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General Conference Presentations Abstracts

Peak Alpha Frequency Neurofeedback Training for Cognitive Enhancement in the Elderly: A Pilot Study (R/C)

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Introduction

Electroencephalographic (EEG) peak alpha frequency (PAF) has been shown to have a positive relationship with cognitive performance across individuals and across states within individuals (Angelakis, Lubar, Stathopoulou, & Kounios, 2004). After the age of 20, PAF is inversely related with age (Kopriner, Pfurtscheller, & Auer, 1984). The present pilot study used a double-blind controlled design to investigate whether training older individuals to increase PAF would result in improved cognitive performance.

Method

Six healthy elderly individuals (age 70 to 78) volunteered. Three were trained to increase their PAF, two were trained to increase their alpha amplitude, and one was pseudo-trained with neurofeedback playback. All participants were “blind” to their condition. Cognitive performance was assessed by “blind” testers before and after 31 to 36 sessions of neurofeedback training (averaging 24 minutes).

Results

PAF neurofeedback (NF) seemed to improve mental processing speed and executive functions, but have no effect on memory, or even negative

effect on visual memory. On the contrary, alpha amplitude NF seemed to improve verbal, visual, and working memory, but worsen story memory, speed of processing, and executive functions. Pseudo-NF had some effects similar to alpha amplitude but smaller in size.

Conclusion

In the elderly, PAF NF may be promising to reverse mental slowing, whereas alpha amplitude NF may improve some memory functions and worsen others. Moreover, the present controlled study presents preliminary evidence that cognitive effects of NF are due to specific EEG manipulation rather than to non-specific placebo factors.

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The Neurofeedback Value of Photic Driving

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Introduction

In 1934, the effects of intermittent phonic stimulation (IPS) were studied. Using IPS, changes in electroencephalogram (EEG) activity were demonstrated (Takahasi, 1998). Studies of visual response often examine only the Brodmann area V1 (BA; Dowling, 1998). Shealy observed positive effects of photic driving on neurotransmitters. Broadal and Regan demonstrate that "simple photic driving" involves complex pathways for the visual signal (Collura, 2002). Visual disturbances show many BAs are involved (Zeki, 1993). Cognitive activation through visual perception activates additional BAs (Cabeza & Nyberg, 2003).

Method

Subjects were selected by a random process for neurofeedback (NF) training sessions using photic driving based on a time-frequency algorithm of the EEG using a new photic driving device, Nexis. Additionally, the subjects were supplied sight and sound feedback using NeuroCare Pro. Twenty-one channel EEG recordings were obtained before each subject began NF training. The EEG was studied and QEEG database reports obtained from NeuroGuide and LORETA. Training targets across the cortex were selected using a combination of criteria.

Results

The post-QEEG and LORETA reports showed significant Z-score improvement. Statistical data in NeuroCare Pro also showed statistical improvements.

Conclusion

Photic driving based on criterion relevant to the QEEG outlying data provides an increase in the robustness of NF.

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Targeting Higher Than Beta Frequencies: Using 7 Hz Resonances as a Basis for Targeting

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Traditional targeting approaches are based on decades-old band designations like beta, alpha, or theta among others. Even when these

bandwidths are “tuned” in some fashion, the basic phenomenology remains. Although there has been limited interest in 40 Hz or gamma-based training, most amplifier systems are incapable of operating effectively in that target range. This problem is exacerbated further when targeting is attempted above this range, particularly in countries in which the main current is 50 Hz 220 V.

ProComp© and other specific EEG amplifiers do, in fact, allow for reasonable acquisition of targets up to their 60 Hz anti-alias filters. This means that, if software is crafted correctly, one can capture and feedback 40 Hz centered activity, as well as activity at considerably higher frequencies such as 47-48 Hz and 54-56 Hz. These frequencies can also be adequately captured and used as the basis for neurofeedback training even in 50 Hz 220 V environments if one also uses an adaptive in-line de-noising routine such as that found in NeuroCare Pro©.

This presentation discussed de-noising techniques and the use of such 7 Hz “resonance” based targeting which includes 7, 14, 21, 28, 35, 40, 47-48, 54-56 Hz, using NeuroCare Pro© and provided both a theoretical rationale and practical guidelines for a novel and interesting way to provide neurofeedback training.

Infrared Imaging of the Frontal Cortex

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Introduction

Infrared imaging is a promising and exciting new tool for the assessment of brain and, especially, frontal lobe functioning. Thermographic imaging has been shown (Shevelev, 1998) to be a dynamic, non-invasive, contact-free method of neuroimaging that has high temporal and spatial resolution and sensitivity. Carmen (2003) has shown specific infrared measurements to be related to certain brain states and sensitive to the effects of treatment. Such images are related to the activity, thermal responses and cerebral blood flow of the cerebral cortex.

Method

We have collected infrared images of patients in various diagnostic groupings. These have included those with migraine, depression, anger, anxiety, pain, ADHD, learning disabilities, autism, Asperger's syndrome, PDD, CVA, traumatic brain injury, mild traumatic brain injury and others. These images have been digitally analyzed to detect patterns and regional thermal differences associated with these problems/brain states. Such images have also been collected before and after pirHEG, nirHEG and neurofeedback sessions.

Results

Digital analysis of these infrared images showed brain correlates related to these various patient problems and/or disorders. Information was presented to suggest that infrared imaging is sensitive to various brain pathologies and/or dysfunctions and that it represents a valid and novel approach to the assessment of brain functions. Data was also presented to show that these images can be used to measure treatment effects and outcomes.

Conclusion

Infrared thermographic imaging has been shown to be a valid and sensitive means of measuring brain regional activity in areas not covered by hair. Such images can be collected in a non-invasive, rapid, dynamic manner so that changes in brain states and blood flow can be validly assessed as well. These may also be used to measure the effects of various neurophysiologic treatments. Implications for assessment, treatment planning, and outcome measurement were discussed.

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Wireless Videoneurofeedback for Peak Performance Training*Jonathan D. Cowan, PhD*

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One of the major thrusts of peak performance training with neurofeedback is to discover and optimize the sequence of focus and alertness during the mission-critical activities of athletes and executives. This presentation showed how to use a new tool, the neurovideo, to help clients understand themselves in a different way. In the same way that motion analysis can be used to understand and point out flaws in a golf or tennis swing, we can now use the neurovideo to examine the changes in focus (concentration) and alertness (mental energy) as someone performs an activity. New hardware and software now allow the PC to be used to record these sequences by simultaneously capturing video and EEG. The prefrontal brainwave pattern is instantaneously analyzed with the InAll and Alertness protocols during both recording and playback. A wireless connection between the sensors/preamp and the computer simplifies the recording of the EEG data in the office or on location.

Working with a client, we can stop the motion and examine what just happened in great detail, asking questions like:

1. What was he doing and thinking when his focus and alertness were maximum?
2. Looking at the critical moments of the activity, what can we learn about the sequences of focus and alertness that accompany them?
3. Are there differences between these patterns that are associated with success and failure?
4. Are there differences in these patterns between peak performers and duffers?
5. Are there times when the client is overusing alertness/mental energy and depleting his reserves?

This procedure is actually the first step in a new form of biofeedback, neurovideofeedback. Additional steps were discussed and several examples shown of how it can be used to help clients understand and optimize their sequences of concentration and alertness.

On the Neuropsychological and Electro cortical Impacts of Mixed Mold Exposure

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Introduction

A multi-center review of medical records was utilized to assess the psychological, neuropsychological, and electro cortical impact of exposure to mixed colonies of toxigenic molds.

Method

One hundred eighty-two (182) patients with confirmed mold exposure history completed clinical interviews, the SCL-90 symptom checklist, limited neuropsychological testing, quantitative EEG with neurometric analysis, and measures of mold exposure.

