QEEG, CPT, TOVA, and other tests

There are many medico-legal and statistical categories that do not relate directly to neurofeedback. Neurofeedback assessment is less concerned with categorization of behavioral details and laboratory tests, and more concerned with understanding how the client functions under various stressors. If there are deficits in functioning, then neurofeedback assessment attempts to determine 1) where and how the brain may be functioning sub-optimally, and 2) how these deficits may be ameliorated. Ultimately, the client's nervous system will be given challenges through neurofeedback training. The adequacy of this training will be assessed and the approach possibly modified based on reports of the client's subsequent changes of state.

Most neurofeedback equipment has 1 to 4 channels of EEG available. It is possible to perform a so-called "mini-QEEG". This information about the relative amplitudes of the different bands at one or more sites can be very useful. Its use is encouraged, especially when using a single-channel referential montage specifically for the purpose of increasing or decreasing the amplitude of a particular band.

5. Initial Client Evaluation

Look for and investigate:

- Arousal levels
- Instabilities
- Disinhibitions
- Local Localized dysfunction
- Addictions and traumatic sequelae

Arousal Level: Is your client over-aroused from over-stimulation by substances, unrealistic demands, toxic lifestyle or relationships. Is there evidence of chronic stress and excess cortisol production? Is your client in the alarm phase of Hans Selye's general adaptation syndrome, or in the adaptation or exhaustion phases? Maybe with the candle burning at both ends he is trying to ignite the middle! Or is your client under-aroused – cold and pale, slow and exhausted.

Be careful! This is probably the crucial issue – because state of arousal will determine whether you train at a lower frequency (for over-aroused) or a higher frequency (for under-aroused). I expect most of your clients will turn out to be over-aroused and require low frequency reward, perhaps in the recently researched realm of the infra-slow EEG.

We will talk more later about how to make this crucial distinction. If you change the frequency in the wrong direction, your client will most likely let you know, either the day of the session or next. Then you can adjust appropriately (keep good records!). However, sometimes the state changes do not make sense at first, and you may continue to adjust in the wrong direction. Observe your client carefully.

Any good textbook of traditional Asian medicine (acupuncture and herbs) will spend a significant amount of time talking about over-aroused (yang type) and under-aroused (yin type) clients. They will also discuss "yin in yang type" and "yang in yin type". They will also discuss the under-aroused (yin) patient who can not tolerate arousal or supplementation. There are chapters on the subtle indicators in the history, complexion, behavior, symptoms, pulse and tongue. Arousal is a traditional issue!

For our present purposes, however, just let your client and your clinical acumen guide the way.

Instabilities: It may be appropriate to consider as "instable" any condition that can change suddenly or dramatically. This would include migraine, fibromyalgia, PMS, mania, depression, suicidality, paroxysmal pain, arrhythmias, asthma, epilepsy, panic attacks, dissociative symptoms, etc. Sometimes the paroxysms are triggered by a change of state, e.g., fatigue, mood, or chemical exposure. Be certain to keep a careful history of the frequency and intensity of your client's symptoms

and of the electrode placements and reward frequencies. Many common recurrent complaints are due to a “kindling” type of cortical irritation, such as occurs in epilepsy.

Disinhibition: Trauma (physical and emotional), attachment issues, genetic susceptibility, and metabolic insult are among the reasons why the prefrontal lobes may function sub-optimally. Among their crucial functions are 1) bodily regulation, 2) attuned communication, 3) emotional balance, 4) response flexibility, 5) empathy, 6) insight 7) fear modulation 8) intuition, and 9) morality (Siegel DJ 2007). Insufficiency of any of these functions may be reason to regulate the prefrontal cortex. It is also possible that during low frequency training of an over-aroused client, you may inadvertently reduce prefrontal function with the appearance of symptoms of disinhibition. You can then adjust your sessions accordingly.

Localized Dysfunction: We will discuss symptoms that suggest localized dysfunction. If there is a history of focal brain injury or if there are imaging studies to support the idea, then specific electrode placements may be used to target the area.

Addictions and Traumatic Sequelae: Possibly the oldest medical writings in human history are contained within the Vedas, India’s sacred scripture. It is said that the chief job of the physician is to keep his or her patients from dying from their addictions. And the chief addiction is the addiction to their own personality. How excellent it is that neurofeedback clients can find resources outside the old patterns of their personalities.

If it is difficult to find a reward frequency that makes sense, or if the client seems ‘slippery’ in moving just above or below whatever frequency and placement you choose, then you may need deep states training. It is also true that you may need a less challenging electrode placement, such as C3-C4 rather than T3-T4.

It is possible that your client may not be comfortable with himself at a deep level due to unresolved feelings, memories, or impulses. Alpha-theta training can provide an opportunity for creative resolution and discharge and incorporation of confused and disturbing psychophysiological factors.

6. Summary of Indications for Training

Arousal level	Suggests adjustment of reward frequency
Instabilities	Suggests stabilization of paroxysmal symptoms
Disinhibition	Suggests enhancing prefrontal inhibitory control
Localized dysfunctions	Suggests special electrode placements
Addictions / traumatic sequelae	Suggests alpha-theta (deep-state) training

7. Contraindications for Neurofeedback Training

Changing the oscillatory patterns in a region of cortex will change the perfusion (blood-flow) patterns. It is easy to see how this could be dangerous if there has been a recent head trauma with slow sub-clinical bleeding. It is also an issue if there is a possibility of a stroke evolving, or the existence of space occupying lesions (tumors, vascular defects, etc.). Recent infections with headache, or recent toxic exposures with behavior changes, are also conditions that should be addressed before neurofeedback is considered.

A computerized quantitative electroencephalogram (QEEG) can detect or suggest many of the conditions which would contraindicate neurofeedback. In many cases, neurofeedback success will be enhanced when the protocols are QEEG driven. If there is any question at all about a client’s suitability for alterations of cerebral perfusion under neurofeedback procedures, a competent physician referral should be obtained.

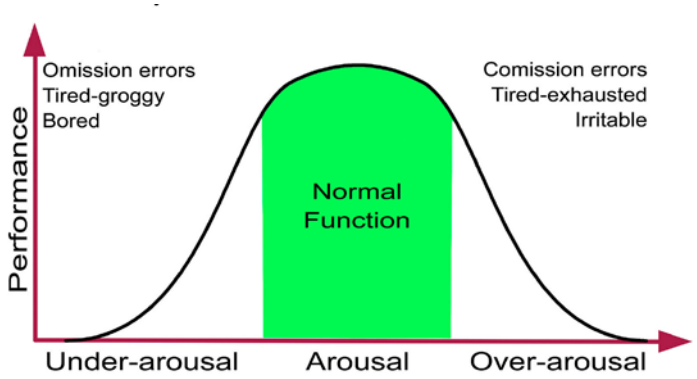
8. Arousal, Performance and Reward Frequency

Among the phylogenetically oldest regions of our brains are those of the brain stem which regulate arousal. These centers are so primitive, pivotal, and powerful that they may pursue a state of hyper- or hypo-arousal independently of the status of other areas of the cortex.

Because the dominant frequencies in a region of cortex are highly linked to local perfusion, the overall balance of brain activity can be dramatically affected by a slight shift in reward frequency. It may be useful to look at the relationship of performance to arousal as illustrated by the curve below.

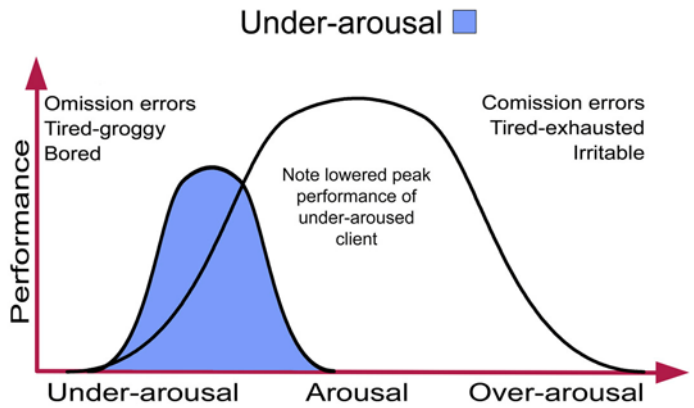
As you no doubt know from experience, significant states of under-arousal and over-arousal are, almost by definition, incompatible with normal, let alone optimal performance. There seems to be no end to what humans will do to self-regulate along this arousal curve. Most normal individuals can tolerate 'normal' levels of over-excitement or fatigue and stay within the needed range of normal function. In other cases, their position along the curve may be shifted.

8-A. The Normal Arousal vs. Performance Curve



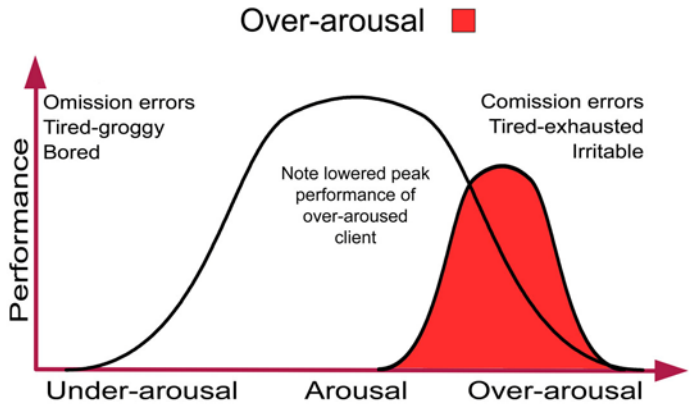
8-B. Chronic Under-Arousal

People who are chronically under-aroused function sub-optimally and in a limited range of environments. They may use stimulants and engage in arousing behavior in an attempt to improve their functioning. Sometimes they are so over-stimulated that they may appear to be over-aroused. Ideally, during training they would limit stimulants and rest adequately. Training with a higher reward frequency may improve their arousal and functioning.



8-C. Chronic Over-Arousal

People who are chronically over-aroused function sub-optimally and in a limited range of environments. They may employ substances or manipulate situations in order to maintain the high level of arousal when needed, and reduce it at other times. Such people may feel compelled to maintain their levels of achievement and do not want to be slowed down or relaxed. However, they may understand the concept of calming the nervous system so that it will function more effectively and possibly faster, not slower. Normally, high-arousal clients will need to be rewarded at a relatively lower frequency. Often it takes several sessions for such clients to understand and tolerate calm states.



