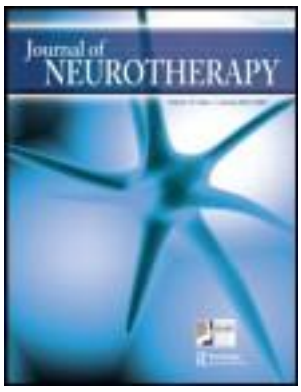

Journal of Neurotherapy: Investigations in Neuromodulation, Neurofeedback and Applied Neuroscience

Abstracts

Published online: 07 Sep 2008.

To cite this article: (2003) ABSTRACTS, Journal of Neurotherapy: Investigations in Neuromodulation, Neurofeedback and Applied Neuroscience, 7:1, 27-95

To link to this article: http://dx.doi.org/10.1300/J184v07n01_05

ABSTRACTS

Peak Alpha Frequency: An Electroencephalographic Measure of Cognitive Preparedness

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Introduction

Electroencephalographic (EEG) peak alpha frequency (PAF) has been shown to correlate with a variety of phenomena including age, memory performance in healthy and demented individuals, different emotional states, schizophrenia, anxiety, nicotine and caffeine administration, recovery from stroke, cerebral blood flow (CBF) velocity, and brain oxygenation (e.g., Klimesch, Schimke, Ladurner, & Pfurtscheller, 1990; Canive et al., 1998; Kostyunina, 1998; Knott, 1988). Moreover, PAF is increased after acute administration of the mind enhancing drug piracetam (e.g., Kinoshita, 1990). These studies have shown that PAF varies between healthy and clinical individuals, with the latter consistently having lower PAF. Moreover, PAF varies between healthy individuals reflecting cognitive performance, with better performance being associated with increased PAF. Finally, PAF varies within individuals both between developmental stages and between different cognitive tasks, or physiological states induced by administration of various substances.

The present study investigated the hypothesis that among other phenomena PAF reflects a state of cognitive preparedness, using three independent datasets from healthy and brain injured individuals. Based on the preceding literature, the following hypotheses were generated. First, that PAF is an index of optimal brain function, being suppressed under brain pathology (hypothesis #1). Second, that PAF shows cognitive preparedness within individuals, reflecting task performance differences at different days (hypothesis #2). Third, that PAF is increased after tasks more in those individuals who had it lower at initial baseline, being affected by the task that forces them to correct their initial unpreparedness (hypothesis #3).

Method

Dataset A involved EEG recordings from 10 individuals with traumatic brain injury (TBI) and 12 healthy age and sex matched controls before, during,

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10.1300/J184v07n01_05

and after tasks of visual and auditory attention (Captain's Log, Brain Train). Dataset B involved EEG recordings from 19 healthy young adults before and after a three-minute working memory task (WAIS-R Digit Span). In this dataset, the procedure was repeated on two different days, so within-individual differences in PAF and performance could be measured. Dataset C involved EEG recordings from 15 healthy young adults before, during, and after a set of reading tasks (task duration 5-20 minutes).

EEG was recorded at 19 scalp electrodes using the 10/20 international electrode placement system. Average PAF for each recording was reported using the EEG Workstation 2.0 software (NovatechEEG, Inc.).

Results

Hypothesis #1 (dataset A) was supported. PAF showed significantly lower values in individuals with TBI as compared to matched healthy controls. Specifically, during initial eyes-closed baseline TBI data showed lower PAF at PZ (p-value corrected for 19 electrodes), FP2, FZ, F4, F8, CZ, C4, P3, and P4 (p-value NOT corrected). During initial eyes-open baseline TBI data showed lower PAF at FP2, T5, P3, PZ, and P4 (p-value NOT corrected). During task, TBI data showed lower PAF at C3, CZ, C4, T5, PZ, P4, and O2 (p-value NOT corrected). During post-task eyes-open baseline TBI data showed lower PAF at F7, C3, CZ, C4, P3, PZ, P4, O2 (p-value corrected for 19 electrodes), F3, FZ, and T3 (p-value NOT corrected). Average PAF across 19 electrodes was not significant for any condition.

Hypothesis #2 (dataset B) was supported, too. Average PAF across 19 electrodes recorded at day one was significantly correlated with Digit Span performance of the same day ($r = .48$, $p = .021$) but not with Digit Span performance of day two ($r = .32$, $p = .10$). Likewise, average PAF recorded on day two was significantly correlated with Digit Span performance of the same day ($r = .42$, $p = .040$) but not with Digit Span performance of day one ($r = .27$, $p = .14$).

Finally, hypothesis #3 (datasets B and C) was partially supported. In dataset B, average PAF across 19 electrodes was significantly increased after Digit Span for those participants who were below the sample median before the task (day one: 8.47-9.55 Hz, $p = .005$; day two: 8.85-9.29 Hz, $p = .008$). It did not increase significantly for those who had it above the sample median (day one: 9.95-10.30 Hz, $p = .107$; day two: 10.33-10.40 Hz, $p = .107$). However, dataset C did not show any significant change in PAF after reading tasks.

Conclusions

In general, all hypotheses were supported by the data analyses. As expected, individuals with brain injury had lower PAF than healthy controls, confirming the consistent direction of PAF differences between normal brain

function and pathology as is the case of other neurological or psychiatric syndromes including stroke, dementia, and schizophrenia. Interestingly, these differences between individuals with TBI and non-clinical controls were more prominent during a baseline that followed a set of cognitive tasks resembling other physiological indices that require stressing the organ to be assessed (e.g., electrocardiogram).

In addition to its sensitivity to gross brain pathology, PAF was found to be particularly sensitive to brain states within individuals on different days. PAF significantly predicted cognitive performance on a working memory task that was performed immediately after EEG recording, whereas it did not predict performance within a few days (although it showed a non-significant trend). This observation is strengthened by the similarity of correlations between the two days (same day correlations: r1 − 1 = .48, r2 − 2 = .42; different day correlations: r1 − 2 = .32, r2 − 1 = .27). However, the nature and duration of this state of preparedness needs further investigation. Although a short working memory task increased PAF in individuals who were lower immediately before the task, a longer set of reading tasks failed to replicate this phenomenon.

It is suggested that EEG normative databases include PAF in their statistical reports and that attempts be made to develop neurofeedback protocols to increase PAF with the goal of improving cognitive performance in both clinical and non-clinical populations.

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Frontal Asymmetry Changes Reflect Brief Mood Shifts in Both Normal and Depressed Subjects

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Introduction

Prior brain studies of transient sadness and happiness have used Positron Emission Tomography (PET) to observe regional blood flow during changes of mood (George et al., 1995; Lane et al., 1997). Our study of brief mood swings used an EEG brainwave biofeedback protocol to measure changes in frontal alpha asymmetry.

Method

Fourteen depressed and 10 non-depressed subjects were asked to think about a happy or sad event, and then switch their thoughts to the alternative in a period of one to two minutes. Alpha asymmetry percentage scores were obtained for each condition and then subjected to statistical analysis.

Results

Seventy percent of the subjects demonstrated a significant shift in frontal alpha asymmetry consistent with mood. Percentage of alpha asymmetry was greater in the right frontal cortex when happy thoughts were evoked and greater in the left frontal cortex when sad thoughts emerged.

Conclusion

Transient mood changes can be evoked in both depressed and non-depressed subjects. While shifts in frontal asymmetry occurred in all but one subject, there appeared to be a time lag for some individuals. Future research could explore the significance of this factor. A growing body of literature on the relationship between subcortical structures and regional brainwave changes associated with mood may be useful in helping to understand the switching phenomena we have observed.

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Effects of Childhood Sexual Abuse on Adult Brain Plasticity as Measured by Quantitative Electroencephalogram

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Introduction

Childhood sexual abuse (CSA) is a problem of epidemic proportions that has been implicated by recent research to change brain structure and function in children (Ito, Teicher, Glod, & Ackerman, 1998). Yet there is little research on CSA with adults, though this population is often included in posttraumatic (PTSD) groups. Previous research by Black, Townsend, and Bodenhamer-Davis (2001) suggested a lack of regulation of posterior sites via the frontal cortex in the alpha band for adults who had experienced CSA. The present study extends this research by examining frequency bands in addition to alpha. More importantly, this study provides a model for using Principal Components Analysis based on Hudspeth's Neuroelectric Image (NEI) algorithm (Hudspeth, 1993) to explore the structural as well as functional implications reported in the literature so that any differences can be visualized in a pristine fashion.

Method

This study compared two clinical groups, 15 adults with a history of CSA and 15 adults with no history of CSA (NCSA). Participants were matched for age, gender, and handedness. The objectives of this study were: (a) to investigate cortical development in the groups using NEI connectivity indices in four frequency bands as well as the unfiltered cross correlation (Hudspeth, 1999), and (b) to examine electroencephalographic (EEG) abnormalities associated with CSA. It was hypothesized that the CSA group would show a greater preponderance of functional connectivity differences and EEG abnormalities.

Results

Results confirmed hypotheses and prior coherence research. Decreased connectivity (functional differentiation) was found to characterize left frontal regions in the theta and beta bands, while increased connectivity (functional redundancy) characterized posterior central regions across all bands in the CSA group as compared to the NCSA group.

Conclusion

NEIs were found to be a parsimonious method for data reduction, preserving important functional and anatomical relationships inherent in the EEG signal. Results confirmed the hypothesis that bands other than alpha (particularly theta) are important in CSA brain functioning. Additionally, effect size maps were found to be useful in highlighting clinically significant findings. As this study is one of the first attempts to examine the impact of CSA on adult cortical integration, it provides a starting point for future research.

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Electrophysiological, Neuropharmacological, and Neurogentic Aspects of Reward Deficiency Syndrome: A Biogenetic Model of Diagnosis and Treatment

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Introduction

It is well known that in the brain reward site the chemical messenger dopamine works to maintain our normal drives of hunger, thirst, and sex. In fact, dopamine has come to be known as the "pleasure molecule" and/or "anti-stress molecule." When dopamine is released into the synapse, it stimulates a number of dopamine receptors (D1-D5) that bring about a feeling of well-being and stress reduction. This is the result of the interaction of numerous transmit-

ters: serotonin (5HT), endorphins (END), GABA (GB), dopamine (DA), norepinephrine (NE), and acetylcholine (ACH). The process of these interactions at the brain "reward site" is called the reward cascade.

Method

Literature pertinent to the "brain reward cascade" model in substance use disorders is reviewed.

Findings

A consensus of the literature suggests that when there is a dysfunction in the "brain reward cascade," especially in the dopamine system causing a low or hypo-dopaminergic trait, the brain of that person requires a dopamine "fix" to feel good. This high-risk genetic trait leads to multiple drug-seeking behaviors. This is so because alcohol, cocaine, heroin, marijuana, nicotine and glucose all activate release of dopamine, which can heal the abnormal cravings. Moreover, this genetic trait is due to a form of a gene (DRD2A1 allele), which prevents the expression of the normal laying down of dopamine receptors in the brain reward site (Blum, Cull, Braverman, & Comings, 1990). This gene and others involved in neurophysiological processing of the above cited neurotransmitters (i.e., 5HT, END, GB, DA, NE, ACH, etc.) have been associated with deficient functions and predispose individuals to have a high risk for addictive, impulsive, and compulsive behavioral propensities such as: severe alcoholism, cocaine, heroin, marijuana, and nicotine addictions, glucose bingeing, pathological gambling, sex addiction, ADHD, Tourettes syndrome, autism, chronic violence, post-traumatic stress disorder, schizoid avoidance disorder, conduct disorder, and antisocial behavior. It has been proposed that genetic variants of the D2 dopamine receptor gene and other "reward genes" are important common genetic determinants of the emerging concept coined by Blum as Reward Deficiency Syndrome (RDS). Ongoing research on chromosomal marking and candidate gene analysis has supported the concept of polygenic inheritance. While certain pharmaceutical approaches include targeting of single neurotransmitter deficits (e.g., SSRIs) as well as blocking dopaminergic activity to reduce drug effects, our approach includes multiple targets and enhancement of dopaminergic function as a life-long goal. Gene therapy studies by Nora Volkow revealed that over expression of D2 receptors in the nucleus accumbens of alcohol drinking rodents results in a significant reduction of both alcohol preference and craving. While the ultimate goal is to early diagnose one's genetic propensity to substance seeking behavior along with potential CNS gene therapy, current diagnosis includes limited non-invasive DNA testing as well as precursor amino acid-enkephalinase inhibitory therapy.

