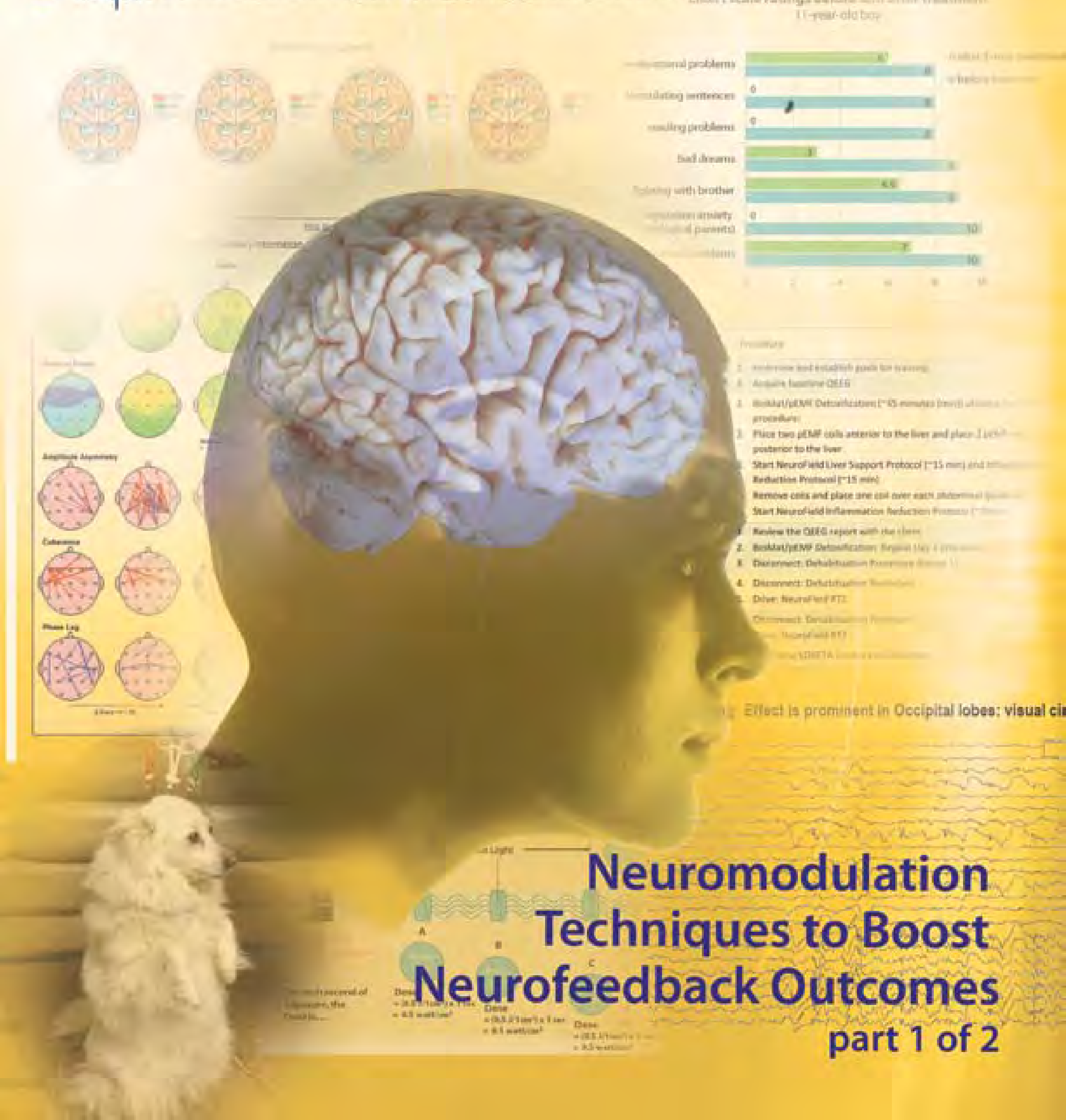
NEURO CONNECTIONS Newsletter

Fall 2014

Vol. 9 *3

ISNR aapb A joint newsletter from the *International Society for Neurofeedback & Research* and the *Association for Applied Psychophysiology & Biofeedback, Neurofeedback Section*



Neuromodulation Techniques to Boost Neurofeedback Outcomes

part 1 of 2

Multi-Modality Intensive Neurofeedback

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Abstract

The objective of this article is to present and investigate the idea of multi-modality intensive neurofeedback (iNFB). This article offers a case study as evidence for the effectiveness of this technique. The following study demonstrates the use of ultra-low pulsed electromagnetic field (pEMF) stimulation, LORETA neurofeedback and other complimentary modalities. Pre-training, intermediate and post-training Quantitative Electroencephalography (qEEG) maps were obtained throughout this 20-session iNFB training program.