8-D. Reward Frequency and State Changes during Sessions

In general:

- For the first session, unless otherwise indicated, start with T3-T4 in the SMR range, say 12-15 Hz.
- Expect to reduce frequency for over-aroused states (more common).
- Expect to raise frequency for under-aroused states (less common).
- Lower or raise frequency by 1 Hz shifts every 2-3 minutes and watch and query for changes.
- Fine tuning may require ½ Hz shifts, especially when working at much lower frequencies.
- It may take several visits to find the optimum frequency (which may be very low, e.g., 1-4 Hz or less.)
- Keep good records in case you need to reverse some changes.
- One goal is to enable the client to reliably monitor and self-regulate state changes.
- Another goal is to lead the client to the peak of the arousal vs. performance curve. Watch and query for maximum alertness and awareness accompanied by maximum calmness and relaxation.
- Selected frequencies and evoked states are specific to each individual and may vary over time.

Cerebral perfusion is closely linked to frequency. Significant state changes can be expected with slight shifts in reward frequency. Observe and question your client carefully. Some clients need several sessions before they can reliably observe subtle shifts.

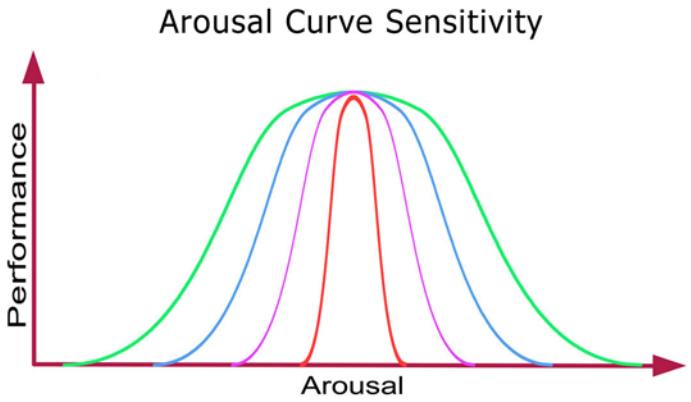
8-E. Arousal Curve Sensitivity

“Sensitivity” is inversely proportional to the width of the arousal curve.

Clients often vary widely in their sensitivity to shifts in arousal, environment, and reward frequency. Those with broad arousal curves are often more stable under a variety of stressors and less sensitive to shifts in reward frequency. Those with narrow arousal curves may experience rapid deterioration in performance with relatively minor mental, physical or environmental stresses. These clients will usually be more sensitive to shifts in reward frequency, sometimes requiring that shifts smaller than

½ Hz be made, and sometimes requiring that the reward bandwidth be made smaller than 3 Hz in size.

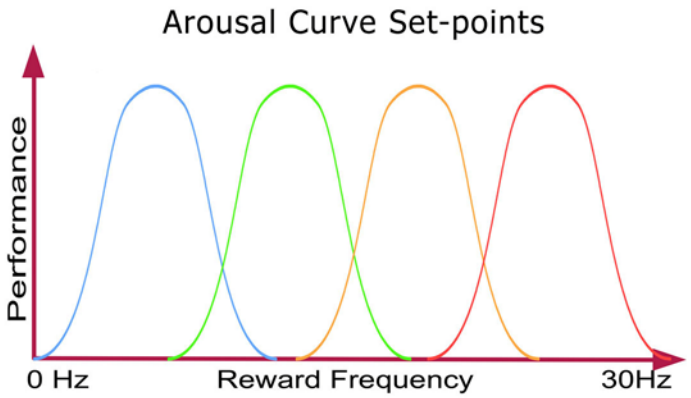
Neurofeedback can be effective regardless of an individual's arousal sensitivity. But expect that the more sensitive an individual is, the more attention needs to be paid to precise reward frequency and state and symptom shifts during and between visits.



8-F. Arousal Curve Set Points

The normal arousal curve shown in Section 8-A is generally accurate regarding shape for a given "normal" individual. However, many highly functioning people can have variation in the width and placement of this curve along the arousal axis. That is called the "set point" (see the graph below).

If we consider reward frequency as related to arousal (as it is, in its coupling with perfusion), then we can illustrate different arousal level set points in the graph below. This graph suggests that 12-15 Hz might cause agitation in an individual whose set points were around 4-7 Hz. Alternatively, 12-15 Hz could be overly sedating for another individual who functions well and naturally with a higher set point. Remember, these set points are not directly and obviously related to EEG power or QEEG topography in particular areas. Rather, they represent a regulatory challenge at a set point frequency which usually leads to client state changes.



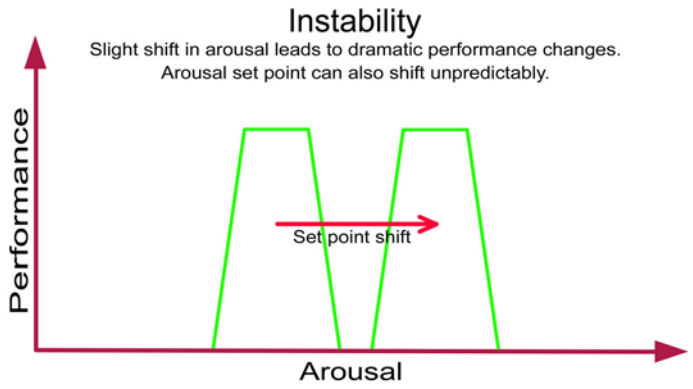
9. Cortical Instabilities

Paroxysmal or chaotic state changes that usually lead to symptoms may be the result of cerebral instabilities.

Stabilities are an issue with any control system, especially one like the brain which is precariously poised between coma and convulsion. Individuals can have paroxysmal symptoms due to instabilities that result from hyper-excitability of regions of the brain. This is a different issue than arousal curve set point or sensitivity. The “kindling” model, which describes seizure evolution, may be applicable to these other instabilities as well.

Hyper-excitability of a region of cerebrum can result in symptoms such as migraines, dissociative events, panic attacks, seizures (including abdominal epilepsy), anxiety, depression, suicidality, paroxysmal pain, etc. It may be caused by alteration of inhibitory control due to genetically-based susceptibility, environmental or metabolic insult, developmental disorders, space occupying lesions, infection, or emotional or physical trauma.

Clients with instabilities may have a history of stabilization through anti-convulsant medications.



10. Disinhibition

Disinhibition here refers to diminished prefrontal inhibitory function, with or without arousal or instability issues.

Trauma (physical and emotional), attachment issues, developmental issues, genetic susceptibility, and metabolic insult are among the reasons why the prefrontal lobes may function sub-optimally. Sometimes the insufficiency of inhibition is due to over-arousal.

Among crucial prefrontal functions (Siegel DJ 2007) are:

1. bodily regulation
2. attuned communication
3. emotional balance
4. response flexibility
5. empathy
6. insight
7. fear modulation
8. intuition, and
9. morality

Insufficiency of any of these functions may be reason to regulate the prefrontal cortex. It is also possible that, during low frequency training of an over-aroused client, you may inadvertently reduce prefrontal function with the appearance of symptoms of disinhibition. You can then adjust your sessions accordingly.

Common illustrations of disinhibition of "lower" centers by the impairment of "higher" (prefrontal) centers are the behaviors caused by alcohol or other metabolic insults, brain trauma, or development disturbances. Hyperactive, aggressive, impulsive and violent behaviors can result.

Remember when training that poor executive functions may result from immature or delayed cortical development, and not necessarily a lack of frontal activation. Such a situation is common in ADHD clients who may also have high arousal.

11. Localized Dysfunctions

Localized dysfunctions may required special electrode placement.

Note: in the appendix you will find graphic representations of this information. You will also find a table that arranges symptoms according to regions in a fashion suitable to use for gathering clinical information.

General neurofeedback training issues include arousal level, instabilities and disinhibition. More specific symptoms, correlated to localized dysfunction, can then be treated when the client is ready. You may be alerted to potential sites of local dysfunction as a result of histories of trauma, developmental defect, and genetic susceptibility. Or you may have access to reports of imaging studies and psychological testing. For neurofeedback purposes, a quantitative electroencephalogram read by a qualified interpreter is the best tool. Good suggestions for local placement may also come from the literature, i.e., lesion studies, case histories, and reports from other practitioners.

In determining electrode placement, we may consider 1) hemispheric laterality or 2) front to back organization.

Hemispheric laterality:

- Right hemisphere
- Left hemisphere

Front to back:

- Prefrontal
- Frontal
- Central
- Temporal
- Parietal
- Occipital

More information on lateralization and cortical specification can be obtained from any number of reliable sources treating the Brodman areas of the cortex. Because of variations in cortical shape and location, and because of uncertainties in EEG signal propagation to the electrodes, the following very general suggestions can be made.

11-A. Localization by Laterality

Left Hemisphere Training: The left hemisphere is more concerned with the "text" (conscious and linguistic) than with the "context" (spatial and emotional) of experience. The left hemisphere has important functions related to sequence, skilled movement, memory and planning. In addition to the above functions, the left hemisphere may be trained for mental calming as opposed to physical calming (right hemisphere).

Right Hemisphere Training: The right hemisphere is more concerned with the "context" (spatial and emotional) than with the "text" (conscious and linguistic) of experience. It is concerned with grasping social and emotional nuance in the moment. In addition to the above functions, the right hemisphere may be trained for physical-emotional calming as opposed to mental calming (left hemisphere).

11-B. Localization along Front-to-Back

Prefrontal Training: It is worthwhile to repeat the excellent elaboration of prefrontal functions described by D Siegel 2007: 1) bodily regulation, 2) attuned communication, 3) emotional balance, 4) response flexibility, 5) empathy, 6) insight, 7) fear modulation, 8) intuition, and 9) morality. Immaturity of executive function is a perplexing problem, which may be compounded by over-arousal of other neural systems. Here, it is left to the practitioner to find ways to query the client regarding changes in this system.

The left prefrontal region can be trained for improvement of planning and organizational skills and for impulse control. This region is often the best place to train for symptoms of obsession and compulsion, as well as tics.

Right prefrontal training has more effect on emotional regulation – aggression, attachment disorders, dominating and controlling, and uncontrolled or inappropriate anger or fear.

Prefrontal training can also be important in attention problems as well as in peak-performance training. Clients may report feelings of benign contentment or a capable awareness of boundaries.

Frontal Training: Frontal training can help mobilize clients into coordinated action. This region of the brain is involved in alertness, awareness of space, initiation and sequencing of action, motor coordination, and expressive speech. It can help lift depression. However, it may be to over-stimulating for some people, who subsequently feel agitated or hostile. Its use should usually come after a person has become stabilized and has had prefrontal training, and perhaps parietal training.

