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Scientific Presentations

in Alphabetic Order by First Author

Brain Function for Semantic Processes with 128-Channel EEG

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Introduction

Concrete words are more quickly recognized than abstract words (Bransford & McCarrell, 1974; Paivio, 1986). Different theories of semantic processing argue that either there are more brain areas that process concrete than abstract words (bilateral versus unilateral; Paivio, 1986), or that the same brain areas process both kinds but that concrete words have more context associated with them (Bransford & McCarrell, 1974). Deep acquired dyslexia is a syndrome caused by extensive lesions to the left hemisphere, and is characterized by more semantic paralexias (e.g., read "dog" for "cat") for abstract than for concrete words (Coltheart, 1980). Some developmental disabilities also exhibit handicaps with abstract words. Second-grade poor readers recall disproportionately fewer abstract than concrete words than normally reading second-graders (Vellutino & Scanlon, 1985). Similar findings are found with pervasively hyperactive children (Sharma & Sinha, 2001).

Methods

The present study will present quantitative electroencephalographic (EEG) and evoked response potential (ERP) data from normal young adults processing concrete and abstract words, recorded with 128-channel EEG.

Results

Results will include topographic mapping, source localization, and time-frequency wavelet analyses to show when and where in the brain semantic processes occur.

Conclusions

Different theories will be addressed and applications for understanding semantic processing difficulties in reading disabilities and attention deficit hyperactivity disorder will be discussed.

References

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The Mixed General Linear Model of Statistical Analysis and qEEG

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Introduction

This paper will describe the application of a statistical model for the analysis of digital quantitative electroencephalographic information (qEEG). The model is similar to regression, which allows one to build a regression or "best-fit" line for the data structure, but also provides for correlations between observations. A linear mixed model states that data consists of two parts: fixed effects and random effects. Fixed effects are the expected values while random effects consist of the variance and covariance of the observations. It is the variance that makes a variable unique; thus, the more accurately we can isolate it the more we might understand what the data is trying to say.

Method

With advances in technology and recently available mixed model methodology, (e.g., the mixed procedure [Mixed PROC] of the SAS® system) the covariance structure can more easily be incorporated into the statistical model.

The Model:

$$Y = X\beta + Z\gamma + g$$

Conclusion

By increasing the complexity of possible statistical analysis, computers have allowed the statistical models created to represent more accurately the mathematical structure of a data set continuing to decrease the amount of unknown variance. This complexity in analysis becomes much more analogous to modeling the underlying neurophysiology processes by specific quantification. The use of a mixed procedure and its method of modeling the data structure appear to provide a more accurate and objective method of analysis, which also provides quantifiable equations for testing predictions.

Visual Evoked Potentials (VEP) Help Separate Psychiatric Patients with Biologically-Based Explosive Behaviors

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Introduction

There are at least two major subtypes of explosive, aggressive behavior based upon identifiable biological substrates; one originating in the basic primitive "fight-or-flight" mechanism of the limbic system and one resulting from disinhibition of the frontal lobes. Visual evoked potential (VEP) amplitudes were statistically analyzed to assess their association with these two types of explosive behavior in children and adolescents and were found to be an objective viable adjunct to present methods of classification.

Method

The data set (N = 326) came from a clinical population heavily weighted with explosive aggressive behaviors. Explosive behavior was considered present when there was any mention on the client's psychiatric intake evaluation of: explosive rage, out-of-control anger or aggression, verbal or physical attacks on other individuals, or Intermittent Explosive Disorder. There were 105 females (32%), mean age 13.7 (SD 2.67), and 221 males (68%), mean age 12.9 (SD 2.98). Explosive behaviors were seen in 82% of the sample of which 80 were females (30%) and 187 males (70%).

Results

Logistic regression analysis indicated that explosive individuals were significantly more likely ($p < .0001$) to produce high amplitude pattern reversal VEP P100 wave forms recorded at the O1 and O2 electrode sites (Bars, Heyrend, Simpson & Munger, 2001). This one variable accounted for 46% of the explosive individuals. Individuals with high P100 wave forms were removed from the data set (N = 202) and a second analysis indicated that increased flash VEP P200 amplitude in the frontal lobe, recorded at the F3 and F4 electrode sites was significantly associated ($p < .0001$) with explosive behaviors accounting for 25% of the total explosive sample.