Conclusions

We propose that, based on this previous evidence, substance abuse treatment must involve physiological, psychological, and spiritual modalities. With reference to the physiology, the authors propose a biogenetic model for the diagnosis, treatment, and relapse prevention of RDS behaviors. Thus, genotyping, pharmaceutical interventions, nutriceutical therapies, neurofeedback, auricular therapy, acupuncture, and chiropractic are discussed as a unifying approach to reduce aberrant cravings and enhance recovery and well being by altering brain chemistry.

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Being Nonlinear Being: Choosing the Chaotic, Complex Path to Understanding System Neurodynamics

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In order to understand the workings of the human mind/brain in the new millennium it will be necessary to adopt not only a new way of *thinking* about neurodynamical systems but a new way of *being* altogether. Linear time- and frequency-invariant systems, which only admit proportional distributive responses, and reductionistic approaches, which are one-way/top-down in nature, do not provide sufficient tool sets for probing the nature of brain structure/function relationships. To take the next steps we must use what we have learned about the brain to help shape the direction of the research itself. This calls for a subtle yet significant shift in consciousness regarding how we approach such research over the next decades.

This will require us to adopt nonlinear dynamical systems (NDS) and systems biology (SB), each with their rich tool sets whose thoughtful use will lead to the breakthroughs we all seek. One shift must be from a rationalistic analysis mode to a "top-down/bottom-up" analysis-synthesis mode. Such an approach will enable us to understand how small, intermediate and large scale neuronal networks interact to form shifting patterns of brain activity. Furthermore, we

need to use the tools of general systems theory toward a better understanding of neuroscience. This will require us to design good neural network models, properly apply feed-forward and feedback principles, and understand stability and regulatory dynamics. Using NDS we should explore how small changes in "order parameters" (as coined by H. Haken, 1984) can lead to large, rapidly occurring shifts in activity patterns as well as small, slowly varying ones. We also need to explore how short- and long-range neuronal connections, and strong and weak coupling of neuronal oscillators, lead to resonance phenomena and synchronization in local and global areas of the brain. And finally, we must address the areas of chaos and complexity, their control and anti-control.

We will review the above-mentioned concepts and discuss several examples from the literature (both our own and others) regarding how the judicious use of these tools can help move us toward a state of "being nonlinear being" with respect to systems neurodynamics.

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The Peacock's Tail: Just Where Is the Color?

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Introduction

Photic driving of the EEG has been available for some time. Entrainment has been found in several studies (Budzynski, Jordy, Budzynski, Tang, & Claypoole, 1999; Frederick, Lubar, Ramsey, Brim, & Blackburn, 1999) to be an effective modality for remediating brainwave problems. Real time measurement of the impact of photic driving is an important ingredient in determining clinical impact.

Combining the driving of EEG by photic stimulation with visual and audio feedback from a second system adds additional pathways beyond a second and third ingredient to increase the robustness of the neurofeedback session.

Method

Roshi II (designed by Chuck Davis) has taken a new and forward-looking approach to remediating EEG. The new system, Roshi II uses a "Neuro-Adap-

tive" filter to reduce EEG that is high in amplitude. The "Neuro-Adaptive" filter also reduces noise and provides an EEG spectral display in real time. The LED diodes are strobed at a mathematically derived effective rate designed to reduce high amplitudes at two electrode positions. The LEDs are placed in front of open or closed eyes.

NeuroCare Pro (NCP; designed by Val and Sue Brown) uses a graphical spectral display to enable the clinician to identify amplitudes that are unusual. Advanced filtering options include FIR, IIR, IQM, FFT, Power Spectrum, JTFA, and Wavelets. NCP takes its information from a ProComp Plus interface. Simultaneous use of NCP not only adds a reporting capability to Roshi, but also adds a dimension in rewarding and inhibiting frequencies that complements and enhances Roshi's complex adaptive systems approach.

Results

Seven clients were trained using these combined techniques. A QEEG recording was obtained before training. The EEG recording was inspected and reviewed using different montages to identify subtle patterns. Various normative databases were used to inspect the out of limit values. Each of the seven clients had 10 training sessions with the combined modalities of Roshi and NCP. A post-QEEG recording received the same evaluation as the pre-training report.

Conclusion

Multi-modality training is not new to the neurofeedback community. Some combinations have met with varying degrees of success. The results of these individual approaches are not surprising to those who have previously utilized either modality. The surprise comes in the combination and in the actual methods of application.

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Pulse Characteristics of Neurofeedback Targets: Differential

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Introduction

Targets in clinical neurofeedback have been understood historically to serve as either "augments" or "inhibits." Within this conventional framework "inhibits" were understood to reflect frequency-based activity that needed to be reduced in intensity level, whereas "augments" reflected activity that needed to be increased in intensity. In most current neurofeedback systems, intensity is measured in amplitude and reflects the amount of signal "captured" by a time-based or frequency-based filtering system with a particular frequency range and level of precision (e.g., IIR 9th order Butterworth 12-15 Hz, sliding window FFT or 1 Hz resolution; Haykin & Van Veen, 1998; Oppenheim & Schafer, 1999).

Limitations of these approaches have been well documented in the literature and the "Mean of the Median" was developed as a way to capture not just intensity but "variability" of the signal used in clinical neurofeedback as a way to begin to address some of the problems connected with intensity-based measures, including a better understanding of the salient differences between "augments" and "inhibits" in terms of pulse characteristics.

Method

Analyses were done of training sessions using NeuroCarePro to reveal the pulse characteristics of each type of filter in "successful" sessions from five different clients (Chugani, Samant, & Cerna, 1998).

Results

The analyses revealed important differences in target response based on a number of important parameters. "Inhibit" targets show clearly different pulse

characteristics including rapid onset, short plateaus, and a symmetric "regression to the mean" whereas "augment" targets show slower onset, longer plateaus, fast drop offs and a positively offset regression to the mean.

Conclusion

In-depth analysis of various target functions in clinical neurofeedback reveal important differences in pulse characteristics in these filters. Incorporating these differences in pulse characteristics into available neurofeedback systems and research efforts may help to clarify several of the continuing questions in the field.

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Infrared Images of Prefrontal Cortical Activity: Correlates of Brain States and Behaviors

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Background

Infrared imaging holds promise as a tool for evaluating pIR HEG (Passive Infrared Hemoencephalography) biofeedback.

Method

Infrared images have been collected over the last two years using infrared video technology to view brain activity. Some basic aspects of this technology were developed in a laboratory setting by Shevelev (1992, 1998). These current images have been digitally processed to emphasize the capture of excess thermal output exiting the brain from the prefrontal cortex originating in underlying metabolic activity and blood flow. The images have been captured before and after pIR HEG sessions, reflecting pre/post session changes as well as changes at intervals of weeks and months (Carmen, 2001).

Findings

Consistent image correlates of various brain states and behaviors have been captured. These include depression, anger, language dominance, as well as migraine and Asperger's. The images also show change over time in the expected direction as symptoms normalize.

Discusson

Infrared imaging through the human skull appears to be a valid measure of relative brain activity within the prefrontal cortex (Shevelev, 1998). This process has some similarities to fMRI and PET scanning in terms of monitoring brain activity. Although it probably does not monitor brain activity as precisely, it is more flexible in that the subject can easily carry out cognitive and motor activities during the monitoring process.

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Passive Infrared Hemoencephalography, 4 Years and 100 Migraines Later

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Background

As of the date of the SNR 2002 Conference, Passive Infrared Hemoencephalography (pIR HEG) is now four years old (Carmen, 2001). While still experimental, supportive anecdotal data for efficacy is developing. Conceptually this process is an outgrowth of Hershel Toomim's Near Infrared Spectrophotometry Hemoencephalography (NIRS HEG) system (Toomim, Remond,

Toomim, Marsh, & Lerk, 1999). The concept of using thermal output as a measure of brain activity has been validated independently by Shevelev (1992, 1998). pIR HEG relies on the measurement of excess thermal output from prefrontal cortical activity as the primary measure. In most cases, patient responses to the pIR HEG system appear to be similar to the responses seen with NIRS HEG, although there also appear to be some subtle differences, which need to be considered when comparing data.

Methods

Headache changes were monitored in 100 migraine sufferers who were exposed to pIR HEG.

Findings

Major improvements in migraine activity with this process have been common, often within four to six sessions.

Discussion

Theoretical implications of the brain mechanisms involved in pIR HEG as well as probable brain mechanisms associated with change in migraine activity will be discussed. Both systems (pIR HEG and NIRS HEG) share a freedom from eye movement and muscle artifacts. All systems do have artifacts that do not represent real data. pIR HEG is no exception. Sources and characteristics of these artifacts will be discussed.

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Shall We Trust the Z-Scores of Normative Databases? An Alternative Solution and a Simulation Study on Accuracy

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Introduction

Quantitative electroencephalography (qEEG) as a tool for the diagnosis of neurological and psychiatric disorders is receiving an increased interest. While qEEG analysis is restricted to the scalp, the recent development of electromagnetic tomographies (ET) allows the study of the electrical activity of cortical structures. Electrical measures of a patient can be compared to a normative database derived on a large sample of healthy individuals. The deviance from the database's norms provides a probabilistic measure of the likelihood that the patient's electrical activity reflects normal brain functioning. The focus of this presentation is the method for estimating such deviance.

Method

The traditional method based on z-scores ("parametric") is reviewed and a new method based on percentiles ("non-parametric") is proposed. The parametric and the non-parametric methods are compared using simulated data. The accuracy of both methods is assessed as a function of normative sample size and gaussianity for three different alpha levels.

Results

Results suggest that the performance of the parametric method is unaffected by sample size, given that the sample size is large enough ($N > 100$), but that non-gaussianity jeopardizes accuracy even if the normative distribution is close to gaussianity. On the contrary, the performance of the non-parametric method is unaffected by non-gaussianity, but is a function of sample size only. It is shown that, with $N > 160$, the non-parametric method can be considered preferable.

Conclusions

Results will be discussed taking into consideration technical issues related to the peculiar nature of qEEG and ET data. It will be suggested that the sample size is the only constant across EEG frequency bands, measurement locations, and kind of quantitative measures. As a consequence, for a given database the

error rate of the non-parametric database is homogeneous; however, the same is not true for the parametric method.

The Effects of EEG Neurofeedback and Neuro-Cognitive Processing in the Educational Environment of an Arts-Based Private Elementary/Middle School

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Introduction

This is a randomized, controlled pilot study investigating the effectiveness of electroencephalogram (EEG) neurofeedback and neuro-cognitive processing in the educational environment of a small unique private arts-based elementary/middle school.

Method

The sample size of the study was twenty-four (N = 24) divided into 12 control and 12 neurofeedback subject groups. The study divided the groups by first and second semester providing two 18-week sessions containing a total of 25 one-hour therapeutic periods, using EEG neurofeedback and neuro-cognitive coaching sessions.

Results

Results indicated that the students using the EEG neurofeedback and neuro-cognitive therapy made improvement in overall academics and in the behavioral aspects of attention problems: hyperactivity, internalizing problems, and adaptive skills. The area of greatest statistical significance was in auditory discrimination ($p =< .001$).

Conclusions

Neurofeedback and neurocognitive training show promise in improving auditory discrimination, concentration and focus skills, and nonverbal intelligence in both special needs and normal children.

The Compassionate Mind: QEEG Studies of Reactive Attachment Disorder and Buddhist Monks

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Introduction

The thought of compassion for another individual originates in the mind (Davidson & Harrington, 2002). The ability to develop and experience deep empathy and compassion is thought to be associated with functioning of the right hemisphere (Schore, 1994). In this presentation, we review studies of children with Reactive Attachment Disorder (RAD) and long time Tibetan Buddhist monks. The former have difficulty developing emotional connections with others, particularly empathy and compassion, while the latter have years of experience meditating on the generation of unconditional love and deep compassion.