Results

Patients reported high levels of physical, cognitive, and emotional symptoms. Ratings on the SCL-90 were moderate to severe with a factor reflecting situational depression accounting for most of the variance. Compared to premorbid estimates of intelligence, findings of impaired cognitive functioning on multiple cognitive tasks predominated. Quantitative EEG results included narrowed frequency bands and increased power in the alpha and theta frequency bands, most frequently located in the frontal areas of the cortex. Measures of toxic mold exposure predicted QEEG measures and neuropsychological test performance. Both measures of exposure and QEEG measures were significantly related to cognitive test performance. Psychological factors appeared to have only a limited relationship to QEEG results, reflective of the arousal level of the frontal lobes.

Conclusion

Most patients are suffering from problems of acute stress, adjustment disorder, or post traumatic stress. Differential diagnosis confirmed an etiology of a combination of external stressors along with organic metabolically-based dysregulation of emotions and decreased cognitive func-

tioning due to toxic or metabolic encephalopathy. Neuropsychological testing reveals impairment similar to mild traumatic brain injuries. The QEEG findings indicate a hypo activation of the frontal cortex, possibly due to brainstem involvement and insufficient excitatory input from the reticular activating system. Findings of a dose response relationship between measures of exposure and the outcome of neuropsychological tests and QEEG measures suggest that toxic mold can cause central nervous system dysfunction. Study limitations include lack of a comparison group, possible patient selection bias, and incomplete data sets to allow some comparisons among variables.

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The Efficacy of Attention Training for Children with ADHD: A Double-Blind Placebo-Controlled Study

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Introduction

This study's main objectives were to recruit children with a primary diagnosis of ADHD to participate in an attention training (EEG biofeedback) paradigm to determine the effect of this treatment on the cardinal symptoms of ADHD. This was the first study to utilize a placebo condition and double-blind interface with this type of treatment.

Methods

The design of the study consisted of a diagnostic workup, 40 sessions (with a crossover after 20 sessions), and pre-, mid-, and post-assessments. Testing measurements were parent, teacher, and self-report rating scales, and a continuous performance test. During the sessions each child played Sony PlayStation games with an active sensor placed at FZ. The children were randomized into two groups. Group 1 received 20 sessions

of brainwave-modulated videogames and then received 20 sessions with the videogames while brainwave activity was monitored. Group 2 received treatment in the opposite order.

Results

Results are based on 53 seven- to 11-year-old children. The primary analysis used in this study was Hierarchical Multivariate Linear Modeling (HMLM). The outcome measures used to determine the efficacy of this intervention (experimental vs. placebo-control) were divided into five domains: (a) ADHD symptoms, (b) aggression and conduct problems, (c) internalizing symptoms, (d) adaptive skills, and (e) academic performance. There were ten significant findings ($p < .000$) across all the domains for the experimental group compared to the control group.

Conclusions

In summary, the attention training via EEG biofeedback showed many significant improvements in the experimental versus the placebo-control condition. Some of the measured improvements included: (a) reduced hyperactivity and improved attention; (b) less aggressive behaviors; (c) better adaptability to change, interacting more successfully with others, improved organizational skills; and (d) children showed improved responding and attention on a computerized attention task. Additional findings and implications were discussed.

Preliminary Data from Comparison of Electrophysiology and Cognitive Profile of 50 ADHD Subjects to the International Brain Database: Implications for Treatment Predictive Validity and Individualized Treatment

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Introduction

Abnormalities in electrophysiology of the brain in subjects with ADHD have been established in many previous studies. However, many of these studies lacked the use of activation tasks, ERPs, cognitive profiles, and standardization.

Method

Electrophysiology and cognitive profiles of 50 ADHD subjects were compared to the International Brain Database. EEG, ERPs, and autonomic measures were recorded during various activation tasks using a 32-channel Neuroscan amplifier. A cognitive screening test battery was also administered to assess attention, memory, impulsivity, motor functions, and executive functions.

Results

ADHD subjects showed a pattern of disturbance in the electrophysiology of the brain and cognition. For the purpose of developing predictive validity for treatment response, discriminant function analyses were run with different sets of variables on the 28 ADHD subjects, comparing the scores on the test battery before and after medication to determine which variables were the best predictors of favorable response to ADHD medication.

Discussion

Using a combination of psychophysiological and cognitive profile, prediction of group membership (responders vs. non-responders) was established with 92.2% accuracy. It was suggested that the same methodology could be used to establish prediction of treatment efficacy for neurofeedback. In addition, treatment efficacy using various neurofeedback protocols can be examined using a similar model.

The FPO2 Baby: The Observed Effects of the Mother's Neurofeedback Training at FPO2 on Pre- and Post-Natal Development of Her Infant

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Introduction

“The FPO2 Baby” is a case study of the effects of FPO2 training on the mother and her infant pre- and postnatally. We observed “in session” ef-

fects on fetal movement and we continue to observe exceptional levels of regulation as manifested in sleep, temperament, and achievement of developmental milestones through the first 15 months. The mother is a multi-parous, 33-year-old woman with a history of severe post-traumatic stress disorder, anxious attachment and post-partum depression. She has had multiple hospitalizations. Her two older children receive special services in school. Her history up to and including the first five months of this pregnancy would not have predicted this outcome.

Method

This is a single case study documented through clinical observation, the mother's and clinician's reports, and an evaluation by attachment specialists at Children's Hospital in Boston.

Results

Fetal movement described as "summersaults" and "aggressive," calmed with FPO2 training of the mother. The infant, now 15 months old, is exceptionally well regulated and securely attached. The mother suffered no post-partum depression after the birth of this baby.

Conclusion

There were significant positive effects from FPO2 training (and, apparently, at no other sites) on both mother and infant, both pre- and postnatally. This positive outcome reflects training that the mother received at the right orbital-frontal or greater amygdaloid area (Schore, 1994, 2003). If replicable, this study would represent a quantum step in the understanding and prevention of the intergenerational transmission of trauma.

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Roshi Assisted Neurofeedback Suppresses Theta*Dale S. Foster, PhD*

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Introduction

The question of whether positive neurofeedback outcomes can be accelerated through the use of sensory stimulation techniques which exploit the brain's frequency-following-response (FFR) tendencies was explored. Repetitive light and sound stimulation techniques have long been used as tools for influencing central nervous system activity and are increasingly being utilized in the field of neurofeedback to improve outcomes (Foster, 1989). The Roshi neurofeedback device utilizes a "complex neuro-adaptive filter" which allows light stimulation to respond rapidly to the EEG in a way designed to suppress the EEG across the spectrum, and appears to do so, especially in the lower frequencies. Previous studies have demonstrated successful clinical applications of the Roshi (Hammond, 1995, 2000). After numerous observations of cases of apparent improved theta suppression with the Roshi, a controlled study was implemented which demonstrated the ability of the Roshi's complex neuro-adaptive filtered photic stimulation to suppress EEG power in the 3-7 Hz frequency band. Neurobiological and neuropsychological mechanisms by which this phenomenon may occur are suggested (Shepherd, 1994).

Method

Data were gathered on 30 male and female subjects, ranging in age from 6 to 47, undergoing neurofeedback training for various problems in an outpatient clinic. Electrode placements varied with active electrodes placed in central, temporal, or frontal areas and references and ground placed either on the ears or mastoids. Two channels of EEG data were sent simultaneously to the ROSHI and to a two-channel Procomp+/Biograph system. Each subject engaged in a 30-second pre-treatment baseline, several 3 to 10 minute periods of eyes-open audio-visual neurofeedback generated by the Procomp+/Biograph system either with or without the Roshi light stimulation, and a final 30 second post-treatment baseline. Analysis of Variance (ANOVA) techniques were used to compare the production of 3-7 Hz EEG with and without the Roshi. A subjective test was also conducted in which point rewards were given toward prizes

when subjects were able to correctly guess when theta frequencies decreased.