Central Training: Much of the pioneering work in neurofeedback was done on the central strip. Sometimes SMR on the right and beta on the left. As equipment became more flexible and clinical experience accumulated, it was found than most clients responded directly to changes in the reward frequency and/or placement of electrodes.

T3-T4 is often the starting point for general single-channel bipolar neurofeedback in the absence of a QEEG. However, for some people it is too challenging or it gives results that are ambiguous. For them, C3-C4 may be a better starting point. C3 and C4 are important choices for somato-sensory deficits. Placement may be fine tuned based on the famous sensory and motor homunculi.

The central strip reflects the activity of both motor (anterior) and sensory (posterior) cortices. Buzsáki (2006, p 33) says that the "central long-range loops between motor and sensory areas" are not closed by brain wiring. This "gap may be closed by actions exerted by the brain on the body and the environment, a process that 'calibrates' neuronal circuits to the metric of the physical world and allows the brain to learn to sense." Is this calibration process affected by neurofeedback?

Temporal Training: Anterior temporal bipolar training at T3-T4 is still an important starting point for general stabilization and regulation of the client, especially with respect to regulation of emotions and pain.

The temporal lobes also contain primary (auditory) and higher-order (visual) processing centers which can be benefited by neurofeedback.

Insula Training: The insula is located medial to the frontal temporal cortex and may be influenced by T3-T4 placement. This area is crucial to interoception, i.e., the representation and thus regulation of internal body states. It is unknown how much neurofeedback of the more superficial temporal regions affects insular functions, but such an influence may partly explain the often strong effect of such training on pain and visceral regulation.

Parietal Training: The parietal cortex is involved with representing the positions and movements of objects in space, including our own bodies. Training on the parietal cortex can be very calming and relaxing. Sensory overload, hypersensitivity, and integration can all be improved by training in this area, as can our awareness of how other individuals' bodies exist and move in space. This seems to lead to increased empathy and social and emotional awareness.

Occipital Training: A large amount of primate cortex is dedicated to visual processing. When visual representations change, we must decide whether it is the outside world coming toward us, or us moving in the outside world. The adjacent parietal cortex with its spatial preoccupations helps in this regard. When visual processing is impaired, whether by hypersensitivity, field defects, double vision, problems with depth perception, or retinal interference, it is worthwhile to institute a therapeutic trial of bipolar occipital lobe neurofeedback.

12. Dissociated Traumas and Addictions — Alpha-Theta Training

Alpha-Theta training (sometimes called "deep-states" training) is useful for traumatic sequelae and addictions.

Many of us associate consciousness with states and experiences we can describe and talk about. Yet we all experienced early life trauma, and occasionally great trauma (neglect, injury, abuse, circumcision), before we had words to categorize the experience. And latter in life, we may have experienced assault, domestic abuse, war, disaster, kidnap, terrorism, near-death experiences, or other events that overwhelmed 'linguistic business as usual' for the cortex. Now, as adults, we try to decipher a cry that is wordless, that somehow informs and modulates our being.

Memory researchers have divided memory into at least two types – implicit (unconscious) and explicit (conscious). Some features are briefly described as follows:

Implicit memory:
- Unconscious
- Sub-cortical involving the amygdala
- Contextually ambiguous and free-floating
- Temporally unrelegated (due to lack of context)
- Associated with early (pre-linguistic) experience or over-whelming trauma or experiences while drugged or intoxicated
- Associated with unconscious inarticulate dispositions toward the world and its experiences

Explicit memory:
- Conscious
- Cortical involving the hippocampus
- Contextually intact within the personal narrative
- Temporally relegated to past (due to context)
- Associated with epochs in an ongoing narrative
- Associated with conscious articulate dispositions toward the world and its experiences

Addictive behaviors may be related to traumatic experiences, whether explicit or not. Whether a client has unexplainable biases toward an habitual behavior, or unexplainable biases towards or against any other life event (commitment, self-care, equanimity, etc.), suspect a deep or dissociated trauma or addiction.

We may know about overwhelming traumas in our clients because they tell us or we see evidence in reports. We may sense the enduring traumatic sequelae in their circularity of reasoning which never dives below their presented surface. We may also suspect traumatic etiology when we have difficulty establishing general protocols for arousal or disinhibition.

Peniston and Kulkosky found alpha-theta training very useful for addictions. Further explorations found it very useful for uncovering trauma-based processes. When these processes start surfacing during neurofeedback, it is essential that the trainer be equipped to handle them. This is a completely different subject. I would highly recommend you consult “Trauma and the Body – A Sensorimotor Approach to Psychotherapy” by Ogden, Minton and Pain.

13. First Session

13-A. Overview

By now you have heard that neurofeedback clients may have issues with:

- Arousal
- Instabilities
- Disinhibition
- Localized dysfunction
- Dissociated trauma and addictions

No matter where you place the electrodes, arousal will be influenced by reward frequency (Othmer, 2006), so arousal level is always a consideration. Instabilities are suggested by paroxysmal symptoms. Disinhibition, localized dysfunction, and dissociated traumas and addictions may all be suggested by history and observation.

In most cases, you will want to treat these neurophysiological factors in the above order. In other words, you will usually want to start by optimizing arousal and then stabilizing instabilities. In some cases this will be difficult unless one first address disinhibition and local dysfunction. Whenever you are changing frequencies, be certain to observe and question your client well. This helps you optimize the frequency and helps the client start learning to be aware of subtle state shifts.

13-B. Arousal Issues: Arousal may be first approached with bipolar training at T3-T4 (C3-C4 for difficult cases). Start with a reward frequency bandwidth of 12-15 Hz and shift every 2-5 minutes, depending on observations or client report. Lower the frequency as long as your client remains over-aroused. Raise the frequency as long as your client seems under-aroused. If your client is too agitated or reactive, you may have to start intra-hemispherically with T4-P4 at 5-8 Hz and then go down.

Deciding whether your client is over- or under-aroused is not always easy, especially at first. This is discussed in much more detail in Section 15: Communicating during the Sessions.

Most clients will need to be slowly shifted down. You may, on occasions, go as low as your amplifier permits. Always try to find a frequency where your client experiences maximum alertness and maximum relaxation and comfort, i.e., the top of the arousal curve. Make a note of the client’s experiences or appearance at each frequency. When you find the optimum frequency, then you may elect to also train for arousal at prefrontal and then parietal locations, even occipitally if indicated. You may note that the optimal frequencies for parietal placements are up to 4 Hz less than those for temporals. And the prefrontal placements may do best at a frequency 2 Hz less than the temporals. If your amplifier can go no lower, you can always try narrowing the bandwidth of the reward bin.

13-C. Instabilities: Instabilities, such as migraine, panic attacks, etc., may be the presenting complaint. As such, you may note that the client experiences changes related to the chief complaint as the arousal frequencies are tuned. Stabilization may require extra time spent inter-hemispherically at T3-T4 (or C3-C4) fine tuning the reward frequency and allowing training to progress. Instabilities may also be improved by follow-up with inter-hemispheric placements at P3-P4, Fp1-Fp2, F3-F4, or O1-O2. If the client seems unresponsive, or if it is difficult to obtain a reliable training frequency, you may need to consider 1) prefrontal training for disinhibition, 2) localized training, or 3) deep states training for addictions and acquired fears, etc. Here is where QEEG may provide useful information.

13-D. Disinhibition: A person may be disinhibited because lower centers are hyperactive, or because prefrontal centers are hypo-functioning and no longer able to inhibit the lower centers. Train accordingly. In some cases, it may be necessary to 1) treat physical or sensory motor distress using T4-P4 starting at 5-8 Hz, or 2) treat emotional distress using T4- Fp2, or 3) treat cognitive distress using T4-Fp2. Then continue with prefrontal training, e.g. Fp1-Fp2.

Note: In many cases, it will be necessary to train left-sided localized dysfunction, for example Fp1-T3 (cognitive), approximately 2 Hz higher than right-sided localized dysfunction, such as T4-Fp2 (emotional) or T4-P4 (physical). See the table at the end of the book.

13-E. Localized Dysfunction: After the client's arousal level has been adjusted, instabilities addressed (if possible), and disinhibition trained, it is time to look at isolated symptoms indicating local dysfunction, which could be located anywhere. Use the table at the end of this manual to find possible correlations between conditions and treatment sites. Monitor the symptoms visit-to-visit. Adjust the frequency to client comfort. Remember – frequency always affects general arousal level. Counter disinhibition when necessary and address disturbing instabilities. Keep a good history.

13-F. Dissociated Trauma and Addictions: At some point in most clients' progress, you will need to address their (relative) lack of awareness of deep states. You may need to do this early in the training if they seem resistant to encountering state change. History of trauma and addictions may or may not be available. Client response will tell you whether or not this line of training is indicated. In training optimum-performance in already highly functioning clients, deep states training will probably be indicated early for the access to creative states that it provides.

13-G. Fine-Tune your Protocol for Individuals

Remember, before you start training, your interview should suggest the following:

- How the client responds to over-arousal by substances or stress — similar states may occur when reward frequencies are too high.
- How the client responds to under-arousal by substances or stress — similar states may occur when reward frequencies are too low.
- How the client responds when disinhibited — similar states may occur when the frequencies are too low and the client is disinhibited, or when the frequencies are too high and the client can't inhibit responding to an agitated state.
- How sensitive your client is to physical, emotional and environmental stimuli — similar states may occur when the reward frequency is changed too dramatically.

When you start training, keep in mind:

- Start with a general stabilizing approach (T3-T4 or C3-C4) to teach self-awareness and arousal regulation, and to determine optimal reward frequency.
- Move the frequency down when the client is over-aroused, and up when he/she is under-aroused. Shift the frequency by 1 Hz at a time in general, or for sensitive individuals ½ Hz or less.
- Some clients, especially the over-aroused, may try too hard and block subtle change or the awareness of it. Be patient, lower the frequency after a few minutes, and make certain they are comfortable and engaged.
- Train what you find, not what you are looking for! Let the client's growing awareness of state-regulation guide you.
- Keep good records so you can reverse any frequency or placement changes that interfered with the client's progress.
- Whenever appropriate, help clients articulate subtle changes in state. You must be a good profiler of *your own* subtle state changes and mirror this quality to your clients.
- For the first session in cases such as bipolar disorder, reactive attachment disorder, spasticity or autism, you may start with intra-hemispheric training rather than inter-hemispheric training. Examples include 1) T3-Fp1 for cognitive distress, 2) T4-Fp2 for emotional distress, and 3) T4-P4 for physical distress. Remember, if you have already determined an optimal frequency for T3-T4 and then train strictly on the left, you may find the required frequency to be 1 or 2 Hz higher.
- Your notes should include your observations of and your client's descriptions of any state changes. Be sure to note the time and the frequency at which they occur.