Method

QEEGs were recorded using Lexicor NeuroSearch-24 and V1.51 software with an appropriate size electrocap. EEG activity was sampled from 19 scalp electrode sites in the standard International 10-20 montage with reference to ear lobes and ground just forward of site FZ. Sampling rate was 128 Hz with 32K gain. Data analysis was completed using NeuroRep Version 4.0, Thatcher Lifespan EEG Reference Database as well as the NovaTech LORETA workstation programs. EEG waveforms were inspected offline and artifacts eliminated. In addition to baseline eyes-open and eyes-closed conditions, the monks were asked to meditate specifically on "Bodhimind" or the generation of unconditional love and compassion for all beings.

Results

Measures of coherence, phase, and amplitude asymmetry were computed in four frequency bands among all combinations of left and right intrahemispheric sites and between homologous interhemispheric sites. Relative power for each of the frequency bands was calculated. Each of the conditions was also analyzed using LORETA.

Conclusion

QEEG results from the Buddhist monks are presented and discussed within the context of children with RAD. Underlying brain structures are identified and implications for a model for the development and experience of compassion are presented.

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QEEG, Psychological Status and EMG Activity in Fibromyalgia

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Introduction

Despite its frequency of occurrence fibromyalgia remains difficult to define objectively. The purpose of this study was to evaluate fibromyalgia sufferers using psychological testing, SEMG and qEEG techniques.

Method

Forty carefully screened volunteers were recruited by advertising. The volunteers were screened for co-morbid medical conditions and any other factors that would contaminate the findings. All subjects were off of medications for five half lives prior to assessment. SEMG and qEEG data and psychological tests were administered following standard procedures.

Results

All subjects showed inappropriate muscle activity. Turning of their heads produced coactivation of the forearm extensors, buttocks (gluteus maximus) and lateral medialis (knees). Psychological testing showed the presence of three distinct groups with the profile patterns covarying significantly. These three groups showed differences in qEEG activity with group one showing elevated frontal Alpha activity, group two showing increased Beta activity

throughout the cortex and group three showing elevated Theta activity in the frontal cortex.

Discussion

These results appear to indicate the presence of subtypes in the fibromyalgia population. The implications for treatment are discussed as well as the need for future research.

EEG and Intelligence

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Introduction

Since the pioneering work of Hans Berger, there have been many attempts to find electrophysiological correlates of intelligence by using a variety of different measures which in most cases were based on event-related potentials (ERPs).

Method

We report findings from a different approach which is based on the analysis of small frequency bands that are dynamically adjusted to individual alpha frequency and bandwidths (Doppelmayr, Klimesch, Pachinger, & Ripper, 1998). Previous work indicates that increasing demands on working memory are associated with an event-related increase in theta band power whereas increasing demands on semantic (long-term) memory are reflected by a selective decrease in upper alpha band power (Klimesch 1997, 1999).

Findings

Based on a similar methodological approach Neubauer, Freudenthaler, and Pfurtscheller (1995) and Neubauer, Sange, and Pfurtscheller (1999) have obtained interesting results with respect to intelligence. As an example, they have found that the extent of decrease in upper alpha power (event-related desynchronization or ERD) is negatively associated with intelligence: More intelligent subjects exhibit a smaller ERD than less intelligent subjects. This finding was interpreted on the basis of the ‘neural efficiency’ hypothesis.

In a recent study from our laboratory (Doppelmayr, Klimesch, Stadler, Pollhuber, & Heine, 2002) we have found different effects for the lower and upper alpha band in a resting situation with respect to the performance of tasks with high demands either on attentional or long-term memory processes. Whereas intelligence tasks with high attentional demands (such as the LGT-3) selectively affected the lower alpha band, those with high demands on long-term memory (such as the IST-70) primarily affect the upper alpha band. These findings could be replicated and extended by analyzing the EEG while subjects were performing a combination of the Ravens Standard and Progressive Matrices. Analyzing task performance according to an additional intelligence test (CFT-3) and the amount of band power changes for individually adjusted frequency bands and bandwidths revealed several significant results for different time segments, frequency bands and topographical positions.

Discussion

The findings of the different studies show several significant differences in band power changes between higher and less intelligent subjects, mainly in the alpha bands. While the results underline the different functional meaning of specific frequency bands as reported by Klimesch (1999) not all of the findings of Neubauer et al. (1999) could be replicated.

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The Quick Assessment (QA): A Behavioral Rating Scale for EEG Neurofeedback Training

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Introduction

The QA is a behavioral rating scale of thirty (30) symptoms designed to measure the frequency of negative behaviors and monitor the change of these behaviors in students receiving EEG neurofeedback training. The behaviors used in the QA are those which are commonly seen as improving with training. As the name "quick" implies, it is intended to be quick and easy to administer.

Method

Before training begins an initial QA baseline is administered. Thereafter, the form is filled out weekly by the student or with the assistance of an aide. Younger students and those with reading and learning disabilities often need assistance to fill out the form for it to be reliable.

The first word(s) of each symptom in the QA is the key word(s) and the following words are synonyms to aid the student in understanding the meaning of the symptom. The form is short, measurable and seems reliable although formal statistical testing has yet to be done. Generally within 5 to 10 sessions behavioral changes begin to be observed. Thereafter, it appears that the QA is sensitive to changes in the student's program within 1 to 2 sessions.

The rating scale of the QA is designed to be measurable in terms of frequency of the behaviors which are weighted numerically so they can be compared for training outcomes. With this measurability, the student's progress can be monitored easily. Blanks are included in the QA so additional symptoms may be added to the list and primary goals can be added if they are not already included in the form.

Results

The QA appears to be reliable in monitoring progress, when progress has plateaued or when regression has occurred. The QA is not intended to replace other testing, such as continuous performance testing, academic testing, IQ testing, etc. Its utility is in monitoring ongoing progress throughout the neurofeedback training process. It lets the therapist know when a student's training has consolidated and he is ready to discontinue the training. At the very least, the QA serves as a guide to a quick interview to help the therapist assess the student's training status.

Discussion

The QA can reveal negative training outcomes as well as the commonly expected positive training outcomes. When most or all of the symptoms shift to the left two columns (the low frequency columns), the program is becoming consolidated.

Skewness in the Time Series of EEG Magnitude and Spectral Correlation

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Introduction

Most quantitative EEG software packages provide the mean value of the EEG time series for EEG amplitude, coherence, etc. However, use of the mean rather than the median as a measure of central tendency generally assumes that data have a symmetric distribution and are not influenced by outliers.

Method

A five-minute, 19-channel quantitative EEG, with linked ears reference, was recorded from 30 normal college students while sitting quietly with eyes closed. After careful artifact rejection, magnitude (at 19 locations) and spectral correlation (SC; at 171 pairs) were computed for each epoch (using Lexicor's Exporter software), at 1-2 Hz, 2-4 Hz, 4-8 Hz, 8-12 Hz, 13-21 Hz, 21-32 Hz, and for the 1.5 Hz band surrounding each subject's peak alpha (PA) frequency.

Results

By observing histograms of all epochs for each variable, spectral correlations in the 1-2 Hz, 2-4 Hz, and PA frequencies were found to have highly skewed distributions, with most observations seen in the 90 to 100% range and a long tail toward the left. The distributions of SC for the 4-8 Hz, 8-12 Hz, 13-21 Hz, and 21-32 Hz bands also tended to be highly skewed for derivations with short interelectrode distance, but more moderately skewed otherwise. Lower peak values and more normal distributions tended to be observed at higher frequencies. Meanwhile, the distribution of EEG magnitudes tended to

be highly skewed toward lower values, with a long tail toward outliers on the right.

Conclusion

Although differences between generators operating at various frequencies could explain the differences in the peak and skewness of the SC distributions we observed, the higher SCs in the 1-2 Hz, 2-4 Hz and PA bands could also arise simply because these narrower bands have fewer component frequencies. Whatever the explanation, these data suggest that the median, rather than the mean, might provide a more valid measure of central tendency for the EEG time series. Further data will be presented comparing findings between identical studies where means and medians are employed.

QEEG Subtypes of Math Learning Disability and Treatment Implications

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Introduction

An analysis was done of 50 randomly selected ADHD client's QEEG topographic brain maps to determine if any unique patterns are present separate from ADHD to differentiate math learning disabilities from ADHD.

Method

Fifty randomly selected ADHD clients with math learning disabilities (MLD) who had QEEG topographic brain maps were evaluated for abnormalities they shared in common different from those expected to be present secondary to their ADHD. The New York University E. Roy John Normative Data Base was used and a minimum of one standard deviation discrepancy from normal was utilized. MLD was defined as 20 standard score units discrepancy between math achievement test scores and the higher of the clients' verbal or abstract reasoning IQ scores, when math achievement was at least two years below average.

Results

The following patterns emerged:

Elevated Parietal Delta: 6%

Elevated Parietal Theta: 26%

Elevated Parietal Alpha: 50%

Elevated Parietal Beta: 20%

There were also coherence abnormalities.

Conclusion

Ninety-six percent of this sample appeared to have MLD QEEG abnormalities in the parietal lobes suggesting that down training the particular elevated bandwidth might expedite the treatment of MLD.

Neurofeedback with Obsessive-Compulsive Disorder

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Introduction

Obsessive-Compulsive Disorder (OCD) is often less than optimally treated using medication or behavior therapy. However, qEEG and neuroimaging research have identified brain patterns associated with OCD (Prichep et al., 1993).

Method

Two patients with OCD were screened with the Padua Inventory, the Yale-Brown Obsessive-Compulsive Scale, qEEG, and in one case, the MMPI. Each patient displayed different qEEG patterns associated with OCD. Neurofeedback individualized to qEEG findings was used.

Results

At the conclusion of treatment, the two patients were again administered the Padua Inventory and an independent colleague conducted the structured interview associated with the Yale-Brown Scale. The MMPI was also administered again. These results and follow-up questioning at four months and more than one year post-treatment validated highly successful changes.

Conclusion

EEG neurofeedback appears to hold promise for treating OCD, which has been firmly established to be associated with abnormal brain patterns.

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The Single-Band Asymmetry Profile

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Introduction

Several studies have shown a relationship between depression and frontal alpha asymmetry (FAA). However, there are some provocative considerations regarding these findings that suggest an expanded inquiry would be desirable. For example, depression rarely occurs in the absence of anxiety and other co-morbidities. Furthermore, the arbitrary limitation of EEG indices to the 7-13 Hz frequency band is not likely to be consistent with the problem lists of real people. Therefore, the cerebral signs of depression are probably not as well defined as some surmise.

Methods

Eyes-closed EEG recordings were obtained from six subjects who qualified for a 'depression' diagnosis based upon MMPI (Scale 2) criteria and, as well, had evidence of other co-morbidities. Artifact-free records from 8 homotopic electrodes (F1F2, F7F8, F3F4, T3T4, C3C4, P3P4 and O1O2) were referenced to the vertex (Cz) and then subjected to the Fast Fourier transform using 1 Hz resolution. Asymmetry indices were computed as ([R − L]/[R + L]), in the manner described by Baehr, Rosenfeld, and Baehr (2001) for each of the 8 electrode pairs and 30 frequency bands. These indices were used to compute group asymmetry means and durations for the defined datasets.

Results

As might be expected, the behavioral (MMPI) and cerebral (asymmetry) indices (profiles) are far more complex than implications that follow from the highly tokenized Depression-FAA relationship. These have implications for future work.

Discussion

The results show that the profiled datasets are consistent with clustering techniques that more closely fit the real complexities of patient problems. Our plan from this point is to increase our population and develop empirical groups.

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The Mozart Effect

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This review deals with the Mozart Effect, an improvement of performance while listening to Mozart music. Previous studies have shown improved spatial temporal reasoning, improved IQ test results, neurophysiological changes, and generally increased coherence among different groups of subjects. This review emphasizes: (a) the effect on epileptiform patterns, both generalized and focal; (b) provides an example of a chronic effect over a period of one to two days; (c) addresses the distinctive aspects of the music that may account for this phenomenon; (d) shows that long-term periodicity in the power of the music is a special quality; and (e) shows that Mozart repeats the melodic line much more frequently than other well-known composers. It is likely that the super-organization of the cerebral cortex resonates with the superior organization found in Mozart's music.

Neurofeedback Enhanced by Light and Electromagnetic Closed Loop EEG in Parkinson's Disease

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Introduction

At the 8th Annual Winter Brain Conference in Miami, Florida, 2001, Dr. Hammond and I (Ibric & Hammond, 2001) presented the positive results of neurofeedback enhanced by electromagnetic closed loop EEG in a case of essential tremor (ET). With this presentation I wish to introduce to the audience two cases of Parkinson's Disease (PD) from my clinic, where motor and cognitive functions were improved using neurofeedback enhanced by light and/or electromagnetic closed-loop EEG.