Results

Although all subjects demonstrated suppression of EEG power in the 3-7 Hz range under neurofeedback conditions compared to baselines, suppression during the Roshi periods was superior to the non-Roshi periods ($p < .01$). When subjects were asked to predict the direction of the theta production graph from an immediately prior period, most subjects demonstrated better prediction of theta suppression during the Roshi periods.

Conclusion

The use of Roshi and other sensory stimulation devices may augment and accelerate neurofeedback training, especially when suppression of slow wave activity is desired. This is an area of application which warrants further study.

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A Randomized, Double-Blind Clinical Trial of EEG Neurofeedback Treatment for Attention Deficit/Hyperactivity Disorder

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Introduction

This presentation was a preliminary report on the outcome of an Institutional Review Board (IRB) approved, blinded, placebo-controlled

study design investigating the efficacy of standard practice neurofeedback for a subgroup of children with Attention Deficit/Hyperactivity Disorder (ADHD).

Method

Thirty-six subjects were randomly assigned to participate in one of two test groups. The treatment group (n = 18) received 40 sessions of EEG neurofeedback treatment. The control group (n = 18) were provided the same number of visits to the same clinic as the treatment group and were provided an equal number of computer-based sessions in an identical room with the same type of equipment. The only difference between the groups was that the treatment patients were provided computer-based EEG neurofeedback during their in-clinic sessions while the control patients were not. During their in-clinic sessions the control patients played a computer game, designed to improve attention and impulsivity but lacking any neurophysiologically contingent feedback signal. All test patients were assessed at baseline, after 20 sessions and at the completion of their protocol (after 40 sessions). Assessments were provided by two independent medical doctors who were blinded to treatment group participation. Parents were also blinded as to which group their child was randomly assigned. Assessments included a neurological evaluation consisting of single channel quantitative and qualitative EEG analysis and a number of psychometric measures.

Results

There was a 40% drop out from the control group and a 7% drop out from the neurofeedback treatment group. Pre- and post-data were presented and hypothesis for the number of control group drop outs was discussed.

The History and Current Applications of the Alpha/Theta Protocol (Keynote Address)

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The historical origins of the alpha/theta protocol were reviewed along with the published reports and *raison d'être* of applications in the clinical field and in the field of optimal performance training. The protocol was then discussed in light of the contemporary research in cognitive neuroscience on the theta rhythm and theta states. A new theoretical proposal was offered as to its efficacy. This was applied to the results of the author and colleagues on music performance and new findings submitted for publication on dance performance and on personality.

Referenced EEG: A Database of Medication Response (Invited Address)

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Introduction

There are those who feel that ultimate acceptance of QEEG and EEG neurofeedback will never fully occur without acceptance from the medical community.

Methods

This presentation addressed a recently released database which produced a report specifying what probability each medication or combination of medications has in clinically benefiting patients.

Results

Studies were presented from different difficult patient populations demonstrating a high degree of clinical correlation with positive outcomes.

Conclusions

While this is particularly useful in treatment resistant patients, the future holds promise for almost all patients to be tested before beginning a course of medication. The implications are profound, both for the future delivery of psychotropic medications, as well as clinically for the members of ISNR.

Coherence Training*Joseph J. Horvat, PhD*

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Introduction

This presentation gave an overview of coherence training and the advantages of its use. It also discussed the effects of coherence training on follow-up quantitative electroencephalograms (QEEGs) and the changes produced by neurofeedback in the QEEG (Guevara & Corsi-Cabrera, 1996; Marosi et al., 1995).

Method

QEEG follow-up studies were analyzed using change scores and t-tests to show the changes brought about by coherence training in follow-up QEEGs.

Results

Follow-up QEEG studies showed that coherence training significantly changes several measures on the QEEG and, to a lesser degree, this research showed that non-coherence protocols were able to produce changes in coherence measures in QEEG.

Conclusion

Coherence training is a viable alternative to other forms of neurotherapy. Follow-up QEEGs must be interpreted cautiously due to probable artifactual changes that are brought about by neurotherapy.

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Integrative Clinical Neuroscience (Invited Address)

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Introduction

Evaluation of individuals with complex neurobehavioral disorders is facilitated by access to comprehensive information on behavior and neurophysiological status. The ability to make use of these data in order to provide better targeted, and increasingly multidimensional treatment, is a significant challenge in clinical settings. This presentation reviewed two aspects of integrative neuroscience: (a) neuroimaging techniques that allow for direct comparison of brain structure and function, and (b) treatment modalities that benefit from cross-disciplinary integration, such as using neurophysiological information to guide pharmacologic intervention.

Methods

An important tool used for integration of structural and functional information in neuroimaging is electromagnetic source localization. EEG source localization technology was pioneered by Fender, Lehman, Kavanagh and colleagues at CalTech in the 1970s (for a review see Fender, 1987) and has been significantly advanced by many other investigators, including Sherg, Pascual-Marqui, Cuffin, Nunez, Tucker and Makeig.

In addition, work on cross-modal registration of *functional* neuroimages has also been accomplished. Combining the accuracy of fMRI or PET for spatial localization of cortical activity with EEG/MEG for temporal localization is the topic of a large number of research studies (some 190 pages of references are easily accessed in Medline).

The introduction of interdisciplinary efforts using these new measurement and analysis tools holds great promise for clinical practice. Predicting and monitoring response to pharmacologic intervention using EEG technology is an example of the interdisciplinary approach. The work pioneered by Suffin and Emory (1995), along with more recent work by Leuchter, Cook, Morgan, Witte, and Abrams (2002), Iosifescu et al. (2004) and others, documents the utility of neurophysiologically-based selection of psychoactive medication, as well as in detecting and monitoring neurophysiological response prior to behavioral manifestation.

Use of similar information is expected to yield improvement in efficacy of EEG neurofeedback.

Conclusion

The routine application of combined neuropsychological, neurophysiological, and neuroanatomical information is likely to improve clinical efficacy with both neurofeedback and pharmacologic intervention.

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Rogue Site Analysis: A Comodulatory Metric of Trauma and Consciousness (Invited Address)

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Introduction

Our sense of meaning may reflect the independent action of single neurons, however transitory. Neuronal individuation may be limited by physical and emotional trauma and thus the capability to quantify neuronal individuation, at any level of measurement, could provide a robust method for psychiatric and neurological assessment.

Method

Rogue Site Analysis (RSA) is a technique to identify transitory activation of limited pools of neurons by identifying which cortical site becomes most functionally independent at any given point in time. Current analysis focuses on dominant frequency activity at 8 ms to 125 ms intervals in ongoing EEG. Twenty-one normals were compared to 10 Aspergers and 9 ADHD children. A rank-order analysis using “spatial” comodulatory regressions provided a moment-to-moment assessment of site independence.

Results

Significant homologue and hemispheric differences exist between individuals as well as between groups. At this time, only gross averages of functional independence were evaluated.

Discussion

Results were analyzed in the context of a cascade-stop model of cognition, which is a general characterization of information processing in the cortex based on phylogenetic and ontogenetic considerations. Validation of RSA was discussed using the above populations. Time course and other analytical approaches were discussed.

Aha! On the Neural Basis of the Eureka Experience (Keynote Address)

John Kounios, PhD

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Introduction

People sometimes solve problems with a unique process called “insight,” accompanied by an “Aha!” experience. It has been unclear whether different processes lead to insight versus non-insight solutions, or if they differ only in subjective feeling.