- At the end of the first session, if you have explored alternate locations, consider finishing with a few minutes at T3-T4 to help stabilize and reinforce the training.
- With practice, you may decide that there will be times during the first session when you will need to train at specific locations or switch to alpha-theta training.

14. The Central Role of Frequency

We have suggested above that you start at T3-T4 or C3-C4 at 12-15 Hz and adjust up or down (usually down) to find the "optimal spot" at the top of the client's arousal curve (somewhere between 0-30 Hz). Additionally, in cases of strong physical, mental or emotional agitation, you may start in an alternate intra-hemispheric placement.

The optimal frequency near the central strip (C3-C4 and T3-T4) turns out to be fundamentally important.

The Othmers have suggested a general relationship of frequencies during average neurofeedback sessions.

Let's use the letter "X" to represent the optimal frequency determined at T3-T4 or C3-C4, then we *may* find other optimal frequencies as follows:

Central and anterior temporal frequencies	=	X (as defined above)
Frontal and prefrontal frequencies	=	X – 2 Hz
Parietal and occipital frequencies	=	X – 4 Hz
Freq for right intra-hemispheric training	=	X
Freq for left intra-hemispheric training	=	X + 2 Hz

Example: After several visits, you determine that the optimum frequency for T3-T4 training in your client is 5 to 8 Hz. If you decide to train parietally, the required frequency range is likely to be about 4 Hz lower; that is, 1 to 4 Hz. If you decide to train frontally, it is likely to be about 2 Hz lower; that is, 3 to 6 Hz. If you train only the right side, the likely frequency will remain the same as the original T3-T4 optimal frequency. If you train only the left side, then the likely frequency will be about 2 Hz higher than the T3-T4 frequency, namely 7 to 10 Hz.

Obviously, if you discover the optimal frequency at T3-T4 to be, say, 1 to 3 Hz, you can not go 4 Hz lower when changing to a parietal placement. In such lower frequencies, there are alternate ways to adjust the reward frequency to optimize client response.

In the very low frequency ranges, 0-2 Hz, different amplifiers may behave differently. It is good to have the advice of your dealer regarding performance at infra-slow EEG ranges. Nevertheless, your client will give you the best information of all. You may occasionally find that frequency shifts as slight as 0.1 Hz make a difference in client response. You may also need to reduce the width of your reward bin to surprisingly narrow dimensions. Don't be afraid to experiment with your gear. Your client will continue to learn state-navigation and will provide you with the directions.

15. Communicating during the Sessions

Most clients know what it is like to feel over-stimulated by certain substances and situations and under-stimulated by others. Some of these states become discrete and routine for the client. Yet it is quite another thing for them to encounter these states during neurofeedback without their typical antecedents. It is also new for them to find they have states that can melt and shift subtly in unusual ways as you adjust frequency or electrode location. Your communication with your clients during every session, and especially the first sessions, is important in guiding them toward efficient state-space navigation and self-regulation.

Before asking your clients about changes, it is usually best to let them experience and assimilate the changes long enough to be able to articulate the feelings, thoughts, images, and phenomena that accompany them. Sometimes, however, the client will become clearly uncomfortable yet not be able to express the details. In order to choose the next frequency effectively, you may need to obtain preliminary descriptive information by offering the client "A" or "B" answers to carefully formulated questions.

For example, an over-aroused client may suddenly report feeling sleepy, sometimes within 15 seconds, after you lower the frequency range by 1 Hz. Does this mean the frequency is now too low and should be raised by ½ Hz? Ask your client to describe the state. Is it familiar? When does it occur? In order to get enough information to decide on the frequency change, you may need to ask, "Do you feel tired-exhausted or tired-groggy?" When an over-aroused individual finally relaxes enough to stop overwhelming his own state awareness, then he may feel that he is genuinely exhausted from over-arousal. You can probably continue to lower the frequency. But if your client feels sleepy in a groggy or sedated way, then you have probably lowered the frequency too much and may want to raise it by ½ Hz.

Similarly, a client may suddenly report feeling "jangled". You may ask her what she means and she may not be able to explain. Does your client mean "jangled" like someone is shaking her, or "jangled" like she has separated into parts that are "jangling" together? The first situation may call for lowering the frequency and the latter for raising it.

Here are some questions to ask:

- Do you feel more aware (of your body, thoughts, boundaries, etc.) or less aware?
- Do you feel more relaxed (or calm or comfortable or peaceful) or less?
- Do you feel more awake (or alert or ready or motivated) or less?
- Does any part of your body feel a different energy (or temperature, or color, or sensation) than the others?
- Does the space around you feel more or less safe (or threatening, or intact, or secure, or manageable, or light)?

With many clients, toward the end of the first session you will change a frequency and, in a minute or so, ask, "How is this?" and receive a cogent and clearly felt reply (for example: "better", or "anxiety is gone", or "calm and alert again", or perhaps "I feel anxious and nauseated", or "I feel my brain is being pushed out of my skull", or "I feel tingling in my left face").

It is not at all uncommon to change the frequency by 1 Hz or even ½ Hz and, within 15 seconds or so, have the client notice a clear and significant difference.

Pay special attention to:

- **Anxiety and irritability, sometimes with nausea**

  Here is something to watch for in clients who have been unconscious during surgery or after a trauma. While lowering the reward frequency and finding more and more comfortable states (sometimes with heightened body awareness), you suddenly get the report of anxiety, nausea, or irritability. Query your client if his tolerance level permits. He may say something like, "It is someplace I do not want to go." Then raise the frequency by ½ Hz intervals to find a peak comfort level for the session. It is not uncommon that your client will go home and sooner or later, often during sleep, suddenly have a powerful, perhaps painful, sensation related to the surgery or injury, and then report an excellent sleep.

  Thus, anxiety does not mean you must lower the frequency. If you have gone low enough toward under-arousal that the client 'connects' with a time they were anesthetized surgically or by fear, then you will have brought them to a place which may provoke anxiety. Listen, question, and adjust. The answer may come during the next session.

- **Sadness**

  Another potential confusing situation is the development of sadness. I have had several cases in which I have lowered the reward frequency and the client has felt tingling and relaxation and then, suddenly, sadness. What type of sadness is it? Is it a depressed, longing sadness, or is it a hurt, want-to-cry sadness? Some clients come in with a veneer of muscular armoring and anger, covering the fact that someone important has betrayed them. As they relax the tension and armoring, they may feel the suppressed sadness and weep. One client said, "I normally would have been angry for days and not know why. I realized that I had preferred the anger to feeling the hurt and sadness. I feel like I just worked through it."

- **Immature behavior**

  Sometimes prefrontal executive functions are weak, as in a child or adult with ADHD. If you over-arouse lower centers, executive functions may not be able to control them, and the result will be immature impulsive behavior. You may need to lower the arousal level. Sometimes T4-P4 or T4-Fp2 at a lower frequency will help calm lower centers. T3-Fp1 at a higher frequency may improve executive inhibition.

  Be cautious. Sometimes low frequency reward may lead to tiredness, frustration and emotional hypersensitivity and outbursts and require raising the reward frequency.

- **Pain**

  Pain can arise as a part of increased physical tension, irritability, and anxiety as a result of training too high. However, it can also arise when, after lowering reward frequency, a client relaxes sufficiently that a knotted or otherwise painful area emerges from the background of general body armoring. It is often beneficial to work with the client to determine the significance and origin of the complaining area. Often the discomfort will dissolve and you can continue to lower the reward frequency.

- **Sleepiness or fatigue during session**

  Sometimes as you increase the reward frequency and arouse the client, he may become overly tense and focused and then feel fatigued and sleepy. At other times, as you lower the reward frequency, the client may cease the over-stimulating processes and recognize a real exhaustion and need to sleep. By helping your client be aware of his arousal state, you can help him monitor his real need for sleep and recuperation. But it is often the case that your client comes in already having a problem with inadequate sleep. Neurofeedback is limited when what is really needed is lifestyle change (diet, sleep, exercise, addictions, chronic stress, etc.).

- **Changes in sleep patterns between sessions**

  Changes in sleep pattern are powerful indicators of arousal shifts. Always look carefully for clues. How easily did your client fall asleep and then wake up, either during the night after the session or the next morning? Was the sleep refreshing? Were there changes in dream patterns or snoring? Pay careful attention to nightmares. Typical nightmares are often just dreams that are too vivid and wake the client – you may need to lower the frequency. Night terrors, however, often occur when the client is so under-aroused that they can not shake off the nightmare and feel paralyzed with fear. These situations usually require raising the frequency and, eventually, deep-states work. Sleep walking and increased snoring are also often indicators that the reward frequency should be raised.

Especially during the first sessions, when you may be changing frequencies dramatically, remember that the session outcome is a result of the time spent at all the different frequencies of that session, not just the final frequency. Don't be surprised, then, if your client returns with some reports of over-arousal, even though you ended the first session at 1-4 Hz.

Start the next session at the final frequency from the previous session. At first, you may have to continue to adjust frequencies, even for several visits.

16. Adjusting your Treatment Plan

16-A. The First Session: General Arousal and Calming

After some practice, you can, in general, expect a significant response during or after your client's first treatment.

For most clients, you can spend the first 1-3 sessions attempting to find an optimum reward frequency at your training site. Usually you can start training at T3-T4. C3-C4 may be better tolerated by some people. C3-C4 may also be better suited if the condition is simply somato-sensory dysfunction or pain without emotional issues. In the case of highly reactive children with bipolar, autistic, spastic disorders, or for an adult in immediate need of physical calming, you can start with T4-P4.

For T3-T4 or C3-C4, start with 12-15 Hz and move down (or up) as needed. In the case of T4-P4 (for physical calming) or T4-Fp2 (for emotional calming), start with 5-8 Hz and expect to lower the frequency even more. You may want to follow these last two right sided trainings with T3-Fp1 for mental calming and executive normalization.

You can use a 3 Hz wide reward bin and shift in increments of 1 Hz. In cases of highly sensitive individuals, you may need to use more narrow bins and shift 0.5 Hz or less at a time. Don't be surprised if you train as low as 0.01 - 0.1 Hz for some cases and use shifts of 0.1 Hz at a time. At such low frequencies, your only options for fine tuning the frequency are to narrow the reward bin or to change the filter characteristics.

Observe your client constantly and question him when needed. Take good notes in case you need to back-up along the frequency trail.