Methods

Both cases were comprehensively evaluated. Evaluation consisted of a review of medical history, current and past medications, and other therapies. Further evaluations included stress test, Beck Depression Inventory, SCL-90R, cognitive testing (IVA), simple EEG over the sensory motor area and QEEG. There were differences between these two cases, with respect to the onset of the disease and their therapeutic approaches. After the evaluations, and according to the QEEG results, patients were trained for a varying number of sessions using Neurocybernetics and Roshi/BrainLink® instruments.

Results

The first case, a 78-year-old retired fireman, was diagnosed with PD about 12 years ago and has been on Dopamine (DA) replacement therapy since. At the same time he had surgery for prostate and bladder cancer. Two years ago he had heart valve replacement. At the intake he presented neck and postural distortion, shuffling gait, spasticity of the legs, and tremor of both hands (left more than right). Cognitively and emotionally he did not seem to be affected. He reported a stress level of 25, which is mild. Case one completed 36 sessions of neurofeedback enhanced by light and/or electromagnetic closed loop with constant improvement of his tremor and gait, and reduced stiffness of his neck.

The second case, an 82-year-old retired aeronautical engineer, was diagnosed with probable PD two years ago. The trials for DA replacement therapy produced adverse reactions and the therapy was stopped. Medical history revealed prostate cancer diagnosed in 1995, and a probable stroke in 1999, followed by the PD symptoms. At the intake the postural distortion, facial

immobility, slurred speech and tremor of both hands (mostly right hand and in standing position) were noticed. Cognitive impairment was also confirmed by the IVA. Emotionally, the patient seemed to be depressed and he had sleep deprivation. The reported stress level was in the mild range, 17 (0-25). To date he has completed 15 sessions of neurofeedback, 14 enhanced by light but mostly by electromagnetic closed loop EEG. Some improvement in his cognitive ability, better gait and blinking more frequently has been noted. He is feeling less depressed. The details of their training will be discussed more fully in the presentation.

Conclusion

In 1992, Sandyk published a report in the *International Journal of Neuroscience* that the external application of weak electromagnetic fields of low frequencies produced dramatic improvements in motor symptoms in PD patients. Currently I am reporting that neurofeedback training can be enhanced by light and/or electromagnetic closed-loop EEG. The results obtained with PD patients are similar to those presented previously by Sandyk (1995) and include the correction of micrographia and the reduction in tremor demonstrated in drawing the Archimedes spirals (Sandyk, 1994). My hypothesis is that the changes in motor control may be related to stimulation of dopamine production. The changes obtained in the emotional make up may be due to correction of serotonergic system. The enhanced production of melatonin by the pineal gland may be responsible for the correction of sleep disturbances (Sandyk, 1996).

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Update on Bispectral EEG Analysis

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Introduction

This presentation will include a brief review of bispectral analysis of the EEG (see Rampil, 1998), and a presentation of the results of two pilot studies recently completed by Leuchter et al. (2002) and Cook et al. (2002) at the Quantitative EEG Laboratory at UCLA in conjunction with the scientific staff at Aspect Medical Systems, Inc. Bispectral analysis is a sensitive index of loss of conscious awareness following administration of anesthetics and sedatives. The two present studies focus on: (a) the use of bispectral analysis in the characterization of memory loss in Alzheimer's and multi-infarct dementia (Leuchter et al., 2002), and (b) use of bispectral analysis in predicting response to antidepressant medication in patients with major depressive disorder (Cook et al., 2002).

DEMENTIA STUDY

Method

Eighteen normal elderly controls, 11 patients with mild to moderate Alzheimer's disease and seven patients with multi-infarct dementia were studied. EEG recorded from left frontal and front temporal electrodes (F7-Fp1, T3-Fp1) was used to calculate the Bispectral Index (see Rampil, 1998). The Mini Mental Status Exam was used to measure the degree of impairment.

Results

The EEG bispectrum showed changes correlated with increasing severity of dementia. Differentiation between dementia and control subjects was strongest for triples [40 Hz, 10 Hz, 50 Hz] (smaller in dementia groups) and [3 Hz, 2 Hz, 5 Hz] (larger in dementia groups). The ratio of these two bispectrum values detected dementia with 89% accuracy. Alzheimer's and multi-infarct dementia groups were best separated by bispectrum values around [6 Hz, 6 Hz, 12 Hz] (larger values in vascular subjects). Bispectrum values around this region were able to differentiate between AD and multi-infarct subjects with 84% accuracy.

DEPRESSION STUDY

Method

Pretreatment, resting EEG was recorded from 51 adults with unipolar major depression in treatment trials with either fluoxetine (20 mg/d) or venlafaxine (150 mg/d) versus placebo, as previously reported (Cook et al., 1999). Hamilton Depression Rating Scale (HAM-D) assessment was performed on each subject as a measure of depression severity. Responders were a priori defined as exhibiting HAM-D = 10 at completion at week eight.

Results

No significant group differences were found at baseline on age, HAM-D, or other demographic characteristics. Across all treatment groups, bispectrum was higher in the more severely depressed patients, particularly in the frequency region where [12 Hz<f1<24 Hz,f2<6 Hz]. Correlation of bispectrum in this region with Ham-D was significant ($R = 0.31$, $p < 0.001$). Baseline EEG bispectrum showed differences between medication responders and nonresponders with less low frequency bispectrum [f1<10 Hz, f2<10 Hz] and more high frequency bispectrum [24 Hz<f1<38 Hz, f2>24 Hz] than nonresponders.

Discussion

Results of these two pilot studies demonstrate the potential of bispectral analysis to provide clinically useful information in both dementia and major depression. Although recorded from a restricted region over the left frontal region, bispectral analysis was successful in differentiating between Alzheimer's and vascular dementia. With increasing dementia severity, low frequency bispectrum increased while high frequency bispectrum decreased. The bispectrum also was useful in predicting clinical response to pharmacotherapy in major depression. Different relationships among frequencies were found to correlate with severity of depression than were found to predict medication response.

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Chronobiological Rhythms: A Potential Confounding Effect in QEEG Assessment

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Introduction

Circadian and ultradian (less than 24-hour) rhythms are present in most if not all physiological variables. An entire field, chronobiology, has developed to study these rhythms. Diurnal variations are commonly reported in all sorts of arousal indices, from task performance to subjective ratings to EEG activity (e.g., Chapotot, Jouny, Muzet, Buguet, & Brandenberger, 2000). Although ultradian rhythms were identified in human EEG more than 30 years ago (Scheich, 1969) and were suggested as a possible confounding influence on EEG biofeedback training 20 years ago (Gertz & Lavie, 1983), their role in quantitative EEG assessment has been largely ignored. The current research attempts to identify and quantify the effects of ultradian rhythms in standard frequency bands.

Method

Nineteen-channel quantitative EEG was recorded from 126 normal participants (102 males, 22 females, 19 to 43 years of age with a mean of 32 years, all right-handed) during eyes-closed and eyes-open resting conditions across the day (8 a.m. to 6 p.m.). Participants contributed typically two recordings per condition one to two hours apart. Spectral magnitudes in standard frequency bands (e.g., delta, theta, alpha) were analyzed in one-hour segments across the day.

Results

The effect of time of day (i.e., the difference between one-hour means from the entire sample's mean) on standard bands ranged from 4 to 16 % across the morning and afternoon. Reduced interindividual variability was also observed

when data were binned into one-hour segments compared to the global (all-day) average, $p < .05$. Dominant spectral magnitudes peaked at 1 p.m. and varied most noticeably between 10 a.m. and 11 a.m. for all sites and at parietal sites between noon and 1 p.m. and between 1 p.m. and 2:30 p.m., $p < .01$. An ultradian rhythm with a two and one-half hour period was evident in dominant frequency activity across the day.

Conclusion

Despite the opportunistic, cross-sectional nature of the data, strong evidence of ultradian and circadian rhythms was found, suggesting that time of day may play a confounding influence in multiple comparisons unless it is controlled. Diurnal variations were greatest around mid-day, which is consistent with the chronobiological literature (e.g., Cacot, Tesolin, & Sebban, 1995; Cummings, Dane, Rhodes, Lynch, & Hughes, 2000). Differences in diurnal variation of specific frequency bands will be discussed.

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The Benefits of Measuring Basal Skin Response During Neurofeedback Training

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Introduction

Basal skin response (BSR) is the measure of skin conductance, as measured on the palmar surfaces of two fingers. As the eccrine gland system mobilizes in response to sympathetic arousal, the glands sweat. This can be a window to the body's acceptance to new brain wave states.

Method

During neurofeedback training, the BSR measure is recorded, but not always fed back until the debriefing at the end of the session. Five clients, either presenting with an anxiety disorder or clinically observed as having high sympathetic arousal were trained with the neurofeedback protocol best suited to their needs (based upon QEEG analysis). During the debriefing at the end of the session, changes in the BSR measurement were compared to changes in the EEG. The client was given an opportunity to correlate these BSR and EEG states.

Results

In the early stages of the clinical trial, the BSR would respond negatively (become lower). This phenomenon is known as relaxation induced anxiety. However, as the client gradually progressed toward optimal brain wave state, the BSR measure would stabilize and/or increase.

Conclusion

Because the BSR measure is closely correlated with anxiety state, its activity determines how well the body is responding to the change in brain wave (and psychological) state. Intrasession fluctuations in the BSR and EEG measures correlated highly with the changes in the client's perception of physiological balance between SNS and CNS changes. Additionally, intersession changes reflected the body's gradual acceptance or refusal of the neohomeostatic state. As the changes became permanent and familiarized, the BSR measures rose. These measures can aid in the clinical decision making of neurofeedback training. Decisions such as when/if you should change protocol, when/if to consider completion of the clinical trial and also aid in gaining insight into the client's report of the experience.

QEEG/ERP/ERD Based Diagnosis and Biofeedback Treatment of Executive Dysfunction

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Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is the most common mental dysfunction in childhood, affecting three to five percent of all children.

It is not a homogeneous disorder. A modern neurobiology oriented approach considers ADHD subtypes to be associated with the impairment of different neuronal circuits in the frontal lobe-basal ganglia-thalamic executive system.

Method

To differentiate between impairments of different executive operations (engagement and disengagement operations, in particular) we measured event-related de-synchronization and late (in the range of 300 ms after stimulus) positive GO and NOGO components of event-related potentials (ERPs) associated with engagement and disengagement operations in a continuous performance task in normal (N = 16) and ADHD (N = 84) groups.

Results

Our data show that the extent of event related desynchronization in alpha band, of event-related synchronization in theta band, as well as the amplitude of GO and NOGO components correlate with both age and task performance. They are smaller in young children in comparison to older ones, and in the ADHD group in comparison to the normal group. Twenty sessions of beta EEG training improved the quality of performance (decrease of omission and commission errors) and led to a significant increase of amplitude of GO and NOGO components as well as to normalization of event-related synchro/desynchronization.

Conclusion

This study is the first to show that not only psychological indexes of behavior, but also ERP/ERD components are "improved" after beta training, which in turn indicates that the biofeedback training changes the brain system for executive function.

Effects of EEG Biofeedback on a Male Polysubstance Abuser: A Case Study

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Background

This single case concerns the treatment of a 37-year-old male drug addict. The client first sought neurofeedback treatment at age 34, while coming down

from a four-day run on methamphetamine. He reported his first drug use at the age of nine (alcohol), rapidly escalating to polysubstance abuse. Drug use included alcohol, marijuana, heroin, cocaine, narcotics, hallucinogens, and methamphetamines. Even though he had been through numerous conventional drug treatment programs, he reported no more than two or three days free from drugs and/or alcohol (other than while incarcerated or hospitalized) in his 25 years of use.

Method

The client completed five sporadic neurofeedback sessions. Standard beta (15-18 Hz) and SMR (12-15 Hz) training was employed, with the goal of introducing Alpha/Theta training in the future. The client continued to use drugs and ultimately discontinued neurofeedback training. Three years later he returned, in jeopardy of being sentenced to a long prison term for his third parole violation for methamphetamines. The first session of standard beta/SMR training resulted in negative outcomes. A brain map was completed, and neurofeedback treatment resumed, focusing on down training various frequencies at many locations.