Method

Subjects solved verbal problems and after each correct solution indicated whether they solved the problem with or without insight. One group solved these problems while being scanned by fMRI; 128-channel EEG was recorded from another group. Neural activity was analyzed separately for problems solved with or without insight (Jung-Beeman et al., 2004).

Results

fMRI revealed increased activity in the right anterior superior temporal gyrus for insight relative to non-insight solutions. Wavelet time-frequency analysis of EEG revealed a burst of gamma-band EEG over the same area beginning .3 sec prior to insight solutions. Additional analyses of EEG immediately prior to the presentation of each problem revealed that subjects' pre-problem brain state predicted whether they would solve a problem with or without insight. Specifically, solving a problem with insight was associated with decreased alpha EEG power over frontal and temporal areas, while solving a problem without insight was associated with decreased alpha over parietal and occipital sites.

Discussion

The right temporal area is associated with making connections across distantly related information during comprehension. The sudden flash of insight occurs when solvers engage distinct neural and cognitive processes that allow them to see connections that previously eluded them. The insight-related EEG differences prior to problem presentation demonstrate that subjects can sometimes prepare by establishing a "mental set" consistent with problem solution by insight.

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Preliminary Findings in the Treatment of Traumatic Brain Injury with Occipital Nerve Stimulation: QEEG and Cognitive Assessment

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Introduction

Mild traumatic brain injury (MTBI) is a hidden epidemic. Our own experience (Thimineur, Sood, & Kravtiz, 1998) in treating chronic pain suggests that almost 50% of these sufferers have concomitant TBI. Reversal of EEG patterns associated with cognitive symptoms using neurofeedback techniques (Schoenberger, Shiflett, Esty, Ochs, & Matheis, 2001) have resulted in improved function. However, our experience suggests that benefits diminish considerably once therapy has stopped. Occipital nerve stimulation is an FDA approved treatment for intractable headaches. Observations of improved cognitive function in several patients treated in this manner suggested that this procedure may provide the necessary level of cortical stimulation to maintain cognitive gains.

Method

A small series of headache patients with TBI were investigated using a study protocol including QEEG and cognitive assessment. Wire leads were surgically inserted into the occipital scapular region and attached to an external stimulator which could be remotely controlled. Patients reporting significant benefits during a two-week trial were given the option of having the unit permanently implanted.

Results

Preliminary findings of QEEG assessment, cognitive testing and self-report measures suggest remarkable and lasting benefits.

Conclusion

We are now petitioning the manufacturer of these devices to support further investigation.

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Event Related Potentials and Event Related Desynchronization Normative Data Base for Children and Its Application for Neurofeedback

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Introduction

Knowledge about EEG organization in the patient's brain is a necessary requirement for the application of neurofeedback. This paper described a recently developed normative data base that besides conventional spectral analysis explores event-related potentials (ERPs) and event-related desynchronization (ERDs).

Method

Two hundred fifty (250) children from ordinary schools in Chur, Switzerland (age from 7 to 16 years, 132 males, 118 females, all whites) participated in the study. Artifacts were corrected by means of independent component analysis (ICA) method. Absolute and relative spectra, spectral ratios, spectral asymmetries, coherence, phase, as well as ERPs and ERDs in four different tasks were used as parameters for the normative data base. The tasks included: (a) GO/NOGO task for assessment executive functions, (b) mathematical task for assessment of abstract reasoning, (c) reading task for assessment reading and speech understanding, and (d) acoustic task for assessment auditory information processing. Power spectra and ERPs can be mapped into Talairach space by using

LORETA developed by Roberto Pascual-Marqui (free software from the KEY Institute, Zurich, Switzerland, <<http://www.keyinst.unizh.ch>>).

Results

The paper discussed the results of comparing the above-mentioned EEG parameters between two groups (180 ADHD patients vs. normal). In particular, our data show that the extent of event related synchronization in the beta band, as well as the amplitude of GO and NOGO components correlate with both age and task performance. Application of EEG spectrograms, ERPs and ERDs for constructing individual protocols of neurotherapy was presented. In particular, our studies showed that 20 sessions of beta EEG training improved the quality of performance and led to a significant increase of amplitude of GO and NOGO components as well as to normalization of ERDs.

Conclusion

This study is the first to show that ERPs and ERDs can be effectively used for constructing individual protocols and for assessing the results of neurotherapy in ADHD children.

Heart-Brain Dynamics: Using Positive Emotions to Improve Health and Performance

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Introduction

Research by HeartMath® has explored the impact of positive emotions on physiological processes and psychological functioning, concluding that sustained positive states lead to a distinct mode of physiological function that is correlated with improved cognitive function and health-related outcomes. This mode, called physiological coherence, is associated with a sine wave pattern in the heart rhythms, increased heart-brain synchronization and entrainment between diverse physiological systems. While breathing methods can induce coherence and entrainment for brief periods, research indicates that individuals can produce ex-

tended periods of physiological coherence by generating a sustained positive emotion, producing psycho-physiological coherence.

Method

Using positive emotion to drive the coherent mode allows it to emerge naturally and for longer periods, even during challenging situations. Using emotion refocusing techniques, patients learn to arrest the physiological stress response and prevent the psychological wear and tear associated with various stressors.

Results

The robust findings of HeartMath's® application to a variety of disorders, including learning and attentional, were presented along with clinical narratives of how clients have benefited. Cases presented included a shooting victim with a damaged cortex, a performing artist who overcame anxiety to sing internationally, and the amelioration of ADD.

Conclusion

Psychophysiological coherence is a distinct mode that has far-reaching implications for human health and functioning. Physiological correlates of this mode can be objectively measured using straightforward methods. Practical techniques exist by which individuals of diverse ages and backgrounds can learn to self-orchestrate coherence with increased consistency, thereby reducing stress while enhancing health and performance.

LENS Neurofeedback with Animals

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Introduction

LENS is a passive, non-volitional neurofeedback procedure in which the patient's own brainwaves drive the neurofeedback. For several years

now LENS has been used clinically with children as young as six months and more recently, with animals. In such a procedure the dogged (pardon please) “placebo-effect” accusation against biofeedback is ruled out, and the animals show the same robust, uncomplicated response as young humans.

Method

Clinical studies used dogs, cats and horses that had observable neurological problems. Electrodes were placed cortically, using a single left and a single right hemisphere C3/C4 placement, and brief stimulation using the radio-frequency band of LENS was applied. Records were kept of the cortical responses as well as observed behavior on a five-symptom checklist by independent observers. Photographs and videos were kept of treatments.

Results

As with humans, over several treatments, the nervous system is usually quieted and optimal functioning restored. Conditions resembling seizures, explosive, anxiety, oppositional defiant and ADHD-like disorders showed amelioration. Annoying “neurotic” behaviors tended to diminish in intensity or vanish as the animal found more productive ways to behave, or with new flexibility abandoned old habitual or compulsive behaviors. Openness to learning that had appeared blocked often was restored.

Discussion

The results of LENS neurofeedback with animals parallel the results of LENS with humans to date, ruling out placebo, as most animals do not regard being immobilized and having wires attached to their heads as persuasive healing maneuvers. EEG data were compared to clinical observations. There were implications that bear on neurofeedback generally, and also hold promise for veterinary science.

Case Studies of QEEG Mapping and Neurofeedback with Autism*Michael Linden, PhD*

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Introduction

This talk described case studies of neurofeedback with children and adolescents with Autism. Pre- and post-QEEG and CPT scores were presented.

Method

QEEG-guided neurofeedback was performed on each student. IVAs and parent/teacher rating scales were conducted regularly. Pre- and post-QEEG maps were administered and compared.