The first sessions will introduce your client to the reality of self-awareness of subtle state changes. Always seek to have the client feel curious, open, and accepting of the results of the training. Your own confidence and awareness of your own state changes will be reassuring to your client.

Once you have done the first session, you will have a sense of your client's general arousal and sensitivity issues. You will also know the best frequency for midline training, and have a sense of what to expect if you train too high or too low at other sites. Each site will have its own significance for your client, but frequency will still influence local and general arousal, activation, and perfusion.

Expect that the optimum midline frequency, X, will be related to training at other sites according to the discussion in Section 14: The Central Role of Frequency.

Please remember that, at the end of the very first session, you will likely have trained your client for several minutes or more at a number of different frequencies before you find the best response. The response at that time and, in fact, the responses that night and next day are due to are the cumulative results of training with several frequencies in addition to the optimal frequency. That is why it is very important to instruct your client to pay close attention that evening and the next day to any changes in mood, cravings, sleep, dreams, appetite, energy, and relationships. This information may influence at the next visit whether you start training with the same frequency, or with one that is higher or lower.

Soon, you will need to consider employing additional sites to deal with the client's evolving issues.

16-B. Instabilities and Inter-Hemispheric Training (see charts and table at back of book)

Your client may have initially sought help with instability issues, such as migraine, asthma, panic attack, dissociative symptoms, paroxysmal pain, bipolar mood swings, or seizures. These and other

symptoms may be triggered with sudden but minor changes in arousal, or may appear chaotically and without provocation. There may be a history of relief brought on by use of anti-convulsants. In such cases, you may want to continue with inter-hemispheric training, since it is stabilizing.

It may be beneficial to train P3-P4, Fp1-Fp2, F3-F4, F7-F8, and O1-O2, as well as T3-T4 in this manner. Paying careful attention to frequency and your client's responses provides you with guidance. In the absence of good clinical results, you may reconsider whether your client has brain allergies or excitotoxin overload. A QEEG may help localize a cortical focus that could be responsible for the symptoms.

16-C. Localized Dysfunction and Intra-Hemispheric Training (see Section 18: Charts and Tables)

As opposed to anticonvulsants, some clients may have symptoms which benefit from antidepressants, stimulants or sedatives. The client may describe some of these symptoms as arising with prolonged high or low arousal situations such as stress or boredom. These symptoms include:

- ADHD
- Anxiety
- Autistic spectrum disorders
- Depression
- Disinhibition
- Obsessive and compulsive behaviors
- Tics and spasticity
- Learning disorders

16-D. Adding Sites

Please take a moment to familiarize yourself with two sets of colored charts and a table, which are located in Section 6-1 and titled as follows:

- Localized INTER-hemispheric Training for Local or Paroxysmal Dysfunction
- Localized INTRA-hemispheric Training for Local Dysfunction
- Tables of Symptoms and Sensor Placements

You will probably start with a T3-T4 placement and determine the optimal reward frequency over a period of 1 to 3 visits. You may continue to treat inter-hemispherically (parietally, prefrontally, frontally, occipitally, and/or temporally) to deal with instability issues. These inter-hemispheric sites are also useful for peak performance training.

You may then choose to work with the remaining complaints using more specific electrode placements. The set of charts in Section 18-B "Localized INTER-hemispheric Training for Local or Paroxysmal Dysfunction" gives you some suggestions for general symptom categories as they vary from front to back (prefrontal to occipital placements). These sites would also be indicated if the symptoms were paroxysmal in nature.

You may also refer to the charts in Section 18-C "Localized INTRA-hemispheric Training for Local Dysfunction". Remember to consider how typical frequencies change with location (see Section 14).

When training inter-hemispherically, frontal sites will usually train about 2 Hz below the temporals, and posterior sites will train as much as 4 Hz below the temporals. When training intra-hemispherically on the right side, most sites will train at about the same frequency as the temporals (except when starting with T4-P4 or T4-Fp2 at 5-8 Hz for extreme agitation, etc.) Most left hand sites will train about 2 Hz higher than T3-T4.

The following general guidelines are worth your consideration:

- Start with general inter-hemispherical stabilization; use as many sites as needed.
- After there are no signs of instabilities, move to right- or left-sided training, as needed.

- Consult the table of symptoms to obtain suggestions for specific placements.
- At first, add only one site at a time and fine-tune the reward frequency. Take time to understand and chart the results.
- With ADHD, depression, anxiety or disinhibition, you may need to add T4-P4 and T3-Fp1 at the same session.
- Right side is good for physical calming, emotional regulation, and right-sided brain dysfunction.
- Left side is good for mental calming, executive regulation, and left-sided brain dysfunction.
- For right-sided training, your client may do better by starting at T4-P4, then moving anteriorly.
- For left-sided training, a good starting point is T3-Fp1. Remember to train about 2 Hz higher than the right side or T3-T4.
- If you have chosen both right and left side locations, divide the session time between them and finish with T3-T4 to stabilize.
- If your equipment permits, you can also train the right and left sides at the same time with two channels, left side higher by 2 Hz.
- Continue to train T3-T4 for stabilization.
- When necessary and when time permits, you can train all indicated sites during each session.
- Long sessions at a single site, especially with frequent sessions, may be difficult for sensitive individuals.
- After general inter-hemispherical stabilization, if there are no localized dysfunctions, you might proceed to alpha-theta training for peak performance and creativity, or for dissociative trauma phenomena, PTSD, or addictions.

17. Managing Uncomfortable Neurofeedback Effects

17-A. The Risks of Neurofeedback

Cory Hammond and Lynda Kirk published an important and thoughtful article in 2008 dealing with reported side effects and adverse reactions to neurofeedback.[3] Such uncomfortable effects in neurofeedback are generally far less severe and appear to occur much less frequently than side effects associated with the practice of internal medicine. Nevertheless, such reported effects must be taken into account. Ethics dictates that our clients are informed of these possibilities. Even a simple exercise program at a gym could lead to exercise induced asthma, infected blisters, dehydration, muscle cramps, sprains, or in rare cases angina. It may therefore be prudent to have a physical exam before participating in an exercise program. But this is not feasible for many people, and currently it is not mandated by law or by ethical guidelines. Neurofeedback will continue to be offered as an exercise for the central nervous system by the unlicensed, and as an adjunct experimental procedure by licensed professionals. With increasing numbers of clients using neurofeedback, is our profession doing enough to try to understand the origin and significance of uncomfortable reactions?

Hammond and Kirk point out that the majority of the uncomfortable reactions reported during neurofeedback involve low frequency protocols and alpha-theta training.

Let's list the events cited in Hammond and Kirk's article. These reported adverse reactions should be in your disclaimer. They include, but are not limited to: anxiety, agitation, headaches, nausea, fatigue, sleep disturbance, increase in somatic symptoms, anger and irritability, crying and emotional lability, temporary disorientation or dissociation, loss of previous symptomatic improvements, panic attacks, manic-like behavior, incontinence, enuresis, increase in depression, increase in OCD symptoms, slurred speech, decline in cognitive functioning, tics, twitches, and seizures. It should be noted that most, but not all, reported adverse reactions are both temporary and mild.

It appears that many of the complaints recorded in the literature, and especially in the internet user's groups, were the result of neurofeedback training by inadequately trained individuals, or of home training by an unqualified individual. Nevertheless, you should approach the study of low frequency

[3] Hammond DC, Kirk L. First, do no harm. Adverse effects and the need for practice standards in neurofeedback. Journal of Neurotherapy. Vol 12(1) 2008. 78-88.

and alpha-theta neurofeedback with the understanding that you may be held responsible for causing a distressing situation in your client. The old excuse that "neurofeedback is effective and harmless" is not going to work forever. If my dentist didn't tell me that a procedure, such as injecting the Novocain, was going to hurt and I was suddenly flooded with pain and anxiety, I would be angry. If he then told me that he couldn't possibly have hurt me, I would be thinking litigation. Remember, many of your clients are coming to you after being exposed to drugs which 1) mask their symptoms, and 2) carry very serious risks. A explanation of the relative risks of neurofeedback would be expected to leave most of your clients quite comfortable.

It is sometimes observed that, as a result of neurotherapy, a client's need for medication may decrease, with the result that he may now be overmedicated and experience drug-related side-effects. This underscores the importance of a thorough history and of working with the client's primary heath care provider, when appropriate.

Whether you are BCIA, AAPB, or ISNR, you agreed to the ethics of informing your client of the situation. This includes the relative risks of neurofeedback. This takes more preparation and work on your part, but your client will have increased respect and tolerance of your efforts to help him or her.

17-B. Traditional Explanations of Uncomfortable Neurofeedback Reactions

I have never heard any formal discussion about reported side-effects to neurofeedback. But I have heard a variety of individual explanations, some plausible, others not so plausible: 1) The client was going to have those symptoms that day anyway, and when they coincidentally occurred when I lowered the reward frequency, I was blamed; 2) I told the client I could correct this new problem in probably ten more visits, but he became whiny and passive-aggressive so we stopped working together; 3) It is too overwhelming for the client to get better so she manifested a reason to stop treatment; 4) It's just one of those things; 5) I just got the QEEG back, I should have trained differently; 6) I should have trained amplitude first instead of coherence; 7) It took 40 visits to get rid of the sleep walking, but then he developed headaches and he can't afford another 40 visits.

I think the most common and the most plausible explanation is the that the protocol was wrong and exacerbated some dysfunction. However, as discussed in Section 17-C, this may not be the main reason why low frequency and alpha-theta work are known for their sometimes uncomfortable and unwanted effects.

In some cases, neurofeedback should be temporarily postponed. For example, I have encountered many practitioners who do not know that it is risky to train a client who is intoxicated. If you change the oscillatory pattern in the brain, you change the perfusion (blood delivery) pattern. The sudden change in the pattern of delivery of blood containing neurotoxins, e.g., excitotoxins, can cause unexpected consequences.

What is even less often appreciated is that plenty of clients come in intoxicated on commonly-encountered chemicals such as MSG (also called flavors or natural flavors, etc.), other excitotoxins, and neurotoxic dyes and scents. A good scientific introduction to some of these issues can be obtained by looking at the research cited at www.feingold.com, or by reading the book by University of Mississippi neurosurgeon Dr. Russell Blaylock.[4]

If you are comfortable with adjunctive nutritional support, you can adapt Perlmutter's questionnaire about neurodegenerative risk, and provide your client with information on important nutriceuticals that are neuroprotective and promote neuroplasticity.[5] Be cautious about operating within the scope of practice of your license.

[4] Blaylock RL. Excitotoxins – The taste that kills. Health Press, Santa FE, NM 1994.
[5] Perlmutter D. The Better Brain Book. Penguin Group, NY. 2004.