Results

The client reported significant changes in drug seeking behavior, and he was able to remain sober, complete a court-ordered cognitive self-change program, stay actively involved in a 12-step recovery program, and began his own successful business. While it is impossible to attribute the improvement in the client's functioning solely to neurofeedback training, the client had reported continued attempts to remain sober in the past which had failed.

Discussion

When working with addicts, it is important to collect as much information as possible, both physiologically (through the use of the brain map) and a thorough intake. A combination of developing training interventions utilizing knowledge of areas of the brain and their function, and matching that to information gleaned from brain maps can prove to be extremely successful. The client remains drug free today, almost two years since he began neurofeedback training, his longest reported length of sobriety since he began using drugs 25 years ago.

SPECT vs. QEEG Map vs. QEEG Scan: Which Is the Most Accurate and Best Value for ADHD?

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Introduction

The use of brain imaging techniques is becoming more widely accepted as accurate diagnostic techniques and predictors of treatment in the field of ADHD. Amen, Paldi, and Thisted (1993) theorized six subtypes of ADHD using SPECT imaging and developed unique treatment recommendations (medications, neurofeedback) for each subtype. Monastra, Lubar, and Linden (2001) have completed numerous studies using a QEEG scan technique to differentially diagnose ADHD and predict medication response. Several researchers (Chabot & Serfontein, 1996; Mann, Lubar, Zimmerman, Miller, & Muenchen, 1992; Lubar, Swartwood, Swartwood, & Timmermann, 1995) have completed research using QEEG maps to help diagnosis ADHD and have suggested that up to 12 subtypes of ADHD may exist.

Method

This presentation will review the past and current research using these brain imaging techniques with children and adults with ADHD. Case examples of results of all three imaging techniques will be discussed.

Results

This is not a research study; only a review of past literature and current case examples will be presented. No comparative statistics will be performed.

Conclusion

QEEG mapping, QEEG scans and SPECT can be used effectively to accurately diagnose ADHD in children and adults. These techniques can also lead to predictions of medication response and specific neurofeedback protocol development. The QEEG scan is the most efficient test to diagnosis simple ADD/ADHD. QEEG maps are the best technique to develop neurofeedback protocols in complex cases with comorbid disorders or when patients are taking medications which cannot be discontinued for assessment. SPECT is best used to predict the type of medications to be successful.

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Low Resolution Electromagnetic Tomography (LORETA) of Cerebral Activity in Chronic Depressive Disorder

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Introduction

During the past 25 years considerable evidence has been published on the finding that unipolar depression and dysthymia have a lateralized localization primarily in the anterior cortex. Early data were reviewed by Davidson (1984, 1987), Silberman and Weingartner (1986), and Tucker (1981). The purpose of the present study was to extend the existing findings using Low Resolution Electromagnetic Tomography (LORETA, Fuchs, Wagner, Köhler, & Wischmann, 1999; Pascual-Marqui, 1995, 1999; Pascual-Marqui, Michael, & Lehmann, 1994). LORETA is the best known inverse solution technique.

Method

The depressive subjects in this study were a group of 15 right-handed females. The selection criteria included a diagnosis of unipolar depression with-

out any diagnosis of comorbid DSM-IV Axis I or II disorder that was provided by a clinical psychologist, psychiatrist, or physician. In addition to the depressed group, a group of 15 age-matched, right-handed, non-clinical female controls were used for comparison subjects. All recordings were accomplished with the use of the Electrocap. Impedances between each electrode site and the ears measured individually were between 3-5 kohms as was the impedance between the ears themselves. The EEG was recorded using the NeuroSearch-24 (Lexicor Medical Technologies, Inc.). Amplification was 32,000. The EEG was sampled at 128 Hz with low and high pass filters set at 0.5 and 32 Hz, respectively. All recordings were taken during eyes-closed condition and included three to four minutes of data. Data were collected continuously in a dimly illuminated and sound attenuated room. Data was transported into the EEG workstation 2.0 software (Novatech EEG, Inc.) for very precise artifact rejection.

Analysis

For each subject in the study, average cross-spectral matrices were computed for the classical bands Delta (2-3.5 Hz), Theta (4-7.5 Hz), Alpha (8-12.5 Hz), and Beta (14-22 Hz). In addition we investigated the narrow bands Alpha1 (8-10 Hz), Alpha2 (10-12), Beta1 (12-16 Hz), Beta2 (16-20 Hz), Beta3 (20-24 Hz), Beta4 (24-28 Hz), and Beta 5 (28-32 Hz). Cross-spectral matrices were computed and averaged over epochs and over discrete frequencies. Asymmetry scores were defined as the difference between measurements across contralateral points.

For power analysis there were 2394 simultaneous tests. For power asymmetry analysis there were 1204 simultaneous tests. We used the step-down version of the t-max procedure (Blair & Karniski, 1994; Holmes, Blair, Watson, & Ford, 1996; Westfall & Young, 1993) with 10,000 random data permutations. All statistical analysis was performed by Multiple Hypothesis Testing (MhyT), a program written by the second author. The t-max test has been shown to exercise strong control over the family-wise error (FWE); that is, for a given Type I error Alpha, the test ensures that the probability to falsely reject any hypothesis is no more than Alpha. The Type I error in this study was fixed to 0.05. Therefore, all results reported are significant at the 0.05 level after correction for multiple testing.

Results

In the asymmetry analysis compared with the control group the depression group exhibited stronger Alpha2 current density in the post central gyrus. In the same band secondary asymmetry were found frontally especially medial frontal and in temporal locations. Power analysis revealed decreased Delta in

the right middle temporal gyrus in the depressed group. Current density was also greater in the posterior cingulate gyrus in generalized Beta and in the affective division of the anterior cingulate (Brodmann area 24) in Beta4.

Discussion

The increased Alpha2 current density in the posterior central gyrus is supported by PET studies (Sutton et al., 1997). The decreased Delta activity in the right hemisphere was also supported by SPECT findings (Kocmur, Milcinski, & Budihna, 1998). The high Beta activity (Beta4) increased bilaterally in the anterior cingulate and medial prefrontal gyrus for the depressed group occurred in the portion of the anterior cingulate referred to as the affective division and has been implicated in major depression (Bush, Liu, & Posner, 2000). The findings in our study are supported in the PET and SPECT literature and show the power of the LORETA technique in terms of its co-registration with these other approaches.

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EEG Biofeedback with Incarcerated Adolescent Felons

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Introduction

The rationale for the study is to explore the utility of EEG neurofeedback in a clinical setting, as an adjunctive treatment for ADHD and other impulse control disorders. Given the relatively high rate of non-responders to stimulant medication treatment, which can be as high as 30-40% (Barkley, 1990), the development of an alternative treatment approach has a great deal of value. Learning problems and behavioral disruptions are common in the adolescent criminal justice population.

Increasing the individual's awareness of fluctuations in level of alertness over the course of a day, and helping him learn to influence this state in a positive direction, results in a decrease in the cognitive noise and distracting thoughts experienced by the individual (Nash, 2000).

Method

Twenty adolescent male felons incarcerated in a residential facility were trained for twenty 30-minute sessions. All sessions were divided into three training segments. All residents were trained using the same protocol: Pre- and post- Conners CPT, WRAML (screening), Kaufman Brief Intelligence Test, Behavior Rating Scale of Executive Function. Complete sets were collected on 7 of the residents and partial sets on the remaining 13 residents.

Results

Clinically significant results were seen with most trainees. Non-verbal IQ scales showed the greatest change. WRAML, BRIEF, and CPT also showed improvements.

Conclusion

Neurofeedback has been shown to be an effective intervention for adolescent felons with significant improvement in learning, IQ, and behavior.

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A Review of the Empirical Basis for Applied Electroencephalographic (EEG) Biofeedback (Neurotherapy) for the Treatment of Neurological and Psychological Disorders

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Introduction

This paper reviews the literature on the clinical application of electroencephalographic (EEG) biofeedback neurotherapy (NT) for the treatment of neurological and psychological disorders. The objectives of the paper are: (a) to determine the efficacy of NT for a number of disorders based on the current literature according to the criteria set forth by Chambless and Hollon (1998) for "Empirically Supported Therapies," and (b) to make recommendations for future research efforts.

Method

A literature search was performed using the PsycInfo Database for "EEG biofeedback" or "neurotherapy." Original research reports published since 1980 with a clinical application of NT for DSM-IV classified disorders using outcome measures were included in the review.

Results

Neurotherapy was found at the time of the review to be "Efficacious and Specific" (according to the above criteria) for epilepsy; "Efficacious" for Attention Deficit-Hyperactivity Disorder (ADHD), and Substance Abuse; and "Possibly Efficacious" for Traumatic Brain Injury and Post-Traumatic Stress Disorder (PTSD). Other clinical applications as reported in the literature lacked sufficient data for clinical trials to classify them within the criteria used here.

Conclusion

Neurotherapy has a promising start toward being a respected therapeutic method in today's evidence-based medical community; however, further research is needed to demonstrate both the specific efficacy and effectiveness (clinical utility) of NT. A multi-level research program is proposed that is aimed at providing both specific efficacy and "clinical utility" data in the most cost effective manner currently available.

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Voluntary Control of EEG Complexity

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Introduction

The science of complexity has recently applied non-linear dynamics, chaos theory, and fractal geometry to a variety of real-world phenomena, including the electroencephalogram (EEG). In the field of neurofeedback, non-linear models of neurophysiology are gaining recognition, but most training protocols continue to rely on conventional linear variables. This study investigates the feasibility of training direct voluntary control over a non-linear measure of EEG complexity.

Method

The fractal dimension (FD) of the EEG, calculated in the time domain, was chosen for the feedback variable based on: (a) a hypothesized relationship between the FD and cortical activation (Accardo, Affinito, Carrozzi, & Bouquet, 1997), and (b) previous research demonstrating responsiveness of the FD to changes in psychological state (Klonowski, in press). A survey of methods for estimating the FD indicated that the algorithm by Higuchi (1988) was the most promising candidate for a neurofeedback measure.

Adult participants received ten neurofeedback sessions, each consisting of eight training trials with feedback followed by two trials without feedback. Training trials consisted of a 30 seconds baseline followed by 300 seconds of feedback. Following the baseline phase for each trial, instructions were given to either increase or decrease the FD; increase and decrease conditions were randomized across all trials. During no-feedback trials, participants attempted control over the FD in the absence of feedback. Eyes-open EEG was measured at Cz (A2 reference, A1 ground) and collected at the rate of 512 samples per second. The feedback measure was calculated every 250 milliseconds and presented as a visual plot of magnitude across time.

Results

Participants were able to achieve highly reliable increases and decreases of the FD. Statistically significant increases and decreases in the FD were demonstrated, although individual differences in degree of control were found.

Conclusion

The fractal dimension of the EEG can be brought under direct voluntary control using a conventional neurofeedback training protocol. Further study will be required to determine the practical implications of training changes in EEG complexity.

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Increase of Visual Acuity in a Male with Amblyopia: A Single Case Study

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Background

This is a single case study of a 71-year-old male with amblyopia (lazy eye) of the right eye. His condition was identified at age twelve. The standard medical belief is that after the age of eight to ten it may be physiologically too late for the brain to make the necessary connections in the visual system and a permanent loss of visual acuity may occur (American Academy of Family Physicians, 1999; American Academy of Ophthalmology, 2000). The client reported that vision in his right eye had always been 20-400 with corrective lenses and a cataract had further impaired vision in that eye. He also reported dyslexia. He was informed that remediation of amblyopia using neurofeedback would be experimental and decided to proceed with training focusing on remediation of dyslexia.

Method

The client completed a comprehensive intake assessment including interview, TOVA, rating scales, and qEEG. Treatment interventions were developed by matching symptomology with impaired brain function as indicated by the qEEG. The client completed 20 neurofeedback sessions. Various bands and treatment sites were employed using both sequential and referential montages while in both a resting state and under reading task. At the end of 20 sessions the client reported no improvement in his vision and discontinued training. Two months later he reported seeing "shadows" out of his right eye and resumed training for 10 additional sessions.