Conclusion

QEEG mapping was helpful in determining subtypes of Autism and in guiding neurofeedback training.

T3 Beta for Normal & Dyslexic Adults While Reading at Three Levels*Charles A. Norman, PhD (1), and Jonathan E. Walker, MD (2)*

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Introduction

This study compared two groups of adults. Group one (n = 19) was diagnosed as dyslexic. Group two (n = 118) had no reported reading problems. T3 was hypothesized as being a point at which auditory words match appropriate visual print to affect comprehension.

Method

Each participant read at three individually determined levels: easy, medium, and difficult. Reading was done silently and comprehension

questions followed. While participants were reading, EEG activity was recorded using the 10-20 system. Artifacts were done manually. The John data base was run, and the clean data were reported in absolute power.

Results

At the easy level no differences were found. At medium difficulty reading levels, there were differences ($p < .05$). The power levels for the difficult reading levels were significant ($p < .01$). While the readers generated increasing power as reading became more difficult, the adults with dyslexia were not able to generate or recruit beta activity when faced with increased levels of reading difficulty.

Conclusion

A future study might determine whether beginning levels of readers who are experiencing reading difficulty show more alpha and less beta activity when reading at difficult levels. Another question is whether neurofeedback therapy can help those individuals with low beta power at T3 who have not acquired, or are not acquiring reading skills to generate or increase beta power and thus make the individual student more teachable.

Movie Maps of Long EEG Treatment

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Introduction

Few have seen the flow of topographic EEG changes over the course of a treatment from beginning to end. This presentation shows a movie made from a beginning to end topographic map.

Method

While beginning and end topographic maps give the end points of this movie, intermediary session data provides the actual guidance for the intermediary representation of changes, making the cinematic interpola-

tions more data-based than they would be otherwise. This 80-session treatment of a fibromyalgia patient took place over a year-and-a-half using the LENS hardware and software.

Results

Linear and non-linear transitional elements were shown in this movie.

Conclusion

Long-term topographic changes can be shown in an animated movie made from topographic maps. This allows an appreciation of both linear and non-linear dynamic trends in the changes that take place in the EEG during LENS treatment.

Three Generations of Brain Maps

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Introduction

Topographic EEG maps of three generations of a family were arranged in a family tree, allowing one to see the genetic trends in the EEG.

Method

Topographic maps from the LENS approach (single-site sequential topographic maps, or “mini-Qs”) were arranged to show different family relationships.

Results

Maps of siblings were much more similar than those of parent and child. How much a parent’s EEG shows in an offspring’s record is a function of the genetic dominance of that parent.

Conclusion

Topographic EEG maps clearly show the influence of genetics.

Use of Neurofeedback to Abort Established Migraine

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Introduction

The evolution of protocols to address migraine susceptibility has led to an increasing observation of the phenomenon that if a person is able to train while having a migraine, it is highly likely that the migraine may either be aborted entirely within the session, or set upon a trajectory of resolution over the course of subsequent hours.

Methods

The EEG neurofeedback protocols turn out to be highly individualized, but are based generally on inter-hemispheric training at homologous sites on the sensorimotor strip with variants of the Sterman/Lubar protocols for seizure management. The principle placement is T3-T4, with reward frequency centering around 12-15 Hz, and with inhibits covering the entire EEG band, or focusing specifically on the 8-11 Hz band, or both.

Results

The disruption of the migraine process within the scope of a 30-minute session occurs in about 50% of cases, and more than 80% of the rest will be set upon a course toward resolution over the subsequent hours.

Conclusion

The ability to abort an ongoing migraine systematically sets neurofeedback apart as an intervention for migraines, and helps to support the case that neurofeedback may contribute also to long-term resolution of migraine susceptibility. These findings suggest that considerably more migraine relief is in prospect if the technique is promulgated into remote use under clinician guidance, so that impacted individuals may avail themselves of the remedy at first need, since the migraine process is easiest to abort during the prodrome. Further, it is then possible to help those who are not able to come to the office while under the duress of a migraine.

Advances in Functional Imaging of Electric Neuronal Activity (Keynote Address)

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Introduction

Extracranial measurements of electric potential differences (EEG) and magnetic fields (MEG) contain high time resolution information on brain function. Traditionally, it has been incorrectly thought that if an event takes place at a certain electrode, then the event is generated in the underlying cortex. The laws of electrodynamics relating electric neuronal activity and EEG/MEG measurements guarantee that there is no simple, direct relation between scalp maps and the actual localization of brain activity. In any case, localization (i.e., EEG-based functional imaging) can only be performed by using correct physics models. An updated review of methods for electric brain activity imaging will be presented.

Method

The following tomographies were compared in terms of point source localization errors: the Low Resolution Electromagnetic Tomography method (LORETA; Pascual-Marqui, Michel, & Lehmann, 1994), the method of Dale et al. (2000), the Local Auto-Regressive Averages method (LAURA; Grave de Peralta Menendez, Gonzalez Andino, Lantz, Michel, & Landis, 2001), and the sLORETA method (standardized LORETA; Pascual-Marqui, 2002). In addition, two further properties were investigated: resolution and error in estimated source strength.

Results

LORETA outperforms LAURA and the Dale method in terms of better point source localization. However, the most outstanding result is that sLORETA achieves exact, zero-error, localization. In general, resolution is quite low, with sLORETA achieving the highest resolution. In all cases, source strength is under-estimated, especially for deep sources.

Conclusion

Point source localization cannot be improved beyond the performance of sLORETA. Barring low spatial resolution that worsens with depth, sLORETA is potentially capable of producing low resolution images for any current density that can be represented as a numerable set of “hot spots.”

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Direct Modification of the Neuropsychological Substrates of Reading Disability via EEG Operant Conditioning

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Developmental Dyslexia (or specific reading disability) has been characterized as an unexpected difficulty in reading experienced by children and adults who otherwise possess the intelligence and motivation necessary for accurate and fluent reading. It is the most common of the learning disabilities, affecting 80 percent of all individuals identified as learning disabled. Prevalence in the United States is estimated to range from 5 to 17 percent of school-aged children, with as many as 40 percent of the entire population reading below grade level.

Functional neuroimaging techniques including Positron Emission Tomography (PET), Magnetoencephalography (MEG), functional Mag-

netic Resonance Imaging (fMRI) and EEG have revealed a specific pattern of differences in the functional organization of the brain between dyslexic and good readers. These findings indicate that the left temporoparietal area is slow to respond and responds with less activation in dyslexic readers than in nonimpaired readers. Dyslexic readers demonstrate relative underactivation of left lateral and posterior regions of the brain during reading. They demonstrate a compensatory reliance on the right hemisphere and left frontal lobe systems during reading that is only partially successful, leading to a less fluent and more effortful reading style.

Psychoeducational interventions continue to emphasize compensatory strategies rather than direct remediation of the specific neurophysiological substrates of dyslexia. This may explain why they have not been more effective, typically yielding improvements in reading scores of less than one-half standard deviation after 100 or more hours of intervention.

QEEG-guided neurofeedback training may be unique among currently available therapeutic reading interventions in that it directly addresses dyslexia at the neurophysiological impairment level. The case history presented described a neurofeedback intervention based directly on current models of dyslexia, which yielded outcomes superior to traditional psychoeducational reading interventions in both speed and magnitude of improvement.

Foundations for a Clinical Approach to Neurotherapy (Keynote Address)

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At present, there is no consensus about the way neurotherapy has to be implemented for clinical purposes. Practitioners use different approaches such as the use of fixed protocols for different disorders, increasing or lowering specific frequencies or ratios. Some others rely on databases to characterize and localize dysfunctional brain zones, and other professionals use a more symptomatic approach trying to establish a relationship between symptoms and frequency EEG bands.