Multi-Modality Intensive Neurofeedback

Intensive neurofeedback training modalities have long been utilized by neurofeedback therapists around the world. In recent years, new technologies have emerged in the field of neurofeedback, which have given rise to a need to re-explore the most effective ways to implement these intensive multi-modality training procedures in clinical practice. Intensive neurofeedback training (iNFB) has long been supported in the research to be a clinically effective approach for increasing brain regulation for many clinical diagnoses (Lubar & Lubar, 1984; Lubar, Swartwood, Swartwood, & O'Donnell, 1995; McKnight & Fehmi, 2001; Peniston & Kulkosky, 1990; Sterman, 1982).

Today, there is a growing need for the development of the most effective and time conscious methods for intensive neurofeedback. We are seeing an increasing demand to implement iNFB training modalities for international and out-of-state clients who seek out our services for neurofeedback. As a result of the growing demand, we have been working to explore and develop the most effective iNFB approaches. Offering effective neurofeedback services to clients fills a need for clients who seek treatment in a time-sensitive and cost-effective manner.

This article explores the effectiveness of the latest integrated multi-modality iNFB approach. Based upon clinical data collected from similar iNFB approaches, the following hypothesis was constructed: Utilizing a multi-modality approach that incorporates the use of pulsed electromagnetic field (pEMF) stimulation and low resolution brain electromagnetic tomography (LORETA) iNFB will increase cortical and subcortical neuronal regulation and yield clinically effective outcomes. This approach will be thoroughly explained and demonstrated through a single case study research design. This article will introduce a *disconnect, drive, and reinforce theory of* *pEMF training; the bio-medical pEMF approach to iNFB; and other important complimentary procedures including nutrition, hydration, and adequate rest.*

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Instrumentation

Quantitative Electroencephalography (QEEG)

All clients who elect to participate in iNFB begin their process with a qEEG. QEEGs are acquired prior to the start of training; throughout training, as needed to assess, evaluate and adjust training; and again upon cessation of training. For the purpose of this case , qEEG was acquired using a DC coupled 19 channel EEG amplifier (NeuroField Q20[1], NeuroField, Inc., Bishop, CA) utilizing an Electro-Cap (Electro-Cap International, Inc., Eaton, OH). To ensure a high quality EEG signal, all reference and cap electrodes were confirmed to have <5K Ohms resistance values measured by a UFI Checktrode ™ model 1089NP. Eyes open and eyes closed EEG data obtained through the process was analyzed and norm-referenced in both linked ear and Laplacian montages via NeuroGuide software (Applied Neuroscience, Inc., Seminole, FL).

Pulsed Electromagnetic Field (pEMF)

The iNFB program utilizes the NeuroField X3000 system which is a four channel frequency generator that can generate pEMF frequencies from 0.31–300,000 Hz. The pEMF output intensity ranges from 1–50 microtesla (or 1–500 milligauss). pEMF is emitted through four 200-wind coils which can be placed strategically on the cranium and/or body. During iNFB, targeted EEG frequency-specific pEMF may be delivered to the brain either as a standalone treatment or in conjunction with real time z-score (RTZ) training.

The RTZ procedure is a feedback system which can be used to instantaneously measure the effect of each pEMF on brain activity. The RTZ procedure measures and analyzes 4–32 seconds of EEG activity following delivery of each pEMF frequency. The EEG activity is instantaneously analyzed using the NeuroGuide z-score-referenced normative database. The software system will repeat pEMF frequencies which meet the set training parameters for the session. Training parameters are determined using the qEEG and matched client symptoms. The RTZ function can be set to threshold on single or multiple frequency bands at single or multiple 10–20 system (EEG) locations.

1 Patent pending

LORETA Neurofeedback

LORETA is an EEG analysis technique that utilizes measured scalp EEG to model a three-dimensional source distribution of generating electric neuronal activity from multichannel surface EEG recordings (Pascual-Marqui et al. 1994, Pascual-Marqui 1999). LORETA neurofeedback allows clinicians to utilize brain imaging technology to effectively train Brodmann areas, hubs, modules, and brain networks. LORETA neurofeedback software and referenced normative database cited by the authors was developed by Applied Neuroscience, Inc. and has been empirically studied to demonstrate a significant level of sensitivity, accuracy and validity (Thatcher, North & Biver, 2005).