Results

Vision in the right eye continued to increase after neurofeedback training was complete. The client reported becoming increasingly "annoyed" by the shadows he saw through the cataract and had it removed from his right eye. Post cataract surgery vision out of the right eye was 20-50 without corrective lenses and 20-20 with new corrective lenses.

Discussion

Neurofeedback may be a viable intervention for the remediation of visual impairment that involves neuroconnections. It also appears that the brain may continue to "train" after neurofeedback training has been completed. More investigation in these directions may be warranted.

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Frequency Structure and Neuronal Generators of Eyes-Closed EEG

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Introduction

Awake, eyes-closed EEG is usually analyzed in the frequency domain. At first, the classical EEG frequency bands were defined as: delta (0.5-3.5 Hz), theta (3.5-7.5 Hz), alpha (7.5-12.5 Hz), beta1 (12.5-18.0 Hz), and beta2 (18.0-30.0 Hz). Later, by means of a factor analysis performed on power spectra, Herrmann, Fichte, and Kubicki (1978) found different bands: delta (1.5-6.0 Hz), theta (6.5-8.0 Hz), alpha1 (8.5-10.0 Hz), alpha2 (10.5-12.0 Hz), beta1 (12.5-18.0 Hz), beta2 (18.5-21.0 Hz), and beta3 (21.5-30.0 Hz). Unlike the original definition of frequency bands, the latter definition of Herrmann was based on an objective quantitative methodology.

Aims

1. To attempt to replicate the results of Herrmann using factor analysis and objective hierarchical clustering methods.
2. To segment the EEG frequencies by using the microstate segmentation technique applied to the frequency domain, and to compare with the results of Herrmann.
3. To find the electric neuronal generators of the different EEG frequency components.

Material

Twenty-five channels eyes-closed EEG was recorded from 17 healthy normal subjects. Twenty artifact-free two-second EEG epochs were selected from each subject.

Results

We were able to replicate the results of Herrmann by factor-analyzing our data, and by employing a hierarchical clustering method. However, microstate segmentation produced different results: delta (1.5-2.5 Hz), theta (3.0-7.0 Hz), alpha1 (7.5-9.5 Hz), alpha2 (10.0-12.0 Hz), beta1 (12.5-15.5 Hz), beta2 (16.0-24.0 Hz), and beta3 (24.5-30 Hz). Low resolution brain electromagnetic tomography (LORETA) was used for the comparison of the generators of the successive frequency bands obtained by microstate segmentation by means of a statistical non-parametric mapping approach. Delta generators were widespread distributed frontal, theta generators were midline frontal, alpha generators were occipital, while beta generators were fronto-temporal.

Conclusion

A methodology is proposed for characterizing the spatio-frequency structure of the EEG, which avoids the analysis of all discrete frequencies, and objectively determines relevant frequency bands.

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The Limbic Forebrain and Emotion

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Every textbook and most articles that concern the relation between emotion and the brain target the limbic systems. However there are two paradoxes that need to be faced for an accurate scientific account of this relationship.

1. Extensive psychophysiological research undertaken to establish a relationship between the brain systems and varieties of emotional experi-

ence and expression has instead discerned a relationship to varieties of attention and memory.
2. Extensive lesions and resections of forebrain limbic systems (other than amygdala) have not resulted in changes of emotional experience or expression, but dramatic changes in attention and in memory.

In order to resolve these paradoxes it is necessary to define what we mean by emotion: Are we referring to any feeling state or only a subset thereof? Also we need to define what structures are to be included as "limbic." In addition, we need to explore other possible behavioral and experiential categories to see whether they better encompass the data. Two such categories are "interest" and "involvement."

The Effect of Interhemispheric EEG training Using Sequential Protocols on ADD

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Introduction

The purpose of this study was to examine the effect of EEG biofeedback using interhemispheric EEG training protocols on attention deficit disorders.

Method

Neurofeedback protocols included T3-T4, Fp1-Fp2, F3-F4 employing a wide range of reward frequencies. The training group was comprised of 33 males and females, age range from 7 to 62 who were being treated for a variety of different disorders. Changes in attentional ability were measured through the use of a continuous performance test (TOVA) which was administered prior to the start of EEG training and every 20 to 25 sessions thereafter.

Results

There was a clear trend towards normalization on both the impulsivity and inattention scales. Those with normal pre-training scores showed no deterioration in their performance indicating that homologous site interhemispheric EEG training had no deleterious effect on attention. In addition, variability and response time were largely in the normal range for this population and remained unchanged following training.

Conclusion

These early results suggest that interhemispheric training using sequential site configurations offers additional protocol options for addressing attention deficits. Since ADD is a frequent comorbidity with many disorders (including head injury, autism, depression and anxiety), addressing the primary symptom will often lead to a resolution of attentional problems as a secondary effect. Such was the case with most of the persons in this study.

Countermeasures to P300-Based Deception Detection and Neural Signs of Psychopathic Personality

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Introduction

Since 9/11 a flurry of new lie detectors has been touted to foil terrorists. One in particular, pushed by Larry Farwell, is called "Brain Fingerprinting." It is actually similar to our very early papers in which the simple amplitude of the P300 Event-Related Potential (ERP) was used as a recognition index for concealed/denied information pertaining to crimes.

Methods

We suspected early on that this test would be easy to beat, and so we went on to look at the scalp distribution of P300–the brain map–as a deception index. (See the second abstract.)

Findings

We show clearly that the original test can be easily defeated by anyone with a bit of motivation, intelligence, and practice. The hit rate drops from 90% to 50%.

Discussion

We do have some ideas for improvement.

Brain Wave Signs of Psychopathy and Honest-Dishonest Response-Specific Signs of Deception

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Introduction and Methods

This is a continuation of our work on ERPs as previously described.

Findings

We show that students judged to be high and low in psychopathic attributes do not (surprisingly) differ in P300 brain maps and amplitude during deception. However in all subjects, honest and dishonest responses are seen to produce different scalp distributions or brain maps (i.e., specific to deception).

The following result has not been seen previously. Another ERP, a long-lasting slow wave from 800 to 1500 ms post stimulus is shown to differ between honest and dishonest responses in normals, but not in psychopaths.

Discussion

We think this slow wave may represent the sustained processing which continues after a lie is told by a normal person with a conscience, but not by a superficial psychopath who might have no second thoughts, let alone regrets, following deception. This difference may help in the diagnosis of psychopathy.

The Neurochemical Basis of Fibromyalgia

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Objectives

This presentation will utilize the taxonomy of soft tissue pain [STP] syndromes to introduce the fibromyalgia syndrome [FMS], its diagnosis, epidemiology, natural history, and pathogenesis.

Methods

The information presented will be gleaned mainly from the medical literature but will also contain evidence from more recent unpublished research. The objective findings will be illustrated and explained from the historical experience of the presenter's clinical and research background.

Summary

The term STP encompasses a group of disorders that can be classified into three simple categories: localized, regional, and generalized. One of those in the generalized category is FMS. Fibromyalgia is an idiopathic, chronic syndrome characterized by a reproducible constellation of painful symptoms and unusual tenderness to deep somatic pressure. Its consistent epidemiological pattern and a predictable prognosis distinguish it from rheumatic diseases, chronic fatigue syndrome, and myofascial pain syndrome, despite overlapping features and prevalence. Once thought to be a disorder of inadequate tolerance for psychological distress, FMS can now viewed as the human model of chronic widespread allodynia. Dealing with FMS has been a complicated process for twentieth century medicine, leading to widely conflicting opinions about it. The reasons for the resultant role modeling may be buried deep in the fabric of belief system anchoring. While the initiating etiology of FMS remains unknown, scientific methodologies have allowed a better understanding of its pathogenesis. No longer is it considered merely a psychological disorder, a diagnosis to be made by exclusion, or a condition devoid of objective laboratory findings. Patients with FMS exhibit objective abnormalities in nociception and in neuroendocrine functions that must contribute substantially to the generalized symptoms. Normal nociception depends on a delicate balance between pronociceptive and antinociceptive forces. Evidence will be presented to implicate abnormalities in both types of nociceptive mediators in FMS. Chronic noxious stimulation can cause central sensitization and neuroplasticity.

Conclusions

The FMS is a common condition of generalized somatic pain that appears to be perpetuated by measurable abnormalities in the central nervous system. As the biological characterization of FMS expands, benefits will include a better understanding of central nociceptive/neuroendocrine function and more focused therapy for this disorder.

The New Legal Standard for Science

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For more than 70 years, courts in the United States have evaluated scientific testimony by looking to see whether the subject matter of the expert testimony was "generally accepted in the relevant scientific community." This was known as the Frye test, named after a case decided in 1923. In 1994, the Supreme Court decided the Daubert decision which replaced the Frye test with an expanded four-part test. In its later Kumho case, the Court explained how the Daubert ruling applied to social science issues. These tests are relevant not only to the introduction of expert testimony on science in courts of law; they are also relevant to matters involving informed consent.

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Helping the Heart with Audio-Visual Entrainment

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Introduction

Hypertension is a life-threatening condition affecting many American adults (National Vital Statistics Reports, 1998). Lifestyle changes and drug therapy are recommended for treating hypertension. Lifestyle changes can reduce blood pressure by five points or so. Most single antihypertension drugs reduce systolic pressure by 11 mmHg and diastolic by 8.5 mmHg. Combining various hypertension drugs decreases blood pressure by an average of 18 mmHg (sys-

tolic) and 12 mmHg (diastolic), with increased side effects (National Institute of Health, 1997).

Audio Visual Entrainment (AVE) is the repetitive and intermittent presentation of light and sound. AVE affects electroencephalographic (EEG) output, purports to alter perception and consciousness. AVE has been used to improve grade-point average in college students. AVE can induce relaxation and hypnotic states. AVE has been used to reduce chronic pain, to treat migraine headache and to treat depression and reduce anxiety. AVE has been used as a treatment for low-arousal brain disorders such as pre-menstrual syndrome, chronic fatigue syndrome, fibromyalgia and seasonal affective disorder (Siever, 2000; Joyce & Siever, 2000).

Method

An eight-week study of 28 hypertensives (under drug therapy) was conducted to test the effectiveness of audio-visual entrainment (AVE) in the sub-delta frequency (0.5-1 Hz) and alpha frequency ranges. Blood pressure, depression and anxiety were measured throughout the study. Alpha frequency AVE has shown strong effectiveness in reducing depression and anxiety. However, the group was neither depressed nor anxious so the benefits of alpha AVE were uncertain.

Clinical observations were also conducted with an anxious group using the "Freeze Framer." High sympathetic and para-sympathetic activity using spectral analysis of heart variability was observed.

Results

Surprisingly in the non-anxious, non-depressed group, sub-delta AVE had marked effects on blood pressure, reducing the systolic 20 points and diastolic 15 points. Within the anxious group, AVE in the low alpha range produced a strong normalizing affect on autonomic activity and rate variability.

Conclusion

Sub-delta stimulation reduced high blood pressure more than when using a combination of hypertension meds. Alpha AVE was not as effective as sub-delta AVE partly because alpha AVE was introduced in the second month of the study and some hypertension had already been reduced. Also, alpha AVE is particularly effective in treating anxiety and depression, which were not factors in this study.

Sub-delta AVE has also been effective in treating some cases of fibromyalgia and attentional disorders and may uniquely affect physiological systems in the body. It appears that low-alpha AVE normalizes heart function in this case by dissociating the person out of self-inflicted anxious thoughts.

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Case Study of Trigeminal Neuralgia Using Neurofeedback and Peripheral Biofeedback

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Introduction

Trigeminal neuralgia (TN) or tic douloureux is one of the most painful conditions known. Characterized by brief episodes of intense, stabbing, electrical shock type pain in the face, the pain (which can be temporarily disabling) comes on spontaneously or may be triggered by light touch, talking, eating, drinking, chewing, tooth brushing, hair combing, water from a shower, kissing or changes in temperature (i.e., cold). Common treatments include pharmacotherapy and destructive and non-destructive procedures (Das & Saha, 2001).

This case is a 46-year-old nurse with trigeminal neuralgia of 15 months duration. She also had sleep disturbance, bruxism and hypothyroidism. Traditional medication was ineffective for pain control and resulted in side effects she could not tolerate. She had been maintained on Darvocet for the past year. Alternative medicine treatments were not effective. The next planned intervention by her neurologist was to sever the trigeminal nerve.