Neurofeedback is being used as a therapeutic tool, and it has shown its benefits to improve the symptoms of different disorders. There is ever growing evidence that neurofeedback works, although we still don't

know the physiological mechanisms involved and there is a lack of standardization in relation to the way neurotherapy is approached.

At present, there is significant evidence that makes us suppose that there is a neurological effect of neurofeedback that relates to neuroplasticity. Now, there is abundant evidence that learning produces structural changes in the cortex. Previous evidence strongly suggests that neurofeedback can be an important tool for neuroplasticity producing structural modification of the brain. Thus, an ethical issue has to be outlined.

It seems reasonable at this point, that if neurofeedback is going to be used in patient care, then a model of therapeutic neurofeedback that should be used has to be designed in a very careful way. The different approaches to neurofeedback were discussed analyzing their pros and limitations and proposing a clinical approach to neurofeedback.

The Neurological Basis of Eating Disorders. II: Follow Up Report of Adding Symptom-Based, QEEG-Based, and Analog/QEEG-Based Remedial Neurofeedback Training to Traditional Eating Disorders Treatment Plans (R/C)

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Introduction

We previously reported that adding neurofeedback to the treatment of eating disorders significantly enhances clinical outcomes, and compared the results of symptom-based (SB), Quantitative EEG-based (QEEG), and task activated analog/QEEG-based Remedial Neurofeedback Training (RNT; Smith, Sams, & Sherlin, 2003). Of the three approaches, we found that the task activated RNT yielded greater reductions in the need for medication. This study reported additional follow-up findings.

Method

Personality, stress indices, attention testing (TOVA or IVA continuous performance tests) and one of three types of neurofeedback training were administered to 142 patients. The neurofeedback protocols used

were from one of three approaches: (a) symptom-based (no QEEG); (b) QEEG-based, using traditionally accepted training protocols; and (c) custom protocols based on the data from task-activated, analog/QEEG data. Three months after discharge follow-up testing was collected and statistically analyzed on approximately 25 percent of the group.

Results

Follow-up testing confirmed that all treatment approaches led to symptom reduction. Medication reduction was significant ($p < .003$), with the RNT group showing the greatest decrease. Depression screening using the BDI-2 showed significant interaction effect ($p < .02$), with the RNT group showing the greatest decreases from pre- to post-testing. Pre-versus post-EDI and MMPI testing showed few statistically significant differences. However, the RNT group showed superior outcomes from the perspective of clinical significance. Although starting with higher initial scores, the RNT group also showed the greatest reductions in depression, markers of psychopathology, and symptoms associated with eating disorders.

Conclusion

Adding neurofeedback training to traditional eating disorders treatment protocols improved clinical outcomes. The task activated, analog/QEEG-based neurofeedback approach, using custom, non-traditional protocols, produced stronger positive clinical effects, namely reduction in the need for medication and lowered levels of depression.

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**Evoked Brain Rhythmic Activity, Cortical Coupling and Cognition
(Keynote Address)***Richard Silberstein, PhD*

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Introduction

Brain rhythmicity is a basic component of neural information processing, and changes in the synchronization of rhythmic activity are a key mechanism for the integration and segregation of neural systems in cognition. This presentation described the use of evoked brain rhythmic activity to examine the role of cortico-cortico loops and cortical synchronization or cortical coupling in cognition.

Methods

We reviewed studies that utilized the steady state visually evoked potential (SSVEP) as a probe of brain function. In these studies, participants undertook cognitive tasks while the SSVEP was elicited by a uniform visual flicker superimposed over the visual fields.

Results

In the first study, we examined changes in SSVEP amplitude and phase during the hold component of an object working memory task. Task related changes in SSVEP amplitude and phase were discussed in terms of changes in cortico-cortico loop dynamics. A subsequent study utilized a sequential version of the mental rotation task (MRT) to examine cortico-cortico loop dynamic correlates of the hold and manipulate components of the MRT. Important findings to emerge were the differential role of excitatory and inhibitory processes in the hold and manipulate components of the MRT. We also examined changes in cortical coupling, reflected in SSVEP event-related partial coherence, during cognition. We observed task and performance related changes in cortical coupling during a mental rotation task and Ravens Progressive Matrices, a task used to measure IQ. Our findings indicated that cognitive ability is correlated with the capacity to dynamically couple and de-couple specific neural systems.

Conclusion

Studies utilizing evoked brain rhythmic activity suggest that cortical processes are mediated by dynamic changes in the resonant modes of cortico-cortico loops and changes in cortical coupling. The relevance of these findings to neurotherapy was discussed.

Neurofeedback with Youth Offenders: A Pilot Study in the Use of Analog/QEEG Based Remedial Neurofeedback Training

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Introduction

Atypical EEG and neuropsychological indicators have been observed among offenders. Dangerous offenders treated with a combined program that included EEG-sensorimotor rhythm (SMR) and galvanic skin response (GSR) biofeedback demonstrated reduction in recidivism (Quirk, 1995). Our study was designed to further evaluate the EEG findings of youth offenders and to provide an initial report of the effectiveness of a task oriented analog/QEEG-based remedial neurofeedback training approach.

Method

Five offenders with significant psychopathology were referred for treatment. The group was evaluated with attentional testing and analog/QEEG assessment prior to and following neurotherapy. Treatment consisted of 20 or 40 sessions of a task-activated, analog/QEEG-based approach.

Results

For all of the youth trained, pre- versus post-audio and visual attention testing demonstrated significant improvement within 20 remedial sessions. Three of the five youth showed rapid advancement in a residential grading system.

Conclusion

EEG abnormalities and deficits in neuropsychological testing were found among offenders. Neurotherapy as an adjunctive treatment appears to hold promise for improvement in cognitive performance as well as recidivism. It is anticipated that different neurofeedback protocols may enhance outcomes.

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The ABC of Dyslexia: Alpha, Balance, and Color

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Introduction

Previous typologies of dyslexia (Tallal, 2000; Eden, 1996) suggest that there are different types of deficits associated with visual vs. auditory dyslexia and therefore, different remedies for each. While phonics-based instruction has been proven (Shaywitz & Shaywitz, 2003) to enhance the auditory phonological capacities of “auditory” dyslexics, the reported relief of colored lenses that is one of the standard treatments for “visual” dyslexics has been questioned as subjective or placebo, etc. This study was funded to provide an objective measure of the efficacy of colored lenses.

Method

Visual dyslexics were given colored lenses according to their optimum visual functioning and matched with both auditory dyslexics and controls. QEEGs were taken while reading with and without colored lenses. Working memory, speed of processing and balance were also tested in with- and without-lenses conditions.

Results

The visual dyslexics showed an abnormal alpha peak, significantly marked at O1, T5, and P3, which was attenuated with the lenses. Aspects of psychometric and balance measures also improved in the “wearing lenses” conditions. The controls and the auditory dyslexics did not show this abnormal occipital alpha peak.

Conclusions

- (1) Attenuation of abnormal alpha frequency is associated with “cognitive preparedness” and the ability to suppress it over the task relevant hemisphere. Some speculations suggest that this may be due to lack of myelination and/or coherence in the occipital-temporal-parietal areas. For example demyelinating diseases lead to blurred vision, involuntary eye movements, co-ordination problems, and short-term memory deficits—all consistent with dyslexia.
- (2) Colored lenses that are prescribed according to an individual’s position in color space allow a preparedness helping reading, balance and processing speed.
- (3) Some implications for neurofeedback are up training of beta at O2, T1 and P3 for visual dyslexics while F3 and F7 stimulation is most likely to benefit phonological dyslexics.