This is not the place to discuss brain allergies or clinical ecology,[6] but there are a number of controllable influences that can have profound effects on neurofeedback outcome.

17-C. The Red Thread

This is just *my* theory to explain *my* observations. I am going to discuss what I believe is an important and manageable cause for what may be the majority of cases of discomfort and failed neurofeedback training.

I have noticed similar reactions that occur in both clients with PTSD and clients with other conditions. And I noticed these reactions primarily with low frequency and with alpha-theta training. Please note that Hammond and Kirk (2008) (op. cit.) found that most adverse reactions occurred with low frequency and with alpha-theta training.

I call these reactions "the red thread" reactions (red being associated with injury and trauma). These reactions may take many different forms, but typically there is an autonomic disturbance which is displayed in one or more of the peripheral instruments – heart rate variability (HRV) power spectrum, electrodermal response, and/or finger temperature. By the time such autonomic disturbances appear in the peripheral instruments, the EEG has often indicated increased beta activity. At first, the client may exhibit minimal changes in facial expression, vocal expression, breathing, complexion, postural bracing, etc. The client is always encouraged to describe any changes in sensation or cognition, but sometimes seems to be swept along and to have identified with the feeling. Sometimes I just observe for a few moments and then ask what is going on. Often the client senses the discomfort and makes it known.

Sometimes the client can fairly easily relate the sudden sensation or mood change to a prior traumatic experience. If the client's discomfort does not dissipate on its own, we have several alternatives; 1) return the frequency to the last known comfortable setting, 2) change electrode location to deal with emergent symptomatology; 3) switch to alpha-theta training to deal with reintegration of traumatic non-verbal memory into narrative memory; 4) teach self-regulation of the disturbing reaction; or 5) after stabilizing the client at the last-known comfortable frequency, wait until the next session to continue any training (have the client log any changes in mood, appetite, sleep, dreams, performance, symptoms, etc.).

What seems clear to me was that many, if not all, clients have a window of tolerance in which they can socially engage and deploy their action resources (curiosity, bonding, play, exploration, etc.). When the client exceeds that window of tolerance, he may become 1) hyper-sympathetic, over-aroused, and tend to fight or flight; or 2) may become hyper-parasympathetic, under-aroused, and tend to dissociation.

The patterns that exist outside of the window of tolerance are sometimes those that had imminent survival value for the client, and are notable in that they bypass executive control and social engagement. Once activated, the client may take minutes to hours to days to return to his window of tolerance.

These are the residuals of overwhelming trauma which have not been incorporated into the narrative memory. When they come forward in whatever autonomic, somatic, reactive, emotional or cognitive form, these may be important (and thus welcome) indicators of where the hurt is located (figuratively speaking).

When a mother lovingly tends to the injuries, losses and fears that are so overwhelming to the child, she does so with the knowledge that her child will eventually learn self-regulation. Neuroscience is

[6] Williams R, et al [Eds]. A physician's handbook on orthomolecular medicine. Keats, New Canaan CN, 1979.

showing [7] that Alan Schore was correct [8] in his assertion that the mother functions as an accessory cortex to help mirror and teach self-regulation.

I believe that the neurofeedback practitioner, together with the computer, function as accessory cortices as well. Healthy attachment in infancy should lead to robust self-regulation capabilities. When attachment has been inadequate, or ruptured by a trauma, the individual may face a life of chronic illness and re-traumatization.

When the client's arousal escapes the window of tolerance, there are methods to return the client to more comfortable territory. One key approach is to re-establish the ventral myelinated vagal social engagement system. This is done by bringing the client's awareness back to the non-threatening immediacy of the room, and activating normal calm communication. Another approach is to start teaching self-regulation of the offending immediate sensations (e.g., HRV training or breathing). The therapist can also mirror the client's postural attitude and perhaps induce empathy and curiosity. There are also hard-wired action/behavior resources that can be recruited, such as curiosity, exploration, play, bonding, caring, etc. This is an advanced topic for neurofeedback practitioners which will be covered elsewhere.[9]

Such an approach has been more aligned with the expectations and experiences of those who work with PTSD. But they also routinely arise in low-frequency bipolar training. Let me give a short example below.

17-D. An Illustrative Case History

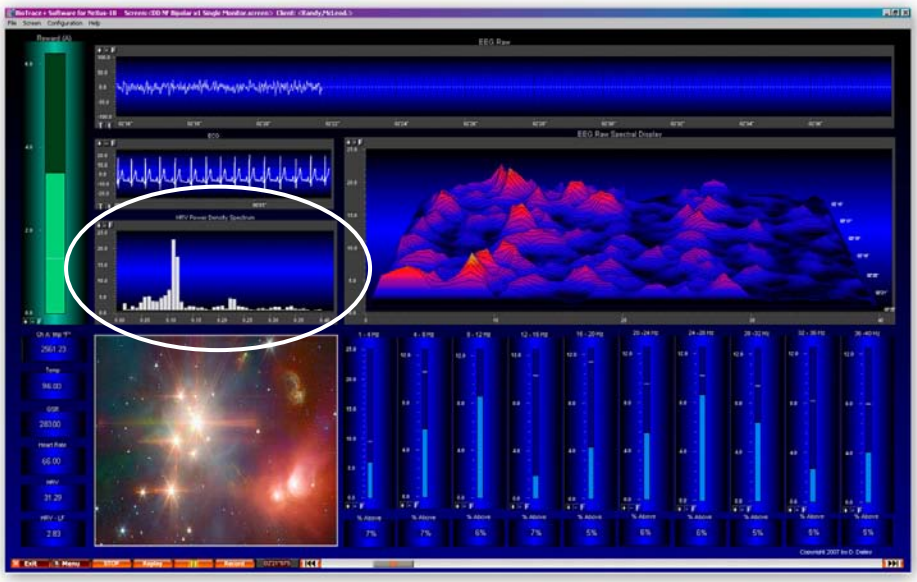
The client was a 43-year-old male psychologist working for the veterans' administration. He had never experienced neurofeedback. I judged him to be a suitable candidate for low frequency bipolar neurofeedback. We started at T3-T4 at 6-9 Hz, since I judged him to be somewhat over-activated. Remember – we are probing *phase flexibility* at a particular frequency here, not how the client does with more or less of a certain frequency. About every 2 minutes, I queried him for changes of state and reduced the reward frequency band by 1Hz. At about 3-6 Hz, he reported feeling significantly relaxed. By the time we got to 1-4 Hz, his voice became markedly slow and calm as he reported feeling very mellow and relaxed, yet alert and owning his space. I moved to a 0.5-2.5 Hz reward band and, within 30 seconds, he reported anxiety; 15 seconds later there was nausea. He couldn't describe the state in any meaningful way. I didn't know if I should lower the frequency more or raise it. I asked him if he was "anxious like tense" or anxious like "I don't want to go there" (dissociation). "I don't want to go there! I don't want to go there!", he stated. I then raised the frequency back to 1-4 Hz and, after about 2-3 minutes, he reported feeling his previous mellow alert state.

We finished the session and I made arrangements to talk with him the next day. That night, after that first session, he went to bed as usual. He was awakened at 2 am with "the worst pain in my entire life" in his arm. The pain was centered exactly where 2 screws had been placed to stabilize that arm when it was broken. The anesthesia had been too light and, although he had no memory of the surgery, he had experienced disturbed sleep ever since. Apparently the neurofeedback had enabled him to get close to the level of dissociation he had occupied during the surgery. During the night following that session, he recovered the historical memory of having holes drilled in his bones while he was semiconscious. After that single session, he reported that he slept much better, woke refreshed, and had much less tension in his associated upper arm and neck.

[7] Cozolino L. The neuroscience of human relationships – Attachment and the developing social brain. W.W. Norton & Company, NY 2006.
[8] Schore AN. Affect dysregulation and disorders of the self. W.W. Norton & Company, NY 2003
[9] Dailey D. Networks and Neurofeedback: Mechanisms or Metaphor? Unpublished manuscript 2009.

17-E. Using the Peripheral Instruments

I will provide more information on monitoring peripheral measures during neurofeedback on my website, www.growing.com/mind. In the meantime, I am assuming you have a basic familiarity with the significance of heart rate variability, electrodermal skin response (GSR), skin temperature, etc.



The Heart Rate Variability (HRV) Instrument

In general, as the client becomes distressed, you may note an increase in electrodermal response, a decrease in skin temperature, and a shift in the heart rate variability. In the healthy state (which usually requires training), the HRV power spectrum peak is at about 0.1 Hz (which equates with 6 breaths per minute). In the above figure, the HRV instrument is located directly above the video display. Notice that the HRV instrument has a peak at approximately 0.1 Hz. If during a session there is an increase in power lower than 0.1 Hz, it may indicate a shift to hyper-sympathecotonia (fight or flight). If the power shifts to above 0.1 Hz, it may indicate an increase in hyper-parasympathecotonia (freezing and disassociation).

If you notice the HRV instrument changing erratically throughout the session, you may want to consider adding HRV training to the client's training program. More information on heart rate variability is available at www.pubmed.gov. It is also likely that your equipment vendor is aware of seminars in HRV training. You may also want to visit my website, www.growing.com/mind, periodically, since I intend to be posting HRV-related materials.

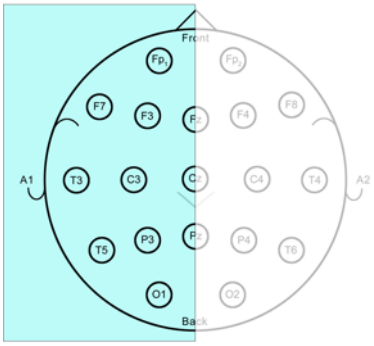
18. Charts and Tables

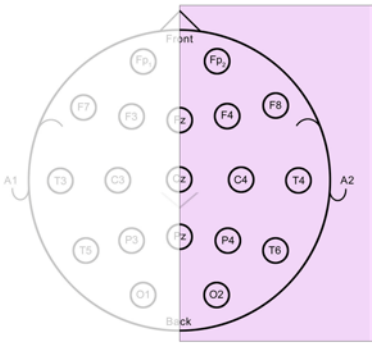
In this section, you will find three series of graphics that suggest site locations for neurofeedback. These are gross overgeneralizations, but hopefully they will help you build visual and verbal images of significant clinical relations. Following these graphics is a table of symptoms with suggested sensor placements arranged by alphabetical order and by region of sensor location.