BioMat

Many pEMF-only training sessions in our practice occur in a specialized room which includes an Amethyst™ BioMat 7000mx Professional (Richway® BioMat). The client may lie on the BioMat while receiving their pEMF session. The BioMat incorporates the therapeutic benefits of far infrared rays, amethyst stone and negative ions into each pEMF session.

Training Room

The pEMF and LORETA neurofeedback sessions occur in specialized rooms which are equipped with a 60 inch LED television monitor for the client, six channels of surround sound multichannel audio and a 40 inch monitor for the clinician. This client-centered environment allows the client to become fully engaged in the video and audio feedback procedure which is associated with the regulation of neuronal activity and function. This 360 degree environment is created to maximize each session to its fullest potential.

iNFB Theory and Procedure

Disconnect, Drive, and Reinforce Theory

Each iNFB program is entirely individualized. Aberrant z-scores are matched to client symptoms to develop the locations, frequencies and metrics to be trained. Deviant qEEG z-scores that match client symptoms are targeted and trained to help the system to become energetically rebalanced. The authors of this article have developed a disconnect, drive and reinforce theory for iNFB.

Dysregulated neural activity can be influenced into a chaotic state, allowing the brain to disconnect from its previous maladaptive state of regulation. That chaotic state can then be reorganized into a more regulated state by driving neuronal activity with a pulsed electromagnetic field. The chaotic neural activity will mimic the frequency that it is being driven, creating a more stable and regulated neural environment. When the newly regulated neural activity is reinforced by RTZ and LORETA neurofeedback within 4 hours the brain is not allowed to return back to its dysregulated state.