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Neurofeedback in ADHD: Results of a Preliminary Randomized Controlled Study (Invited Address)

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Introduction

The standard treatment for ADHD is the use of stimulant medication. The amount of prescribed psychostimulants is growing disproportionately to the prevalence of ADHD. But drug therapy is not always accepted

by patients and their families, and the long-term efficacy has not been reported. EEG biofeedback has been considered as an alternative or adjunctive treatment for ADHD. Two recently published studies (Monastra, Monastra, & George, 2002; Fuchs, Birbaumer, Lutzenberger, Gruzelier, & Kaiser, 2003) have found that neurotherapy leads to similar improvements in behavior and performance on cognitive measures as stimulant therapy. Also, in contrast to stimulant therapy, the effects of neurofeedback persist after withdrawal of medication. There are two major limitations of current studies that evaluate the efficacy of neurofeedback for the treatment of ADHD: a lack of adequate controls and no long-term outcome measures.

Method

This report provides data of an ongoing study of neurofeedback for the treatment of ADHD that controls for expectancy effects and follows children for six months post treatment. Twenty (20) children were trained to self-regulate their slow cortical potentials and 20 children learned how to control EEG spectral frequencies.

Results

In both groups, preliminary data of follow-up evaluations six months after the end of training showed significant improvement in target behaviors as well as in intelligence scores and less deficits in attention variables.

Discussion

While the study was successful in providing evidence of long-term effects after neurofeedback training, the question about the specificity of effects is still open.

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SMR Neurofeedback Efficacy in the Treatment of Tourette Syndrome

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Introduction

Although practiced widely, there is almost no documentation in the literature for the efficacy of neurofeedback (NF) in the treatment of Tourette Syndrome (TS). The only publication is a case report of two patients by Tansey (1986). The Tourette Syndrome Association funded our pilot study for twenty children (age 7 to 12) to provide such documentation. The purpose was to provide evidence for efficacy of NF using a double-blind design. We reported the results from the first six subjects.

Method

Five of the children were boys (age 9 to 10) and one was a girl (age > 10). They received 40 sessions of either SMR or electromyographic (EMG) training in an identical manner. The parents and therapists were "blind" to the treatment group's identity.

Results

We have completed processing the data for four of the six subjects to date. After 40 sessions, three subjects demonstrated an increase in production of SMR, as measured by 13-5 Hz activity during baseline recordings at Cz and a positive change in the theta: beta ratio. The fourth child did not reliably increase SMR nor did the ratio change. Both Tic ratings and ADHD related symptom ratings improved for the three SMR improved subjects, but not for fourth by the end of training and at the six-week post-treatment follow-up.

Conclusion

We concluded that the normalization of motor function and behavior is related to the ability of the subject to increase SMR and the positive effect of SMR training. We continue to recruit subjects into the study.

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EEG Predictions of Intelligence: Frontal Lobes, Power, Coherence and Phase Delays

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Introduction

The objectives of this study were: (a) to evaluate the ability of the power spectrum of brain electrical activity (qEEG) to predict performance on neuropsychological tests, and (b) to identify a reliable and valid set of EEG summary variables to estimate the cognitive health of the brain.

Methods

The Wechsler Intelligence Test-Revised (WISC-R) and 19 channels of eyes-closed EEG were recorded from 426 normal control subjects ranging in age from 6 to 18 years of age. The results of power spectral analyses of the EEG were correlated with the subtests of the WISC-R using a multivariate step-wise regression analysis. The multivariate regression equations were independently validated by comparing the predicted full scale IQ versus the measured full scale IQ in the original sample of 426 normal subjects to the EEG and IQ scores from 87 learning disabled children and 62 brain injured patients.

Results

The multivariate R with EEG as the independent variable and neuropsychological test performance as the dependent variable varied from 0.52 to 0.6 at $P < .0000001$. The correlation between the predicted full scale IQ and the measured full scale IQ was 0.575 ($df = 425/14$, $P < .0000001$).

Conclusions

Both network and power measures were significantly related to intelligence and were consistent with published studies. A new finding was that shorter phase delays in the frontal lobes and longer phase delays in posterior cortical regions consistently predicted higher IQ.

Adult ADHD Neurofeedback Combined with Biofeedback and Metacognition: A Different Emphasis Than Neurofeedback for Childhood ADHD (Invited Address)

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Introduction

Adult ADD is characterized by inability to sustain attention when material is slow paced, repetitive, boring or deemed irrelevant. Associated symptoms include: impatience, impulsive statements or actions, pervasive frustration with work and hyperfocus on things of interest. Comorbidity includes anxiety and dysphoria.

Findings

EEG patterns correspond to mental state: distraction/inattention due to internal ruminative activity correlates with beta bursts 23-34 Hz; beta 19-22 Hz with emotional intensity (may be anxiety). Mentally hyperactive, intense, high achievers may have high amplitude frontal and central 15-18 Hz activity. Some show slowing centrally and frontally with a 13-15 Hz (SMR) 'dip.' Adults can distinguish how mental states correspond to different frequency bands.

Method

Neurofeedback (NFB) is combined with biofeedback (BFB): relaxation using hand warming, decreased muscle tension, improved respiratory sinus arrhythmia (RSA), and alertness monitored by electrodermal response (EDR). To generalize self-regulation and make it automatic, cognitive and behavioral strategies are paired with attainment of the de-

sired EEG pattern, autonomic nervous system (ANS), and electromyogram (EMG) levels during the sessions.

Results

Self-regulation training (NFB plus BFB) was associated with a greater than 10 point increase in IQ, normalization of continuous performance test scores (IVA, TOVA) paralleled by reported improvements in home and work performance and a reduction or elimination of stimulant and antidepressant medications.

Discussion

Excess slow wave activity and/or excess high frequency beta activity corresponded to the client being more in their own world; low SMR is consistent with fidgety, impulsive behavior and a lack of organized consistent functioning. High left prefrontal and frontal slow wave activity was consistent with lack of appropriate inhibition. Neurofeedback to increase activation in these areas corresponded to the client sustaining external attention. Biofeedback assured a relaxed yet alert mental and physiological state. The pairing of these changes with strategies assured generalization to daily living.

Hemoencephalography Adverse Reactions

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Introduction

Several adverse reactions to Hemoencephalography (HEG) therapy have been reported. This study was undertaken to determine the most likely causes and to develop methods to avoid them in the future.

- (1) A person with a case of tic doloroux experienced a one-week hospitalization after several hours of exposure to HEG.
- (2) A high-functioning autistic child experienced 24 hours of angry depression after his second 30-minute HEG session.

- (3) Mild transient one- or two-hour headaches, common to the initial HEG session, have been reported to last as long as a week.

A study of pain literature (Asher et al., 2004), prompted by discovery of the AF8 emotional regulator (Eisenberger, Lieberman, & Williams, 2003), revealed the ComtVAL168met pain sensitivity Genotype (Zubieta et al., 2003). This gene has Valine and Methionine alleles that determine pain sensitivity. Recognition that this gene may define 25% of the population as extremely emotionally sensitive led to grading our present clients for emotional sensitivity. Those with two Methionine alleles (25% of the population) should be virtually pain free. Those with two Valine alleles should belong to the highly sensitive group (25% of the population) and the remaining 50% should belong to the intermediate class. It is expected that the effect of these variants of the ComtVal158met gene should be modulated by the AF8 emotional regulator.