In other locations in this document you will find suggested protocols for a therapeutic trial of empirically driven neurofeedback. Remember, if you do not get adequate results within about 10 sessions, you may need to obtain a QEEG (quantitative electroencephalogram) in order to determine significant functional asymmetries.

18-A. Unilateral (Hemispherical) Training

As an extremely broad generalization we can make the following limited but significant associations. Familiarize yourself with these charts, but later depend upon the tables relating complaints to sensor placements.

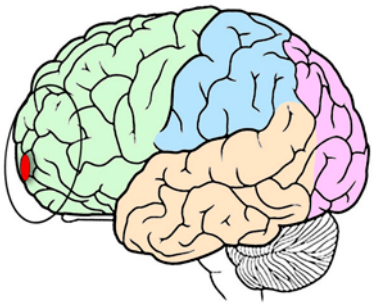
Left Hemisphere Training	
• Conscious awareness • Sequential processing • Textual processing • For mental calming • For left brain symptoms	

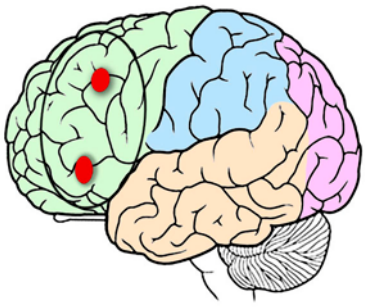
Right Hemisphere Training	
	• Body and spatial awareness • Social-emotional awareness • Contextual processing • For physical calming • For right brain symptoms

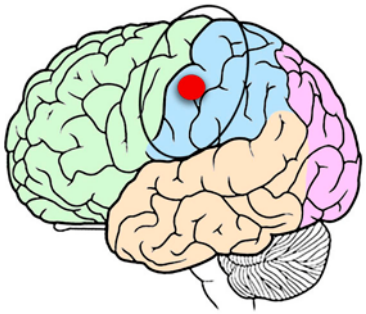
18-B. Localized INTER-hemispheric Training for Local or Paroxysmal Dysfunction

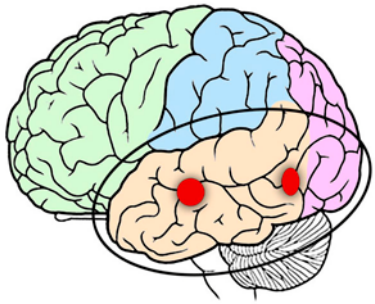
(see Section 16-D: Adding Sites)

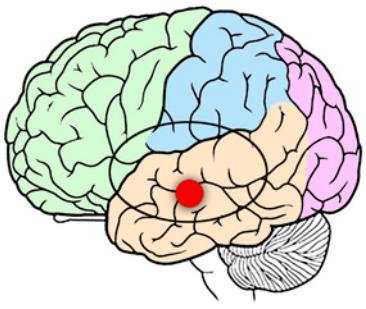
As an extremely broad generalization we can make the following limited but significant associations. My apologies for the sometimes unusual wording. It is in order to enable easy symptom look-up in the table which follows.

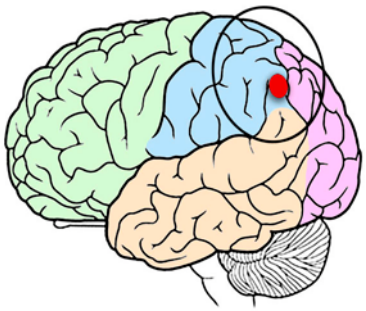
Prefrontal Training	
	Aggression Attachment disorder Attention problems Controlling or manipulative behaviors Disinhibition Executive disturbances Fear in excess Organization & planning deficits Obsessive & compulsive symptoms Poor impulse control Tics

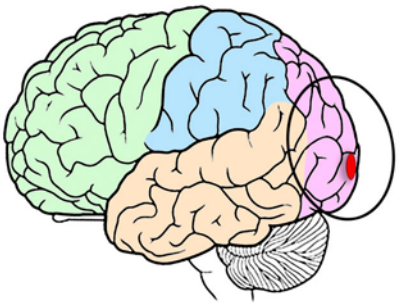
Frontal Training	
	Alertness diminished Emotional expression poor Motivation diminished Motor control diminished Movement initiation poor Movement sequencing poor Spatial awareness diminished Speech articulation and clarity poor Speech early language development poor Speech prosody diminished Speech initiation diminished Speech word finding poor

Central Training	
	Emotional management Motor deficits – either side Somato-sensory deficits – either side

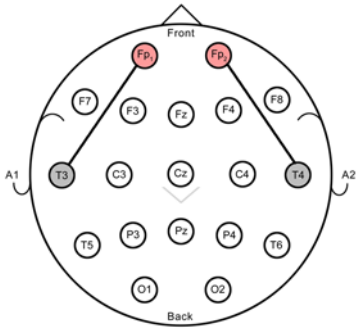
Temporal Training	
	Auditory processing poor Composure Emotions uncontrolled Enjoyment lacking Reading ability poor Recognition of faces Recognition of objects Recognition of patterns Social awareness Social engagement poor Visual context Visual detail processing

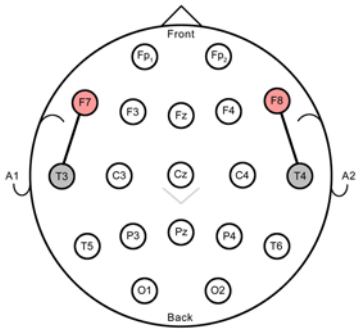
Insula Training	
	Note: The insula lies medial to the temporal lobe, approximately underneath T3 and T4. Physiology unregulated Interoception poor

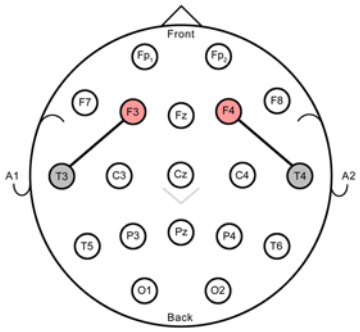
Parietal Training	
	Anxiety (follow with Fp1-T3) Arithmetic abilities poor Awareness of body poor Awareness of emotions poor Awareness of spatial relations poor Confusion between right and left Counting abilities poor Motor control diminished – esp. fine movements Muscular tension Restlessness Sensory integration poor Sensory hypersensitivity

Occipital Training	
	Visual context discrimination poor Visual detail processing poor Visual field defects on either side Visual hypersensitivity

18-C. Localized INTRA-hemispheric Training for Local Dysfunction

T3-Fp1	**Prefrontal**	T4-Fp2
Attention deficit hyperactivity disorder Behavior uncontrolled Concentration difficulties Impulse control poor Obsessive-compulsive symptoms Organization poor Thoughts uncontrolled Tics Tourette's syndrome		Aggression Attachment disorder Behavior aggressive Behavior controlling Behavior manipulative Emotionally detached Emotionally reactive Emotions uncontrolled Fear excessive

T3-F7	**Frontal Inferior**	T4-F8
Speech articulation poor Speech clarity poor Speech initiation diminished Speech word finding poor		Emotional expression poor Singing difficult Speech autistic Speech early language development poor Speech prosody diminished

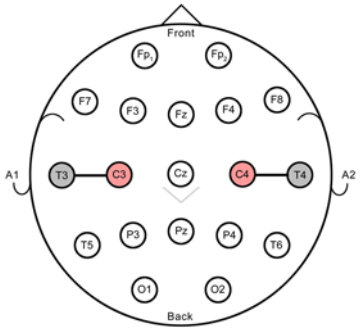
T3-F3	**Frontal Superior**	T4-F4
Alertness diminished Motivation diminished Fine motor control poor Movement initiation poor Movement sequencing poor Depression		Gross motor control poor Spatial awareness diminished

T3-C3

Central

T4-C4

Emotional management poor
Motor deficits – right sided
Somato-sensory deficits
– right sided



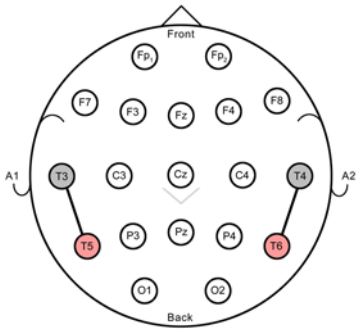
Emotional management poor
Motor deficits – left sided
Somato-sensory deficits
– left sided

T3-T5

Temporal

T4-T6

Audio processing poor
Reading ability poor
Recognition of objects
Visual detail processing



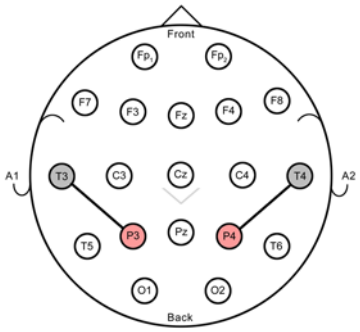
Composure
Emotions uncontrolled
Enjoyment lacking
Recognition of faces
Recognition of patterns
Social awareness poor
Social engagement poor
Visual context discrimination
poor

T3-P3

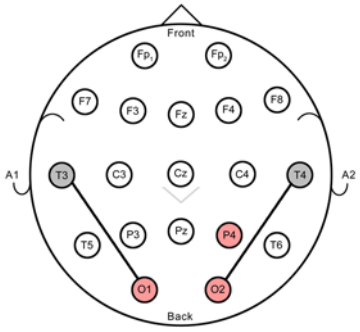
Parietal

T4-P4

Arithmetic abilities poor
Confusion between right
and left
Counting abilities poor
Motor control diminished
– esp. fine movements



Anxiety (follow with Fp1-T3)
Awareness of body poor
Awareness of emotions poor
Awareness of spatial relations
poor
Muscular tension
Restlessness
Sensory integration poor

T3-O1	**Occipital**	T4-O2
Visual detail processing poor Visual field defects on right		Visual context discrimination poor Visual field defects on left

18-D. Tables of Symptoms and Sensor Placements (following pages)

Please note that some conditions appear twice with slightly different rewording. Thus, “Aggression” is also entered as “Behavior aggressive” to facilitate lookup. This does not imply a weighting of some conditions differently than others.

Note: Instabilities are often treated with inter-hemispheric placements, e.g., T3-T4, P3-P4, etc. Remember that these conditions are often treated with stabilizing or anti-convulsant medications. As they improve with neurofeedback, it may be necessary to consult with the client’s medical doctor concerning possible modification of the prescription.

BH = Both hemispheres (i.e., inter-hemispheric training such as T3-T4… etc.)

The ‘checkbox’ column on the far left is there to allow you or a client to mark conditions of interest in order to facilitate evaluation of related sensor placements in the treatment plan.