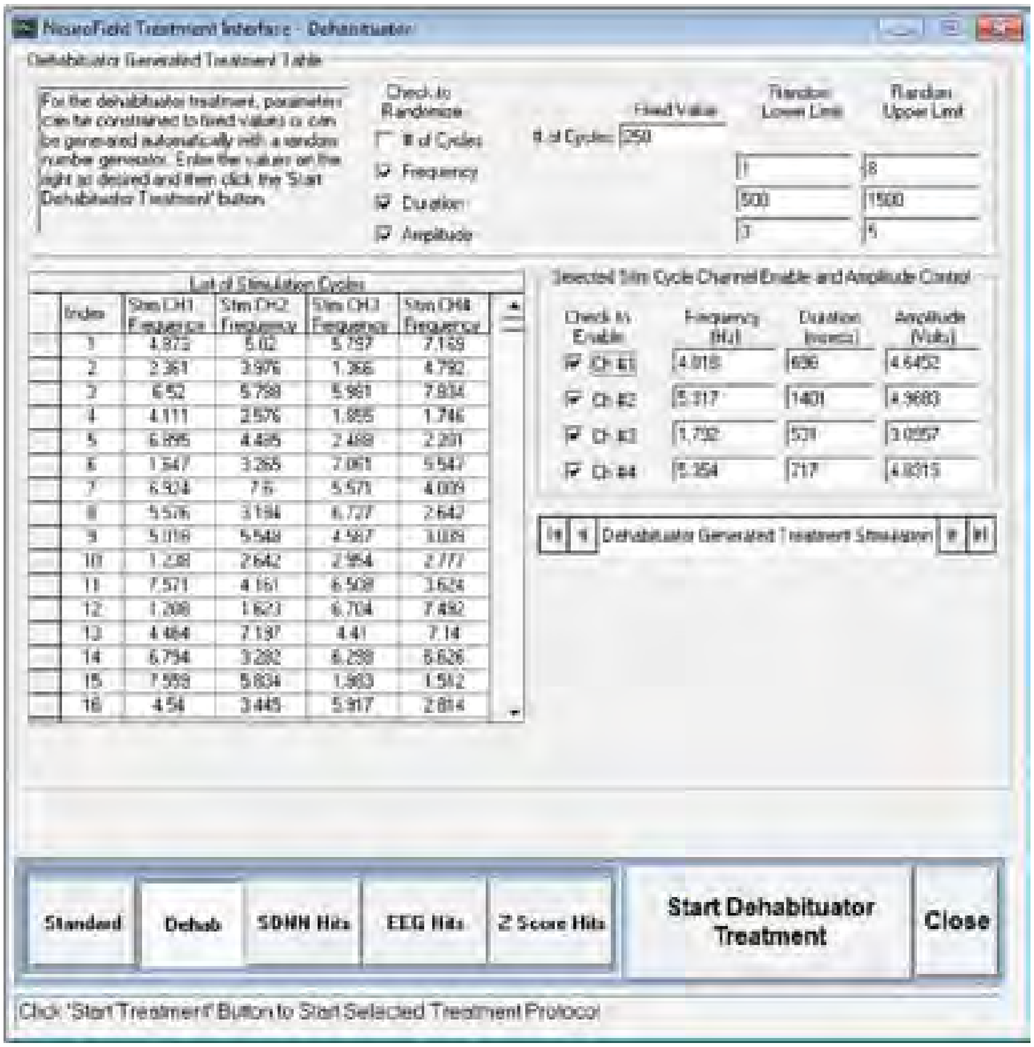

Figure 1: *NeuroField dehabituator settings. pEMF frequencies are given to the system within determined frequency (Hz) parameters at randomized durations (ms) and amplitudes (V). Dehabituator protocols are guided by qEEG and client symptoms.*

Dysregulated neuronal activity is specifically targeted utilizing a procedure called dehabituation. The dehabituation procedure is a function of the NeuroField software which can be adopted to influence the client's dysregulated areas of the brain. Specific dehabituator protocols are guided by qEEG and client symptoms.

The randomization properties of the dehabituator are theorized to influence the brain into a brief chaotic state. To create this chaotic state, pEMF is given to the cranium through the NeuroField 200 wind coil system. Each coil is placed on the scalp over the areas of targeted dysregulation. Multiple randomized pEMF frequencies (Hz) are given to the system at randomized durations (ms) and intensities (V) (Figure 1). The energy introduced to the cortical system through this methodology is very low, ranging from 1 to 50 microtesla. When the neuronal system is pulsed by the randomized nature of the dehabituator the brain is not allowed to establish or maintain a dominant frequency. Pulsing multiple frequencies can also function as a "wake up call" encouraging the recruitment of adjacent neurons.

Dehabituation of the brain through ultra-low intensity pEMF is not known to cause a global depolarization/repolarization of the neural network, as is the case with electroconvulsive therapy (ECT). Ultra-low intensity pEMF dehabituation simply encourages the neural activity to function at varying frequencies which can contribute to a more flexible and adaptive neural network. The clinician may choose to dehabituate the areas of greatest dysregulation within the frequency band of the greatest dysregulation. A brief disjoining or interruption of the frequency band, through dehabituation, is utilized so that the brain can now be introduced to and learn a new dominant frequency.

Immediately following the dehabituation procedure the brain is guided back into a more regulated state using pEMF frequencies. pEMF frequencies and protocols used during this phase are determined through qEEG and symptoms. Neuronal activity, in its temporarily disconnected chaotic state, will begin to entrain upon the pEMF driving frequency, allowing the clinician to gently guide the brain through ultra-low intensity pEMF toward more regulated and energetically balanced neuronal functioning.

pEMF can also have an inhibitory properties. Driving the brain through pEMF can create an environment that will suppress the most dysregulated frequency bands. In the case presented in this article, relative power in the delta frequency band was the most deficient. The delta frequency band was chosen to drive the brain because of its low power in respect to the other frequency bands and its inhibitory effects on the faster beta wave forms.

The last phase of this theory is reinforcement. When the newly regulated neuronal activity is reinforced by LORETA neurofeedback within four hours, the brain is not allowed time to return back to its dysregulated pattern. LORETA neurofeedback provides the brain with a tremendous amount of information about its state of functioning. LORETA neurofeedback functions as an effective training modality to help the brain increase self-regulation, flexibility and appropriateness (Cannon, Lubar, Gerke, Thornton, Hutchens & McCammon, 2006).

Body and Brain pEMF

During pEMF-only sessions, clients relax and enjoy the therapeutic benefits of the BioMat in addition to receiving their NeuroField session addressing brain and body energetic alignments. The BioMat and pEMF can be utilized to target circulatory, detoxification, and inflammation issues. Poor circulation and inflammation often accompanies traumatic and chronic conditions. The body responds to injury with a host of immune reactions to neutralize the system and return it to a homeostatic state (Pavlov, Wang, Czura, Friedman, & Tracey, 2003). Inflammation is essential to the natural healing processes of the body, however, the body and brain often times will over-respond to this need, which may result in delayed healing responses.