Method

Thirty-four (34) clients who had been seen in HEG neurotherapy within the last three months were included in the study. Each client was given an initial TOVA and MicroCog test combined with a guided history questionnaire and took the sensitivity examination in *The Highly Sensitive Person* (Aron, 1996). The results were divided into three emotional stability groups and graded by their sensitivity to a tool, taped to the inner surface of the forearm, warmed by an electric current. The value of the current deemed uncomfortable by each client determined a position in each group: (a) highly stable: > 200 milliamperes (ma.), (b) intermediately stable: 100 to 200 ma., and (c) highly sensitive: < 100 ma.

Results

The results from each group were: (a) 12%, (b) 21%, and (c) 67%.

Conclusion

The normal distribution in the population is 25%, 50% and 25%. It is clear that most of those seeking therapy belong to the highly sensitive group and must be dealt with accordingly. Introductory time on HEG is restricted to a maximum of three 3-minute segments for the most sensitive subjects and progressively increased by 2 minutes each for the first

five sessions. Careful observations and questioning are recommended for these clients during each of these sessions.

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Anxiety, Anger, Depression, Traumatic Brain Injury and Hemoencephalography

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Introduction

Anxiety, resulting from amygdala activation, has evolutionary advantages in rapidly preparing the individual for flight or fight in threatening situations. A brain pathway, excitatory and exceptionally fast, has been found from the striatum to the amygdala via the special branch of Broca. Another, slower inhibitory pathway traverses the cortex before reaching the amygdala. The cortical pathway, available via F8 or Fp2, is a regulator of emotion. It has been shown (Eichenberger, Lieberman, & Williams, 2003) to regulate the anterior cingulate cortex, a common route for pain and emotional activation. The relative speed and activation of these components determines the resulting experience.

Method

Hemoencephalography (HEG) at Fp1 and Fp2 or F8 was used for remission of symptoms in seven anxiety and two traumatic brain injury (TBI) cases. Before and after QEEG or LORETA studies were obtained.

Results

HEG training at the hypothesized pathways resulted in significant improvements in all nine cases within 12 to 30 sessions. The QEEG and LORETA brain maps showed significant changes. Anxiety results were stable when checked two years later. TBI results treated at F8 are stable at six months.

Conclusion

This preliminary presentation opened new HEG pathways for analysis and treatment of dysfunctional anxiety, PTSD, anger, depression, or TBI cases.

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QEEG Findings and EEG Biofeedback with Adults Reporting a History of Childhood Sexual Abuse

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Introduction

Childhood sexual abuse (CSA) is a prevalent problem that has been linked to many psychological maladies including post traumatic stress disorder, dissociative disorder, depression, anxiety, substance abuse, and suicidal ideation and attempts. Research has also shown physiological correlates even in high functioning adults (Black, Townsend, Hudspeth, & Bodenhamer-Davis, 2004). The purpose of this presentation is to review QEEG findings in adults reporting a history of CSA, discuss treatment implications, and provide case examples.

Method

Ongoing research at the University of North Texas Neurotherapy Lab has looked at QEEG patterns of adults reporting CSA. Over 45 adults were evaluated on measures of relative power, absolute amplitude in each of the four bandwidths, power ratios, and coherence using neuro-electric eigenimage (NEI) connectivity indices. The individuals were compared to a sample of adults denying any abuse and matched for handedness, age, and gender. Some of these participants have undergone EEG biofeedback and psychotherapy as well.

Results

Main QEEG findings in adults reporting CSA include decreased alpha and theta relative power at all sites, increased delta relative power in posterior regions, and increased connectivity in delta between brain regions centrally across the motor strip.

Conclusion

Adults who report CSA exhibit significantly different QEEG profiles when compared to a matched group of adults denying any abuse. Findings and case examples suggest EEG biofeedback is a viable option for treatment. Likely treatment protocols include a reduction of delta activity, alpha/theta enhancement, and coherence training.

REFERENCE

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Cerebral Blood Volume and Oxygenation Assessment of the Child with Cerebral Palsy

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Introduction

Many non-invasive measurement methods are used for brain research. We can cite electroencephalography (EEG), magnetoencephalography

(MEG), functional magnetic resonance imaging (fMRI), and near infrared spectroscopic imaging (NIRS). EEG and MEG measure the electrical cerebral activity; fMRI and NIRS measure the blood oxygen level-dependent, the hemodynamic response.

Objective

We developed a device to record EEG and event-related potentials (ERPs) from the human scalp. In this study we investigated the potential causes of seven children (7 to 10 years old) with spastic cerebral palsy. Our objectives were: (a) to observe regional functional activation; (b) to assess levels of hemoglobin oxygenation, cerebral hemodynamics in the prefrontal cortex, temporal lobes and parietal lobes with our Neurobek system (NBCW-IR32; a functional near-infrared spectroscopy) and QEEG; and (c) to determine cocontraction's relation to strength and motor function, the extent of ankle muscle weakness in children with cerebral palsy.

Materials and Methods

We used simultaneous electroencephalogram-near infrared spectroscopy (EEG-NIRS) and electromyography (EMG). The EEG was recorded from 20 scalp electrodes (Fz, Cz, Pz, Oz, Fp1, F3, F7, C3, T3, P3, T5, O1, Fp2, F4, F8, C4, T4, P4, T6, O2) bipolar montages with electrodes placed according to the International 10-20 System of electrode placement. A continuous wave technique was used. Muscle relaxation was confirmed using surface electromyography. EMG data were recorded simultaneously to identify stretch responses. A comparison group of seven children without cerebral palsy (four males, three females; mean age 8.3 years) participated in the study. The children received 40 sessions of cerebral oxyhaemoglobin (HBO₂; a noninvasive monitoring of regional cerebral oxygen saturation).

Results

After complex stimulation, increased alpha QEEG power correlated significantly with changes in local cerebral blood oxygenation. Increased theta QEEG power also correlated with CBV in fNIRS. The fNIRS-EEG measurements demonstrated a positive cross-correlation in the occipital cortex between alpha activity and concentration changes of deoxygenated hemoglobin.

Conclusions

We concluded that the fNIRS-EEG is a valid method for assessing spasticity, measuring the efficacy of treatments aimed at decreasing spasticity in children, and guiding therapeutic intervention in persons with cerebral palsy.

QEEG-Guided Power and Coherence Training Remediates Tic Disorder

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Introduction

The disorder is not well-managed with drug therapy in many instances (Woods, Twohig, Flessner, & Roloff, 2003). Drugs are not totally effective in relieving tics, and also have side effects (Lechman, 2002; Kushner, 1999). Neurotherapy is potentially a superior approach, both in terms of efficacy and side effects.

Methods

Ten consecutive patients with tic disorder were evaluated in our clinic. A quantitative EEG (QEEG) was used to guide neurofeedback training. The abnormalities found were ranked according to their statistical significance. The most severe abnormality was trained first, then the second most severe, etc. If power or coherence was too low, it was trained up. If power or coherence was excessive, it was trained down. Usually, each protocol consisted of 10 sessions of power training or 5 sessions of coherence training. Training was carried out using EEG Spectrum equipment. Details of the methods used for coherence training may be found in our closed head injury paper (Walker, Norman, & Weber, 2002).

Results

Tic frequency was assessed by family, self-reports, doctor's evaluations and follow up.

PATIENTS	# OF SESSIONS (COHERENCE)	# OF SESSIONS (POWER)	% DECREASE IN TICS	MEDICATION STATUS (≥ 3 MO)
1	27	12	100	FREE
2	15	19	95	FREE
3	30	10	90	FREE
4	33	5	90	FREE
5	12	20	90	FREE
6	20	30	90	FREE
7	20	19	90	FREE
8	20	0	60	FREE
9	15	10	60	FREE
10	37	23	20	REDUCED

Conclusion

Neurofeedback dramatically reduces tic behaviors in most patients and enables them to stop or reduce their medications.

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