Conclusion

The use of VEP studies as a classification tool provides empirical identification of two large subsets of individuals with trouble controlling explosive, aggressive behaviors. Better understanding leads to better treatment outcomes.

References

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Extended Follow-Up of Peniston Protocol Results with Chemical Dependency

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Introduction

This study is a clinical replication of the Peniston electroencephalographic biofeedback (EEG biofeedback) protocol for treating chemical dependency (Peniston & Kulkosky (1989, 1990).

Method

This study involved a clinical trial with 16 chemically dependent subjects treated in a university-based outpatient clinic between 1993 and 1995. Ten of the subjects were probationers classified as high risk for re-arrest. Subjects completed an average of 31 alpha-theta biofeedback sessions. Treatment effects were assessed using pre- and post-treatment psychometric data from the Beck Depression Inventory (BDI) and the Minnesota Multiphasic Personality Inventory-2 (MMPI-2), as well as long-term follow-up of abstinence and re-arrest rates. MMPI-2 profiles for the entire sample were compared to equivalent probation and clinical groups not receiving EEG biofeedback.

Results

Pre-treatment BDI scores for the EEG biofeedback group were indicative of mild to moderate depression, but their post-treatment scores were significantly reduced, to within the normal range. Substantial differences were noted on seven of the MMPI-2 scales between testing periods, suggesting less psychopathology following EEG-biofeedback treatment. Long-term (74 to 98 months) follow-up that included collateral informants indicated that 81.3 % (n=13) of the EEG-biofeedback subjects were abstinent. Re-arrest rates and probation revocations for the probation subgroup were lower than those for the probation comparison group (79.15% versus 40%).

Conclusion

These results attest to the robust nature of EEG-biofeedback for chemical dependency, even with subjects from the criminal justice population.

References

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The World is Flat! The World is Round?

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Introduction

Since Dr. Berger first recorded electroencephalogram signals (EEG), the traditional methods of analysis have all been based around the time domain. Advancements in equipment, computers, and applications now make it possible to analyze EEG using not only the frequency domain, but also the time/frequency-space domain.

A query, "Joint Time Frequency Analysis," to the internet search engine, Google, yields 696,000 items. Adding "EEG" yields 7,080 returns. Understanding the components of EEG is the foundation for neurofeedback. Advanced analysis methods are appropriate for professional, state of the art neurofeedback.

Method

Researchers have used Joint Time Frequency Analysis (JTFA; Molin & Touradj, 2002) and its derivatives to analyze EEG from deep structures (Mikkonen, 2002), from seizure patients, from newborns, and from event related electrical potentials (ERP), sleep, and other situations (Enghoff, 1999).

Results

Researchers report significant findings using advanced mathematical analysis. These findings are not apparent without these techniques. JTFA is used to isolate the transient, non-periodic, "chirp-like" qualities present in EEG (Durka).

Conclusion

In neurofeedback we base our work on significant current findings. It would appear from current research, in press and in print, that advanced mathematical analysis yields data not previously seen and, as an additional by-product, at frequencies significantly above 40 Hz. Neurofeedback moves forward in its approach to EEG training. Additional studies in neurofeedback are needed to make the role of transient, non-periodic, and "chirp-like" elements (Mikkonen, 2002) in the EEG and how neurofeedback can impact these EEG elements clearer.

Exploring Measures of Change in Neurofeedback: Is There Value in Auto and Cross Correlations, First Derivatives and Correlation Dimension?

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Introduction

Various measures for change in neurofeedback have been proposed including QEEG z-scores and ratios using amplitude-based measures within training sessions, such as theta/beta ratio and traditional spectral densities (Fell et al). Recent work has confirmed the possible value of several other measures including the Correlation Dimension [C(r)] and the First Derivative (FD; Lamberts, et al) as well as the Auto Correlation (AC) and/or Cross Correlation (CC) of Joint Time Frequency Analysis (JTFA), specifically the Wigner-Ville distribution (Lai et al). In this study, these measures were applied to neurofeedback training data to determine their usefulness for differentiating successful from less successful outcomes.

Method

Data was analyzed from 20 clients (recorded with ProComp+) reporting success and 20 not reporting success at the 10th. Calculations included ACs and CCs of Wigner-Ville distributions, FDs of the original filtered data streams and C(r) [step size of 33 and r dynamically set to the 4th moment about the mean of the data stream]. All calculations were performed in NeuroCARE Pro.