Method

Neurofeedback (T4-A2, C3-A1 and T3-T4) and peripheral biofeedback techniques were used along with stress management and cognitive behavioral therapy.

Results

Over the course of 37 weeks, 29 neurofeedback sessions and 10 peripheral biofeedback sessions, this client's pain was dramatically reduced and significantly controlled. The C3-A1 and T3-T4 neurofeedback placements (Othmer & Othmer, 1999) appeared to be the most effective in symptom reduction. Peripheral biofeedback sessions, primarily EMG were helpful in reducing dysponesis. She eliminated the 100 mg Darvocet with 650 mg Tylenol. At six month follow-up, she is maintained on 25-50 mg of Ultram per day. The client emphasized her strong feeling that incorporating the peripheral biofeedback (particularly the EMG techniques) into the neurofeedback program was an integral part of her success in managing this very painful condition. She is most pleased to avoid the facial surgery.

Conclusion

This unusual treatment of T3-T4 neurofeedback along with peripheral biofeedback, stress management and cognitive behavioral therapy may offer an alternative to medication and surgery for trigeminal neuralgia sufferers.

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Preliminary Findings of Effectiveness of Biofeedback and Neurofeedback Modalities in an Integrative Treatment Program for Eating Disorders

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Introduction

Eating disorders have one of the highest mortality rates of any DSM-IV diagnosis (Fichter & Quadflieg, 1999) and research indicates that traditional treatment methods have not been very effective. In contrast, Mirasol's residential treatment program incorporates both traditional psychotherapeutic modalities (individual, group, family) and alternative therapies (autonomic and EEG

biofeedback, polarity, naturopathic and acupuncture/Chinese medicine). This pilot study assessed the effectiveness of Mirasol's integrative treatment approach and preliminary QEEG findings.

Method

All women were independently diagnosed with an eating disorder prior to admission. At intake each patient was administered a Test of Variables of Attention, MMPI-2, Beck Depression Inventory-2, Eating Disorders Inventory-2, Eysenck Personality Inventory, Tellegen Absorption Scale, and Marlowe-Crowne Test. The same measures were re-administered four weeks later. Weight was monitored weekly. One-third of the women also received QEEG evaluation. Participants received an average of eight sessions of polarity, acupuncture, autonomic biofeedback, and 12-16 sessions of EEG biofeedback. Patients were enrolled in daily group treatment and two individual psychotherapy sessions per week. Protocol selection in EEG biofeedback was based on a combination of symptom complaints, TOVA scores and/or results of QEEG analysis.

Results

Data from 18 anorexic and 51 bulimic women were analyzed. T-tests revealed significant decreases in BDI scores, Neuroticism scores, and all EDI subscale scores, and a significant increase in Extraversion scores for both anorexics and bulimics. In addition, anorexics gained weight significantly. All tests were significant at the .03 level. QEEG findings in the 22 cases where LORETA QEEG data was available demonstrated 100% had cingulate abnormalities. QEEG analysis also revealed the following on a sample of 23 cases: elevated frontal slowing (82.5%), elevated posterior slowing (90%), elevated Beta (61%), and coherence abnormalities in 100% of the cases.

Conclusion

These results demonstrate significant improvement in mood and relevant personality characteristics and the EDI showed reduced eating disorder symptoms. Weight changes were in the desired direction for both over- and under-weight patients. Initial QEEG data in the 22 cases using LORETA analysis showed 100% had cingulate abnormalities, suggesting that eating disorders are likely to be an OCD spectrum disorder.

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EEG Differences Between TBI Patients with Attention Deficits and Controls During Cognitive Tasks and Second Resting Baseline

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Introduction

According to previous research, different regions of the brain are activated when a person is required to use different types of attention like selective, alternating, focused, sustained or divided attention. According to research with positron emission tomography (PET) scans the frontal, prefrontal, and parietal areas (especially in the right hemisphere), seem to be the most frequently activated areas during tasks requiring attention. Previous research was not able to differentiate among different types of attentional deficits using electroencephalogram (EEG) baseline. This research addresses differences in the EEG between traumatic brain injured (TBI) patients with different types of attentional deficits caused by their injury and a non-clinical population, while performing cognitive tasks or post-tasks resting condition.

Method

This study is focused on differences in EEG absolute power between TBI patients and non-clinical controls during cognitive tasks and post-tasks resting condition. The participants consisted of 10 individuals with TBI and 10 non-clinical controls (matched for age and gender).

The attention skills of the experimental (TBI) and non-clinical controls were assessed through a variety of psychometrics as well as through scaled self-reports. Psychometrics included the Digit Span and Digit Symbol from WAIS-R, the Paced Auditory Serial Addition Test (PASAT), and the Integrated Visual and Auditory (IVA) test. EEG was recorded during eyes-open and eyes-closed resting conditions, six cognitive tasks (taken from the software program Captain's Log), and a post-tasks eyes-open resting condition. Analysis included one cognitive task and the post-tasks eyes-open resting condition. The cognitive task examined is an auditory task where the person discriminates among different types of melody. EEG from eyes-open baseline was subtracted from task and from post-tasks eyes-open resting condition. These EEG differences were compared between clinical and non-clinical individuals.

EEG was recorded with 19 channels according to the 10/20 International electrode placement system. Channels F1, F2, T3 and T4 were omitted during statistical analysis because they were contaminated by muscle artifact or eye movements. The rest of the 15 channels were grouped into five brain areas.

These five groups consisted of the frontal right (F8, F4), frontal left (F7, F3), central (FZ, CZ, PZ, C3, C4), right posterior (P4, T6, O2) and left posterior areas (P3, T5, O1). Four frequency bands were examined: theta (4.5-7.5 HZ), low alpha (8-10 Hz), high alpha (10.5-12 Hz) and low beta (12.5-21.5 Hz).

Results

Significant differences were found between the clinical and the non-clinical controls during task and post-tasks eyes-open resting baseline. Most of the differences were found during the task condition. Depending on the type of attentional deficit, EEG differences occurred in the frontal or posterior regions, replicating previous research with PET scans. Moreover, EEG differences were found in all four frequency bands but mostly in low alpha and low beta.

Conclusions

The EEG results of this study show that different types of attentional deficits have different EEG patterns. These results encourage future researchers studying attentional deficits to take into consideration the specific type of attentional deficit. A final point to consider is also the possibility that the different types of attentional deficits are not easily shown through a resting baseline but during cognitive tasks or in the post-tasks resting condition.

Pathologies of Regional EEG Comodulation: Issues and Interpretation

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Introduction

The comodulation metric is based on the correlation of trends in calculated spectral magnitudes across time between electrode pairs in selected relevant frequency bands and during given states. As such it discloses the underlying regional integration of neuronal networks that is specific to these bands and states.

Method

It has been shown that disturbed eyes-closed comodulation patterns arising from the precise dominant posterior frequency of a given individual can iden-

tify specific integration abnormalities. Other abnormalities are disclosed by tracking relevant frequencies during engaged states. Many of these findings have been validated by alternate imaging methods and histories of surgical interventions.

Findings

A spectrum of meaningful comodulation patterns has been observed thus far with this metric, and appears to reveal and/or clarify various clinical pathologies. To date distinctive patterns have been observed in association with seizure pathology, closed head injuries, somatic disorders, visual disturbances, and affective syndromes.

Conclusions

Use of the comodulation metric can identify disturbed patterns of functional integration that both confirm expected pathologies and identify more subtle corruptions of organization. Proper use of this metric, however, depends upon a clear understanding of QEEG methodological issues and a grasp of relevant physiological mechanisms.

Stimulation of Acupuncture Points Enhances SMR Amplitude in the Treatment of Seizure Disorders

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Introduction

Stimulation of eight acupuncture points enhances the amplitude of SMR. This stimulation protocol was derived from a more elaborate protocol associated with an energy psychology technique.

Method

Seizure disordered clients self-administered stimulation of eight acupuncture points during QUICK QEEG intake assessment.

Results

SMR at location C4 increased in amplitude (microvolts) on average by 26.9% ($SD = 14.1$, $p < .01$). Case examples of seizure disordered clients treated

with neurotherapy and the acupuncture stimulation protocol indicated markedly accelerated treatment and often the ability to abort impending seizure activity.

Conclusion

Self-administered acupuncture point stimulation facilitates SMR enhance/Theta inhibit neurotherapeutic treatment of seizure disorders.

Helping Autistic Spectrum Disorders

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Introduction

Autistic spectrum disorders have core symptoms "characterized by the triad of impairments of social interaction, communication, and imagination associated with a narrow range of repetitive activities" (Wing, 2001, p. xiv). Relevant DSM-IV diagnostic codes are Pervasive Developmental Disorder (PDD) and Asperger's Syndrome (AS). Delayed language is not characteristic of AS. They want to have social interactions but lack the social graces to do it appropriately. They often present like little professors with extensive knowledge in their area of interest. Symptoms overlap with Attention Deficit Disorder.

Incidence is on the rise and currently one child in 150 is affected. Brain differences include: smaller cells in the limbic system (Bauman, 2001), larger brains due to more growth in grey and white matter during the first three years of life (Courchesne et al., 2001), fewer Purkinje cells in the cerebellum (Courchesne), different activation of the fusiform gyrus for facial recognition (Pierce, Muller, Ambrose, Allen, & Courchesne, 2001), and abnormal interaction between frontal and parietal brain areas (Pavlakis, 2001). EEG brain maps show less activation in the areas of the right hemisphere that process emotional information (unpublished data from Gunkelman).

Method

The charts for over 50 clients with autistic spectrum disorders, age five to fifty-one, are being reviewed to check EEG patterns and to determine if these clients have benefited from neurofeedback training. Information includes EEG assessments, medication status, parent questionnaires, clinical observations, IQ testing, continuous performance tests and academic measures. Full

testing was not possible with all clients but minutes of EEG data was always obtained at intake (CZ placement, eyes open), artifacted and analyzed using Lubar's protocol with the Autogen A620. Training parameters were based on the client's symptom picture, EEG pattern, and knowledge of cortical functions. The most frequent intervention was to decrease the client's dominant slow wave frequencies while enhancing 13-15 Hz activity with placement at Cz or C4 referenced to the right or the left ear, respectively. When full cap assessments showed excessive slow wave activity at other locations (P4, T6, FZ, F3, Fp1) these sites were also used. Coaching in metacognitive strategies was done as appropriate for academic levels.

Results

EEG patterns resembled ADD patterns but amplitudes tended to be more extreme. Excess slow wave activity in either the delta through theta range or excess alpha activity was found. Peaks at 7 Hz had the morphology of pediatric alpha. Full cap assessments showed slowing (excessive low alpha, 8-10 Hz) in the right parietal region (P4) and some slowing at T6. There was high amplitude theta at FP1, F3, Fz and Cz. There were also differences in coherence and comodulation.

Sufficient training (sometimes more than 100 sessions) consistently produced a decrease in theta/beta ratio with the clearest change being an increase in SMR. IQ increases of about 10 points were found. TOVA data were inconsistent: autistic children could not complete the test and Asperger's children often scored well even prior to training. Parents noted improved social interactions: children went from having no friends to initiating and maintaining some peer friendships. The largest improvements were in those who received more than 80 sessions. Autistic clients were all difficult to work with. Those with AS were easy to work with once they knew the routines.

Discussion

EEG differences observed in autistic spectrum disorders provide a rationale for using neurofeedback. Excess slow wave activity corresponds to being more in their own world; low SMR is consistent with fidgety and impulsive behaviour and also with the tactile sensitivity exhibited by many; high left prefrontal and frontal slow wave activity is consistent with lack of appropriate inhibition; high slow wave activity in right parietal-temporal area is consistent with inability to interpret social cues and emotions. Improved social interaction found in conjunction with EEG shifts makes sense: more activation means more alert to the outside world and thus better able to benefit from socialization efforts. The positive results support neurofeedback as an intervention in autistic spectrum disorders, particularly Asperger's syndrome. Further research could build on these observational data.

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Efficacy of Average Compared to the Best Therapists in Neurofeedback

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A study of selected published papers (references follow) that used TOVA scores to report gains show some unexpected results. From these the pathway to improvement can be seen. Also, from these scores the duration of average number of sessions required for normalization of TOVA is predicted.

The best therapists required slightly less than half as many sessions as the average therapists. Efficacy was independent of the instrumentation used by the therapists or therapist technique. The number of required sessions depended only on therapist quality and initial client scores.