The pEMF coils were placed posteriorly and anteriorly to the liver. The liver is the body's primary organ for detoxification. The liver can become compromised by poor nutrition, toxic conditions, unhealthy lifestyle, chemicals, heavy metals and food allergens. Liver toxicity can prevent the absorption and utilization of nutrients vital for healthy functioning. Offering support to the liver can be an important adjunctive method for guiding the body back toward a healthy state of function which may optimize neurofeedback outcomes.

iNFB Procedure

Table 1 illustrates the iNFB procedure implemented for the subject of this study, who received an intensive course of twice daily sessions for a total of 23 sessions over a two week period. The outline of his plan of care includes the recording and analysis of the first qEEG, brain and body pEMF, and the application of the *disconnect, drive and reinforce theory of iNFB. A detailed outline of the training protocols and procedures are available from the authors by request.*

Day (1–14)	Time (AM/PM)	Procedure
1	AM	1. Interview and establish goals for training 2. Acquire baseline QEEG
	PM	1. BioMat/pEMF Detoxification (~45 minutes (min)) utilizing the following procedure: 2. Place two pEMF coils anterior to the liver and place 2 pEMF coils posterior to the liver 3. Start NeuroField Liver Support Protocol (~15 min) and Inflammation Reduction Protocol (~15 min) 4. Remove coils and place one coil over each abdominal quadrant. 5. Start NeuroField Inflammation Reduction Protocol (~30min)
2	AM	1. Review the QEEG report with the client 2. BioMat/pEMF Detoxification: Repeat Day 1 procedure 3. Disconnect: Dehabituation Procedure (Figure 1).
	PM	4. Disconnect: Dehabituation Procedure 5. Drive: NeuroField RTZ
3–14	AM	1. Disconnect: Dehabituation Procedure 2. Drive: NeuroField RTZ
	PM	3. Reinforce: LORETA z-score neurofeedback

Table 1

Complimentary Procedures

During iNFB, clients experience rapid biological and neurological system changes. It is imperative that clients who participate in iNFB are thoroughly educated on the importance of adequate nutrition, hydration and rest. Each session and accompanied biological and neurological changes require a large amount of glutamate. Glutamate is the key compound in cellular metabolism and serves as metabolic fuel body and brain function. When the body and brain are not sufficiently supplied with the energy, the successive sessions may be less effective. Before the morning (am) session, clients are recommended to have a healthy breakfast containing a mix of protein (minimum of 15 grams), fat, and carbohydrates. Between morning and afternoon sessions clients are encouraged to consume 10–12 grams of easily digestible proteins and carbohydrates. Clients are encouraged to abstain from caffeine, alcohol and refined sugars.

Hydration is also imperative to iNFB. Clients are recommended to consume 8–16 ounces of water before, between and after each session. Necessary quantities depend upon many factors including: age, weight, lifestyle and activity level. Fluid intake aids the body and brain in detoxification and rehydration at the cellular level. In clients with normal kidney function, urine coloration is a good indicator of proper hydration. Urine that is clear to faint yellow is a sign that the client is properly hydrated. Clients are asked to monitor hydration through urine coloration.