Results

In “successful” cases, AC and CC curves showed a clear lessening of initial deviations over training, approaching the linearization that would be anticipated. C(r) showed an overall increase across training sessions, while FD curves renormalized as anticipated. These changes were not evident in “unsuccessful” training.

Conclusion

Several novel measurements -- both linear and non-linear -- revealed a consistent picture of change in EEG as a result of reported successful neurofeedback. These measures appear to be potentially useful indicators of outcome in neurofeedback training.

Treatment Effects Related to EEG-Biofeedback for Crack Cocaine Dependency in a Faith-Based Homeless Mission

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Introduction

EEG biofeedback has been demonstrated as effective in the treatment of alcoholism, as evidenced by Peniston and Kulkosky's research efforts (1989, 1990). Most research with alpha-theta EEG biofeedback has addressed alcohol addiction. Given that cocaine is the most common drug problem of patients entering treatment for drug abuse (NIDA's Drug Abuse Treatment Outcome Study, 1999), research in the treatment of this “untreatable” population is warranted. The current study is a four-year research project developed by the Southwest Health Technology Foundation (SWHTF). It is currently underway at the Open Door Mission in Houston, Texas, and utilizes EEG biofeedback with mostly homeless “crack” cocaine addicts in a nine-month residential, faith-based treatment program.

Method

Two hundred and seventy (270) male addicts received 30 sessions of a variant of the Peniston-Kulkosky alpha-theta biofeedback protocol. Outcome measures included psychometric as well as behavioral measures. To be considered a “success,” subjects must have: (a) current living arrangements [no longer homeless], (b) no substance use [including alcohol, marijuana, and “crack”], (c) no subsequent involvement with the criminal justice system, and (d) current employment or student status.

Results

After the introduction of the neurofeedback to the mission regimen, length of stay tripled, beginning at 30 days on average and culminating at 100 days after the addition of neurotherapy. Similarly, before neurotherapy, the mission was “graduating” 12 men per year from their drug treatment program, which now has increased to an average of 12 graduates per month. One-year follow-ups of 94 treatment completers indicate that 95.7 % of subjects are maintaining a regular residence; 93.6 % are employed/in school or training, and 88.3 % have had no subsequent arrests. Self-report depression scores dropped by 50% and self-report anxiety scores by 66%. Furthermore, 53.2% reported no alcohol or drug use 12 months after biofeedback, and 23.4% used drugs or alcohol one to three times after their stay. The remaining 23.4% reported using drugs or alcohol greater than 20 times over the year. Urinalysis results corroborated self-reports of drug use.

Conclusion

These findings are significant in that conventional forms of substance abuse treatment report 65-70% relapses within the first year after treatment (McKay, Atterman, Rutherford, Cacciola, & McLellan, 1999). Given the discrepancy between “lapse” and “relapse” in the addiction literature, it is important to recognize the large gap in number of uses reported. Overall, these findings suggest that the synergy between neurotherapy and faith-based programs are effective in the treatment of crack cocaine addiction.

References

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

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Introduction

Infrared imaging holds promise as a flexible tool for evaluating dynamic changes in prefrontal cortical brain activity.

Method

Three thousand six hundred (3,600) infrared images have been collected over the last three 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).

Results

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.

Discussion

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, PET, and SPECT in terms of monitoring brain activity. Although it probably does not monitor brain activity as precisely, it has an advantage of flexibility and ease of use that allows monitoring of cognitive and motor processes during varying task demands.

References

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Tomographic Neurofeedback: A New Technique for the Self-Regulation of Brain Electrical Activity.

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Introduction

A major limitation of the current neurofeedback paradigm is the limited information provided by a single or a small number of electrodes placed on the scalp. A considerable improvement of the neurofeedback efficacy and specificity could be obtained feeding back brain activity of delimited structures. By means of inverse solutions such as the Low-Resolution Electromagnetic Tomography (LORETA), spatially delimited brain activity can be evaluated in neocortical tissue. We implemented LORETA neurofeedback for the first time and carried out a set of experiments with the aim to show learning of brain current density activity.