There are two tables on the following pages that correlate symptoms with electrode placement. The first table is alphabetized by region and the second table is alphabetized by symptom. Otherwise, the two tables are identical. Because the second table is alphabetized by symptom, that makes it ideal for using with your clients by placing a check marks beside the symptoms they have and then looking for commonalities in the involved regions or in the specific electrodes.

Alphabetically by symptom or concern: (B=both, R=right, L=left, H=hemisphere)

	Abdominal epilepsy	BH	T3-T4	Temporal
	Aggression	RH	Fp2-T4	Prefrontal
	Alertness diminished	LH	F3-T3	Frontal
	Anxiety (follow with Fp1-T3)	RH	P4-T4	Parietal
	Arithmetic abilities poor	LH	P3-T3	Parietal
	Asthma	BH	T3-T4	Temporal
	Attachment disorder	RH	Fp2-T4	Prefrontal
	Attention deficit hyperactivity disorder	LH	Fp1-T3	Prefrontal
	Audio processing poor	LH	T5-T3	Temporal
	Awareness of body poor	RH	P4-T4	Parietal
	Awareness of emotions poor	RH	P4-T4	Parietal
	Awareness of spatial relations poor	RH	P4-T4	Parietal
	Behavior aggressive	RH	Fp2-T4	Prefrontal
	Behavior controlling	RH	Fp2-T4	Prefrontal
	Behavior manipulative	RH	Fp2-T4	Prefrontal
	Behavior uncontrolled	LH	Fp1-T3	Prefrontal
	Bipolar mood swings	BH	T3-T4	Temporal
	Composure	RH	T6-T4	Temporal
	Concentration difficulties	LH	Fp1-T3	Prefrontal
	Confusion between right and left	LH	P3-T3	Parietal
	Counting abilities poor	LH	P3-T3	Parietal
	Dissociative symptoms	BH	T3-T4	Temporal
	Emotional expression poor	RH	F8-T4	Frontal
	Emotional management poor	LH	C3-T3	Central
	Emotional management poor	RH	C4-T4	Central
	Emotionally detached	RH	Fp2-F4	Prefrontal
	Emotionally reactive	RH	Fp2-T4	Prefrontal
	Emotions uncontrolled	RH	Fp2-T4	Prefrontal
	Emotions uncontrolled	RH	T6-T4	Temporal
	Enjoyment lacking	RH	T6-T4	Temporal
	Epilepsy	BH	T3-T4	Temporal
	Fear excessive	RH	Fp2-T4	Prefrontal
	Impulse control poor	LH	Fp1-T3	Prefrontal
	Interoception poor	BH	T3-T4	Insula
	Interoception poor	BH	T3-T4	Insula
	Migraine	BH	T3-T4	Temporal
	Motivation diminished	LH	F3-T3	Frontal
	Motor control diminished – esp. fine movements	LH	F3-T3	Frontal
	Motor control diminished – esp. fine movements	LH	P3-T3	Parietal
	Motor control diminished – esp. gross movements	RH	F4-T4	Frontal
	Motor deficits – left sided	RH	C4-T4	Central
	Motor deficits – right sided	LH	C3-T3	Central
	Movement initiation poor	LH	F3-T3	Frontal

	Movement sequencing poor	LH	F3-T3	Frontal
	Muscular tension	RH	P4-T4	Parietal
	Obsessive-compulsive symptoms	LH	Fp1-T3	Prefrontal
	Organization poor	LH	Fp1-T3	Prefrontal
	Panic attacks	BH	T3-T4	Temporal
	Physiology unregulated	BH	T3-T4…	Insula
	Physiology unregulated	BH	T3-T4	Insula
	Reading ability poor	LH	T5-T3	Temporal
	Recognition of faces	RH	T6-T4	Temporal
	Recognition of objects	LH	T5-T3	Temporal
	Recognition of patterns	RH	T6-T4	Temporal
	Restlessness	RH	P4-T4	Parietal
	Seizures	BH	T3-T4	Temporal
	Sensory hypersensitivity	BH	P3-P4	Parietal
	Sensory integration poor	RH	P4-T4	Parietal
	Singing difficult	RH	F8-T4	Frontal
	Social awareness poor	RH	T6-T4	Temporal
	Social engagement poor	RH	T6-T4	Temporal
	Somato-sensory deficits – left sided	RH	C4-T4	Central
	Somato-sensory deficits – right sided	LH	C3-T3	Central
	Spatial awareness diminished	RH	F4-T4	Frontal
	Speech articulation poor	LH	F7-T3	Frontal
	Speech autistic	RH	F8-T4	Frontal
	Speech clarity poor	LH	F7-T3	Frontal
	Speech early language development poor	RH	F8-T4	Frontal
	Speech initiation diminished	LH	F7-T3	Frontal
	Speech prosody diminished	RH	F8-T4	Frontal
	Speech word finding poor	LH	F7-T3	Frontal
	Thoughts uncontrolled	LH	Fp1-T3	Prefrontal
	Tics	LH	Fp1-T3	Prefrontal
	Tourette's syndrome	LH	Fp1-T3	Prefrontal
	Vertigo	BH	T3-T4	Temporal
	Visual context discrimination poor	RH	T6-T4	Temporal
	Visual context discrimination poor	RH	O2-T4	Occipital
	Visual detail processing	LH	T5-T3	Temporal
	Visual detail processing poor	LH	O1-T3	Occipital
	Visual field defects on left	RH	O2-T4	Occipital
	Visual field defects on right	LH	O1-T3	Occipital
	Visual hypersensitivity	BH	O1-O2	Occipital

Sorted by region: (B=both, R=right, L=left, H=hemisphere)

	Emotional management poor	LH	C3-T3	Central
	Emotional management poor	RH	C4-T4	Central
	Motor deficits – right sided	LH	C3-T3	Central
	Motor deficits – right sided	RH	C4-T4	Central
	Somato-sensory deficits – left sided	RH	C4-T4	Central
	Somato-sensory deficits – right sided	LH	C3-T3	Central
	Alertness diminished	LH	F3-T3	Frontal
	Emotional expression poor	RH	F8-T4	Frontal
	Motivation diminished	LH	F3-T3	Frontal
	Motor control diminished – esp. fine movements	LH	F3-T3	Frontal
	Motor control diminished – esp. gross movements	RH	F4-T4	Frontal
	Movement initiation poor	LH	F3-T3	Frontal
	Movement sequencing poor	LH	F3-T3	Frontal
	Singing difficult	RH	F8-T4	Frontal
	Spatial awareness diminished	RH	F4-T4	Frontal
	Speech articulation poor	LH	F7-T3	Frontal
	Speech autistic	RH	F8-T4	Frontal
	Speech clarity poor	LH	F7-T3	Frontal
	Speech early language development poor	RH	F8-T4	Frontal
	Speech initiation diminished	LH	F7-T3	Frontal
	Speech prosody diminished	RH	F8-T4	Frontal
	Speech word finding poor	LH	F7-T3	Frontal
	Interoception poor	BH	T3-T4	Insula
	Physiology unregulated	BH	T3-T4	Insula
	Visual context discrimination poor	RH	O2-T4	Occipital
	Visual detail processing poor	LH	O1-T3	Occipital
	Visual field defects on left	RH	O2-T4	Occipital
	Visual field defects on right	LH	O1-T3	Occipital
	Visual hypersensitivity	BH	O1-O2	Occipital
	Anxiety (follow with Fp1-T3)	RH	P4-T4	Parietal
	Arithmetic abilities poor	LH	P3-T3	Parietal
	Awareness of body poor	RH	P4-T4	Parietal
	Awareness of emotions poor	RH	P4-T4	Parietal
	Awareness of spatial relations poor	RH	P4-T4	Parietal
	Confusion between right and left	LH	P3-T3	Parietal
	Counting abilities poor	LH	P3-T3	Parietal
	Motor control diminished – esp. fine movements	LH	P3-T3	Parietal
	Muscular tension	RH	P4-T4	Parietal
	Restlessness	RH	P4-T4	Parietal
	Sensory hypersensitivity	BH	P3-P4	Parietal
	Sensory integration poor	RH	P4-T4	Parietal
	Aggression	RH	Fp2-T4	Prefrontal
	Attachment disorder	RH	Fp2-T4	Prefrontal

	Attention deficit hyperactivity disorder	LH	Fp1-T3	Prefrontal
	Behavior aggressive	RH	Fp2-T4	Prefrontal
	Behavior controlling	RH	Fp2-T4	Prefrontal
	Behavior manipulative	RH	Fp2-T4	Prefrontal
	Behavior uncontrolled	LH	Fp1-T3	Prefrontal
	Concentration difficulties	LH	Fp1-T3	Prefrontal
	Emotionally detached	RH	Fp2-F4	Prefrontal
	Emotionally reactive	RH	Fp2-T4	Prefrontal
	Emotions uncontrolled	RH	Fp2-T4	Prefrontal
	Fear excessive	RH	Fp2-T4	Prefrontal
	Impulse control poor	LH	Fp1-T3	Prefrontal
	Obsessive-compulsive symptoms	LH	Fp1-T3	Prefrontal
	Organization poor	LH	Fp1-T3	Prefrontal
	Thoughts uncontrolled	LH	Fp1-T3	Prefrontal
	Tics	LH	Fp1-T3	Prefrontal
	Tourette's syndrome	LH	Fp1-T3	Prefrontal
	Abdominal epilepsy	BH	T3-T4	Temporal
	Asthma	BH	T3-T4	Temporal
	Audio processing poor	LH	T5-T3	Temporal
	Bipolar mood swings	BH	T3-T4	Temporal
	Composure	RH	T6-T4	Temporal
	Dissociative symptoms	BH	T3-T4	Temporal
	Emotions uncontrolled	RH	T6-T4	Temporal
	Enjoyment lacking	RH	T6-T4	Temporal
	Epilepsy	BH	T3-T4	Temporal
	Migraine	BH	T3-T4	Temporal
	Panic attacks	BH	T3-T4	Temporal
	Reading ability poor	LH	T5-T3	Temporal
	Recognition of faces	RH	T6-T4	Temporal
	Recognition of objects	LH	T5-T3	Temporal
	Recognition of patterns	RH	T6-T4	Temporal
	Seizures	BH	T3-T4	Temporal
	Social awareness poor	RH	T6-T4	Temporal
	Social engagement poor	RH	T6-T4	Temporal
	Vertigo	BH	T3-T4	Temporal
	Visual context discrimination poor	RH	T6-T4	Temporal
	Visual detail processing	LH	T5-T3	Temporal