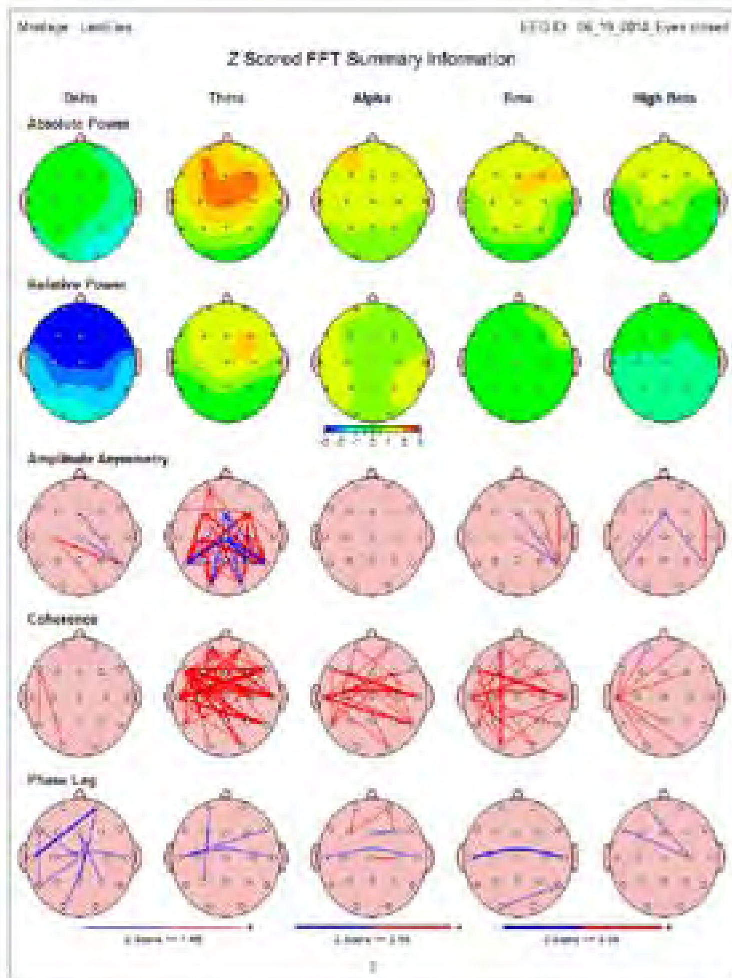

Figure 2: *Summary Z-Score Analysis of pre-iNFB training QEEG. Note the pattern of excessive fronto-central slowing in 4-7 Hz bands, as well has diffuse hypercoherence in theta, alpha and beta bands. A pattern of excess amplitude asymmetry in the theta band of 4-7 Hz is also noted.*

Rest is another essential factor that influences iNFB. Clients are recommended to sleep 7 hours prior to qEEG and neurofeedback sessions. Between am and pm sessions clients are encouraged to relax and avoid strenuous activities. Monitoring sleep patterns is also an effective way to measure clinical outcomes.

Case Study Results

Serial qEEG studies were obtained at three time points during the course of this iNFB case study. The first qEEG was obtained prior to the start of the program (Figure 2). The second qEEG was obtained following 11 total sessions (Figure 3), and the last qEEG was obtained after 20 total sessions (Figure 4). The qEEG comparisons show improvement of the theta, alpha, beta and high beta frequency bands. Improvements are also noted in amplitude asymmetry, coherence and phase lag metrics. Client symptoms of anxiety, insomnia and depression also decreased correspondingly.

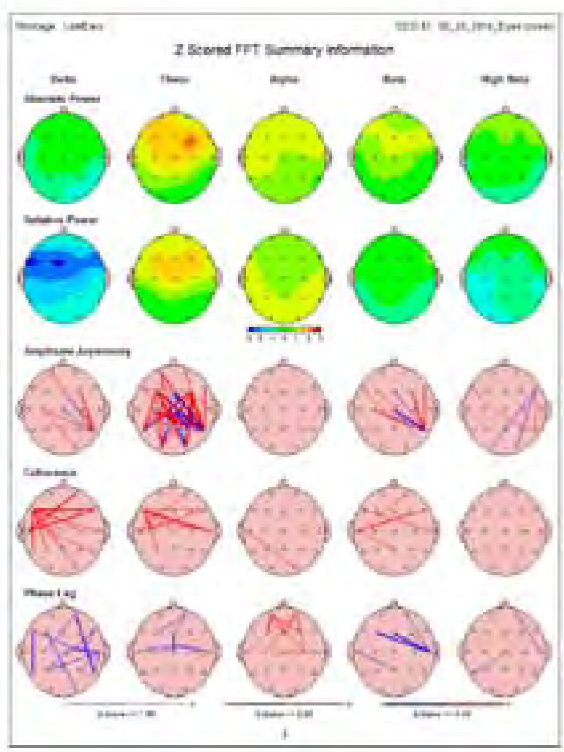

Figure 3: Summary z-score analysis after 11 iNFB sessions. Note the reduction in the pattern of excessive absolute power of fronto-central theta, alpha, beta, and hi-beta bands. Notice also a reduction of hypercoherence is in theta, alpha, and beta bands.