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Using LORETA and the Counting Stroop to Study Early Stage Alzheimer's Patients

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Introduction

The U.S. population is aging and the diagnostic and health care costs related to diseases associated with aging are frightening to contemplate for the future. Developing inexpensive diagnostic and study methods for these diseases is clearly desirable. One disease in particular that is currently difficult to identify with available brain imaging and behavioral diagnostics is Alzheimer's Disease (AD). The gold standard for AD diagnosis is still autopsy in which diseased brains show evidence of the pathology: senile plaques and neurofibrillary tangles. The research being reported utilized a technique called Low Resolution Tomographic Analysis (LORETA) to study early stage AD patients and similar aged, healthy controls during the Counting Stroop, a cognitive task that is analogous to the Color-Word Stroop (Bush et al. 2000), to evaluate its efficacy as a diagnostic and study tool in the early stages of Alzheimer's disease.

Method

Participants were early stage AD patients (n = 6) and similar aged healthy controls (n = 8). EEG recordings were conducted with Lexicor's V4.1E software and a 19-channel electrode cap utilizing the 10-20 international electrode placement system. Impedance was kept below 5 kilo-ohms and the sampling rate was 128 samples per second. Relative power bands were defined as delta (2 -3.5 Hz), theta (4-7.5 Hz) and beta 1 (13-21.5 Hz). The computerized stimuli came from the Counting Stroop: incongruent stimuli (IS) and the neutral stimuli (NS).

Within groups statistical evaluation was accomplished by subtracting the NS data from IS data for the group aggregate and non-parametric t-tests performed with LORETA Wizard. The LORETA-KEY was used to provide 3-dimensional images of intracerebral EEG-data.

Results

Between groups comparisons demonstrated obvious pattern and relative power differences that support current research in the AD field. However, the within group t-score comparisons did not reveal any significant activation differences between the IS (hard task) and the NS (easy task) across all 3-D neural locations.

The two groups, AD and healthy controls, differed in the use of what is typically labeled as delta, theta and beta 1 activity. In particular, the AD group produced 2 to 3.5 Hz, 4 to 7.5 Hz, and 13 to 21.5 Hz frequencies during the IS task in the left and right temporal lobes while the controls produced it during the NS task. Also, the AD group turned on 2 to 3.5 Hz activity at the anterior cingulate (Brodmann area 24) during the IS task while the control group demonstrated the activity during the NS task.

As of the date of the submission of this abstract, a statistical program to compare the two groups' patterns within the LORETA purview is being developed by a colleague, Marco Congedo, MA. These results will be added to the presentation if available.

Conclusions

In the literature, one of the primary relative power differences observed with quantitative electroencephalography (QEEG) between patients with moderate AD and their healthy contemporaries is that AD patients produce more 4 to 7.5 Hz (theta) activity during eyes-closed resting conditions. As the severity of the disease progresses, 2-3.5 Hz (delta) activity increases and 13-21.5 Hz (beta 1) activity decreases (Coben, Danziger, & Storandt, 1985; Jelic et al., 2000). Though the outcomes of this investigation were the result of cognitive tasking, this study found between group differences in each of those frequency ranges. These results were obtained with AD patients in the early stages of the disease.

The temporal lobe is one of the first cortical areas to show evidence of atrophy in AD patients (Kaye et al., 1997). According to research by Kaye et al., the temporal lobe volume (measured without the hippocampal tissue or parahippocampal gyrus regions) in preclinical dementia participants changed more over time (decreased) than that of the healthy participants. Their supposition is that the disease process may be in motion (e.g., temporal lobe volume loss) as much as six years prior to the onset of clinical dementia symptoms. This project's demonstration of cognitive task activation differences in the delta, theta and beta 1 bands between the early stage AD group and the control group lend support to the conclusions of Kaye and colleagues.

Finally, the Counting Stroop has been demonstrated with fMRI to show increased anterior cingulate activity during the IS task in healthy normal people (Bush et al., 1998). The cingulate has been implicated in neural attention circuitry. This project has demonstrated a differential use of the 2 to 3.5 Hz (delta) activity between the groups during the IS task. The AD group turned on the lower frequency during the IS task while the control group utilized it during the NS task. The NS task is the easier of the two tasks and doesn't instigate the attentional conflict and as such would not be expected to demonstrate activity above that of the IS task at the cingulate.

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Six Case Studies Examining the Effectiveness of a Comprehensive Adaptive Approach to Neurofeedback for Attention Deficit in an Educational Setting

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Introduction

Six AD/HD elementary school students completed 19 hours of neurofeedback training over six months averaging 45 sessions. Five of the six students measurably improved in parent/teacher report and/or objective data relatively congruent with QEEG analysis. Improvement seemed related to lower theta/beta ratios. This comprehensive adaptive approach is theoretically based upon restoring neurological flexibility and resilience, allowing circadian rhythms to renormalize and functionality to emerge (Brown, 2002).

Method

Three male and three females, ranging 9-12 years old, attending a private learning center specializing in dyslexia were previously diagnosed with AD/HD. Five out of six were taking 15-20 mgs of various psychostimulant medications. Evaluation measures included QEEG analysis with theta/beta ratios (Monastra et al., 1999; Lubar, Monastra & Linden, 2001), IVA, Stroop, WISC-III ACID subtests, ADDES behavior ratings and a Likert scale of improvement evalua-

tion. QEEG data was analyzed in terms of absolute and relative magnitude, as well as in terms of theta/beta ratios. Theta-beta ratios averaged across 19 channels ranged from 1.40 to 7.69.

Active electrodes sited at C3 and C4, referenced and grounded on ipsilateral ear lobes, input to two channels of the ProComp+ that fed data to a KeyData laptop accommodating NeuroCarePro software with dual monitor capability. Approximately thirty seconds of baseline were recorded before and after each session. Inhibits targeted 2-6 Hz delta/theta, 8-13 Hz alpha under eyes-open conditions, and 23-38 Hz high beta at all times, producing visual and auditory feedback when the emergent median remained within a neighborhood defined by no more than 80% divergence. Feedback for all targets, including augments, was disabled by default if excursions occurred outside inhibit boxes. Visual and auditory information also reflected feedback if the mean of the median remained within 12-15 Hz SMR on the right, 16-20 Hz beta on the left, 21 Hz and 40 Hz, either separately or simultaneously using comprehensive portals. Excursions outside augment boxes had no effect on other targets. Changes were monitored by NeuroCarePro snapshot spectral analysis comparatives.

Results

Medication titration began within 7-10 sessions. The only child not on medication maintained unprecedented straight A's and is returning to mainstream schooling. One student discontinued medication and four reduced to half the original dosage, two of which demonstrated consistent success in cognitive measures, transfer of benefit, and stabilization of medication reductions. Two with severe theta/beta ratios were inconsistent in measures and returned to two-thirds and original dosage levels respectively with positive report the last two weeks of school. QEEG analysis echoed other measures in varying degrees consistent with previous findings (Chabot, Merkin, Wood, Davenport, & Serfontein, 1996).

Conclusions

Without a control group cross-validating results, a systematic simultaneous procedure under relatively controlled conditions with single case studies can be regarded as a between-person replication of objective and subjective data (Barabasz, Barabasz, & Blampied, 1996). The present study replicates findings five out of six times in support of previous results found in neurofeedback research (Lubar & Lubar, 1984; Lubar, Swartwood, Swartwood, & O'Donnell, 1995; Linden, Habib, & Radojevic, 1996; Thompson & Thompson, 1998). That training effects were replicated with varying degrees of severity on different types of psychostimulants within a rotating schedule following an adaptive

protocol, increases confidence in the effectiveness of this comprehensive approach to neurofeedback for AD/HD. One and possibly three-year follow-up will assess longevity. Further research may confirm the seeming correlation between consistency of success and degree of theta/beta ratio.

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QEEG in Death Penalty Evaluations

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Introduction

Death penalty cases are complex and require comprehensive evaluations in order to provide adequate mitigating information in the penalty phase. A com-

prehensive evaluation should include neuropsychological and neurophysiological measures to properly evaluate the brain function of the individual. QEEG is a valid and useful neurophysiological measure in these cases.

Methodology

Comprehensive evaluations were performed with over 20 death row inmates. The evaluations consisted of obtaining extensive psyco/social developmental history, comprehensive neuropsychological testing and QEEG. The cases were at different stages in the legal process (pre-trial, post-conviction, habeas-corpus). Some of the defendants had previously been evaluated and others had not. None of the defendants had received a valid neurophysiological measure of their brain function. The evaluations were performed in a culturally competent manner.

Results

All of the evaluated individuals presented with significant brain dysfunction. The results were consistent with the psycho/social/developmental history and had ecological manifestations over the life span. In several cases the neuropsychological testing was unable to provide clear and definite information regarding the brain dysfunction. In all cases QEEG showed significant lack of comodulation consistent with acquired and/or developmental brain dysfunction.

Conclusion

QEEG is a valid neurophysiological measure that should be included in all comprehensive evaluation of brain functions. QEEG has many advantages over other neurophysiological measures and therefore is the method of choice to be included.

QEEG Reference Database Evaluation of Adult ADHD: Follow-Up Analyses with LORETA

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Introduction

White and Lubar (2002) suggested that QEEG normative reference databases may potentially provide additional markers for adult ADHD other than

traditional amplitude or power ratios. In that study, both eyes-closed and eyes-open EEG baselines were analyzed with the NeuroRep QEEG Analysis and Report System (Hudspeth, 2000) and the Sterman-Kaiser Imaging Laboratory's (SKIL) Topometric Software Package (Sterman & Kaiser, 2000). The most notable potential markers identified were right prefrontal hypo-phase in the 13 to 22 Hz band and frontal hypercomodulation at the dominant frequency, which was often in the 9 to 10 Hz range (White & Lubar, 2002).

Method

The present study further investigates potential QEEG markers by incorporating the use of Low Resolution Electromagnetic Tomography (LORETA) for the same 10 adults with ADHD. The previous results gained from comparison against the adult QEEG reference database (Hudspeth, 2000) and the SKIL adult database (Sterman & Kaiser, 2000) will be used to guide the present investigation of current source density as measured by LORETA. All LORETA image files will be created with the aid of the EEG Workstation (Congedo, 2001) and viewed with the LORETA-KEY software (Pascual-Marqui, Michel, & Lehmann, 1994).

Results and Conclusion

Results of the LORETA analyses for each individual's eyes-closed and eyes-open baseline dominant frequency revealed that the modal location of the current source density generators were typically in the visual association cortex. For the eyes-closed condition, the modal generator was found in Brodmann Area 19, primarily the lingual gyrus. For the eyes-open condition, the modal generators were in Brodmann Areas 19 and 30, including the lingual gyrus, posterior cingulate, and parrahippocampal gyrus. These results and possible implications will be discussed with regard to the previous QEEG findings.

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Executive Profiling: QEEG and BF in Assessment and Training of Executives

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Introduction

This pilot project investigated the use of neurofeedback and biofeedback within an integrated assessment and training program for enhancing the health and performance of top-level executives.

Method

Five pharmaceutical executives had a QEEG, IVA Continuous Performance Test, a Stress Profile (HR, RR, 2EMG, RR, Temp) under baseline, stressors and recovery, and a paper and pencil Self Regulation Assessment to determine personal risk factors (personality, family background, life style) and success enhancement factors (hardiness, attention, cooperation, etc.).

Results

Results showed three had abnormal QEEGs while the other two had moderately abnormal results as assessed by a neurologist. Three had elevated EMGs, three had breathing disorders, two had extremely low temperatures and four EDRs did not return to baseline during testing. The IVA showed high impulsivity and mind wandering in three executives. Type A behavior with perfectionism, poor life style habits, and family histories were common risk factors among most executives. Enhancement factors were universally high hardiness scores and good communication/cooperation scores. Subjective assessments were more favorable than objective measures. Intensive feedback interviews confirmed the validity of the profiles and determined the areas for training. All executives reported that the QEEG was the most impactful and the first they wish to train.

Conclusion

Performance and health enhancement must include objective and subjective assessment of both the mind and body prior to training top level executives. Top-level highly functioning executives have areas that can be improved and the use of the QEEG is highly viewed as part of self-discovery and personal enhancement.