Method

Three individuals were trained to improve brain activation, suppressing low alpha (8-10 Hz) and enhancing low beta (16-20 Hz) current density in the anterior cingulate gyrus cognitive division (ACcd). Participants took part

in six experimental sessions, each lasting approximately 30 minutes. Randomization-Permutation ANCOVA tests were conducted on recordings of the neurofeedback training. In addition, a randomized trials design was performed at the end of the treatment. The hypothesis under testing was that participants acquired volitional control over their brain activity so to be able to obtain more rewards during the plus condition as compared to the minus condition.

Results

We found evidence of volitional control for two subjects ($p=0.043$ and $p=0.1$) and no evidence of volitional control for one of them ($p=0.271$). The combination of the three p-values provided an overall probability value for this experiment of 0.012 with the additive method and 0.035 with the multiplicative method. These results strongly support the hypothesis of volitional control across the experimental group. Trends of the beta/alpha power ratio in the ACCd were in the expected direction for all the three subjects; however, the combined p-values did not reach significance.

Conclusion

Possible applications of the technique are important and include the treatment of epileptic foci, the treatment of specific brain regions damaged as a consequence of traumatic brain injury, and in general of any specific cortical electrical activity.

QEEG and Neuropsychological Consequences of Exposure to Toxic Molds

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Introduction

Recently, there has been much controversy over the possible health consequences of exposure to certain structural molds (toxic molds). However, little has been done to examine possible neurological consequences of such exposures. This presentation summarizes some findings from QEEG and selected neuropsychological testing performed on a group of individuals who had been exposed to these toxins either in their homes or places of employment.

Method

Specific antigen counts found to be abnormal in response to a range of toxic molds were used as predictor variables in a multiple regression to attempt to predict the variance in QEEG z-scores and selected neuropsychological tests (subtests from the Delis-Kaplan Executive Function System, Wechsler Adult Intelligence Scale-Third Ed., Wechsler Memory Scale-Third Ed., and the Intermediate Visual and Auditory Continuous Performance Test). In addition to these, the Symptom Checklist-90 was analyzed separately.

Results

The antigen serum levels analyzed revealed a number of significant patterns in QEEG variables, including effects in Mean Frequency, Relative Power, and Absolute Power in all frequency bands. In addition to this, several clinically important correlations were found between QEEG variables and the above named

neuropsychological tests. Specific neuropsychological deficits of varying severity were also found in this population.

Conclusion

Exposure to toxic molds appears to have a negative impact on both cognitive functioning and the underlying cortical regulation supporting that functioning. Implications for treatment and future research will be discussed.

Tourette Syndrome: Three Year Follow-Up of a Successful Treatment Outcome

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Introduction

This presentation is a multidimensional and developmental analysis of EEG, LORETA, behavioral, and psychometric data obtained from an 11 year-old boy who was successfully treated for Tourette syndrome. A presentation of the initial pre- and post-treatment data was presented when he was 8 years old (Daly, 2001). The present research examines the long-term affects of the treatment from a three-year longitudinal developmental perspective.

Method

Data from four time periods will be presented. The periods are: (a) pre-treatment (PT), (b) PT plus 9 months, (c) PT plus 21 months, and (d) PT plus 35 months. Comparisons between selected parameters of QEEG and LORETA data were statistically analyzed for all four periods. Information acquired from neuropsychological, behavioral, educational and other standardized psychometric measures was also examined.

Results

The QEEG and LORETA data clearly indicated that the positive QEEG & LORETA changes (i.e., normalization with respect to age related QEEG database samples) have been sustained. There also have been age appropriate developmental changes in his EEG, especially in posterior alpha and anterior beta frequencies. The distribution of current densities (LORETA) with reference to selected Brodmann areas is particularly informative and will be compared to findings from other neuroimaging techniques (Wolf, et al.).

Conclusion

The positive treatment effects of neurobiofeedback therapy for Tourette syndrome for an 8 year-old boy were sustained over a three-year period. Advanced statistical and trend analysis techniques provide a detailed specification of the major parameters of interest that could be associated with the sustained efficacy of the treatment and neuro-developmental changes.

References

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Attention Training with ADHD Children: Preliminary Findings in a Double-Blind Placebo-Controlled Study

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Introduction

Attention training or EEG biofeedback (neurofeedback or neurotherapy) has been shown in previous studies to be effective in minimizing the cardinal symptoms of Attention-Deficit/Hyperactivity Disorder (ADHD) in children (Lubar, Swartwood, Swartwood, & O'Donnell, 1995; Monastra, Monastra, & George, 2002). However, some of the main criticisms of the previous research is a lack of adequate controls, failure to control for treatment bias, and diagnostic workups (Baydala & Wikman, 2001). This is the first randomized double-blind placebo-controlled neurotherapy study performed with ADHD children.