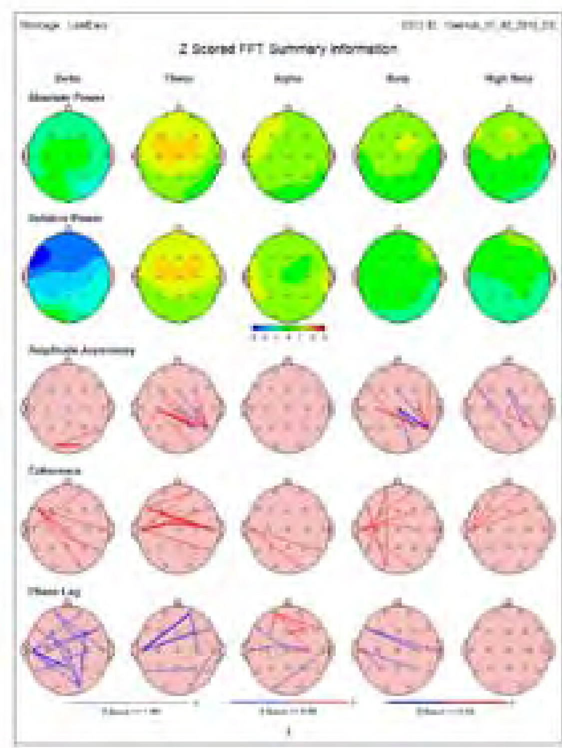

Figure 4: Summary z-score analysis after 20 iNFB sessions. Note the continued reduction in the pattern of excessive absolute power of fronto-central theta, alpha, beta, and hi-beta bands. There is progressive regulation of amplitude asymmetry in theta 4-7 Hz bands.

Discussion and Implications

This case study clearly demonstrates the functional neuroplasticity and adaptability of the brain, highlighting iNFB's potential as a practical and effective treatment alternative to traditional two to three times weekly outpatient treatment models. Further research focusing on the comparison of intensive vs. non-intensive neurofeedback utilizing large subject samples of intensive, non-intensive, and control neurofeedback groups would be helpful .

Increasingly, neurotherapists are coming to understand the critical importance of addressing underlying bio-medical conditions that can affect a positive neurofeedback outcome. Common bio-medical factors include: chronic inflammation, compromised cerebral circulation, heavy metal toxicity, chemical toxicity, nutritional deficiency and hormonal changes. Bio-medical testing and procedures can aid in obtaining increasingly positive neurofeedback outcomes. Underlying bio-medical conditions are often the missing link when clients plateau or are resistant to change through neurofeedback training. The use of nutrition, hydration, and rest is a very important to consider while seeing clients for neurotherapy.

Taking a comprehensive bio-medical iNFB approach is very important to the continual demonstration that neurofeedback is a promising treatment for even the most treatment resistant psychological and medical diagnoses. In recent years, new technologies like NeuroField's pEMF system have emerged, allowing practitioners to combine the power and properties of pEMF with neurofeedback to address the entire energetic biological system. The most important way to implement this wealth of technology is to know your client. Be sure to obtain comprehensive intake information prior to beginning treatment with any individual. An overlooked underlying biological problem may likely affect treatment outcomes and client satisfaction.

About the Authors

Jamie Moore has *been a Registered Nurse for 35 years. He graduated from Saint Joseph School of Nursing in 1979. Jamie spent much of his nursing career as a critical care and Hyperbaric nurse which is where his extensive study of the brain was nurtured. Jamie has studied under many pioneers in the field of neurofeedback, including Leslie Sherlin, PhD, QEEGD, BCN, BCB, John Anderson, MA, LADC, BCB, BCN, QEEGD and Nicholas Dogris PhD, BCN. Jamie has been working in the field of neurofeedback since 2008. Jamie's medical background and experience brings a fresh perspective to the field of neurotherapy. He is board certified in neurofeedback through the BCIA and is the co-founder of Integrated Neurotherapy Center, Inc. located in Omaha, NE.*

Erica Kube is *a graduate from the program of neuroscience and biology at the University of Nebraska, Omaha where she has received recognition for her achievement and outstanding performance. Through the university, she has authored work which has received top awards for research and creative activity. Erica has completed extensive training with experts in the field of neurotherapy including John Anderson, MA, LADC, BCB, BCN, QEEGD and Nicholas Dogris PhD, BCN. Erica is currently finishing her Master's of Science in Clinical Counseling, degree to be conferred November 2014. She has been practicing neurotherapy since 2010 and is the co-founder of Integrated Neurotherapy Center, Inc. This advanced training and passion for learning the latest, innovative, multi-modality approaches have increased the efficiency and effectiveness of neurotherapy, from which her clients achieve maximum health and quality of life.*

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