Method

The design of the study consisted of a diagnostic workup, 40 sessions, and pre-, mid-, and post-assessments. The diagnostic workup consisted of a structured clinical interview with the parent(s), and IQ, achievement, continuous performance test (CPT), and quantitative electroencephalogram (QEEG) with each child (all the children were tested medication-free with a 48-hour washout period). Each child was required to have ADHD as the primary diagnosis, IQ greater than 80, if on medication only taking psycho stimulants, and no history of head injuries, seizures, or other serious mental disorders (i.e., depression, anxiety).

During the sessions each child played Sony PlayStation games with an active sensor placed at FZ. In order to ensure that each child received treatment, a crossover occurred after 20 sessions. The children were randomized into two groups. Group One received 20 sessions of brainwave-modulated Sony PlayStation videogames and then received 20 sessions with the videogames while brainwave activity was monitored. Group Two received treatment in the opposite order.

Pre-testing occurred before sessions began and consisted of parent, teacher, and self-report rating scales. Mid-point-testing occurred at the crossover point and consisted of the previous rating scales, CPT, and QEEG with each child. Post-testing occurred after the 40 sessions were completed. Parents and teachers completed rating scales while the children were re-administered the intake procedure.

Results

Forty-four children (28 males and 16 females) seven to 11-years-old (average age 9.2) in grades two through five have participated. Half of the children were medicated on a psycho stimulant only. Each child had a primary diagnosis of ADHD (25 primarily Inattentive; four primarily Hyperactive; and 15 Combined). Average IQ was 104 (range = 80 to 132).

Conclusion

This study will not only look at the efficacy of a placebo-controlled design, it will address how medication, diagnosis (diagnoses), and other variables affect outcomes with EEG biofeedback. This study will also examine how children learn to perform this training using growth-curve modeling.

References

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Advanced Buddhist Meditation: Multiple States and Their Neurophysiological Correlates

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Introduction

Although the term "meditation" has become a common word in our culture denoting a method for engendering a state of inner peace or tranquility, there are many forms of meditation, some of which engage very different mental states and processes (DeLuca & Daly, 2003). Many of these states have not been differentiated on a neurophysiological basis. We discuss the nature of these different practices and present QEEG and LORETA findings of two Tibetans, one Buddhist monk and one ex-monk during such conditions. We compare differences between concentration and analytical meditation as well as between meditation on emptiness and compassion.

Method

All QEEGs were recorded using a Lexicor NeuroSearch-24 and appropriate size Electrocap. EEG activity was sampled in the standard International 10-20 montage. The sampling rate was 128 Hz with 32K gain, high-pass filter on. Several meditation conditions were investigated: (a) concentration, or single pointed meditation employing mantra repetition; (b) visualization, or the visualization of a Buddhist protector deity in front of oneself; (c) self-generation, or the visualization of oneself manifesting as the deity; (d) dissolving, an experiential state involving the experience of dissolving into emptiness; (e) analytical, or in this instance, the contemplation of the notion of the preciousness of human life; (f) emptiness, analytical meditation on the nature of emptiness or innate wisdom mind; and (g) compassion, an experiential state involving the generation of a state of great love and compassion

Results & Conclusion

Findings suggest subtle differences in broad and single band activity between meditation conditions in terms of both location and power. Differences are subtle as all of the meditation conditions rest upon the practice of concentration meditation. Analytical meditation evidenced a greater area of posterior alpha absolute power as compared to concentration meditation. Meditation on emptiness evidenced greater right temporal absolute

power as compared to meditation on compassion. Additional subtraction analyses and LORETA findings are also presented. These findings support the notion that these meditative states involve different brain states and neurophysiological correlates.

References

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Treating Fungal Sinusitis

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Introduction

More than 37,000,000, or one out of seven, Americans suffer from chronic sinusitis (CRS). During the last decade its rate of occurrence has been steadily increasing. Previously, the standard school of thought was that fungus allergy was involved in less than ten percent of cases. Until now the cause of chronic sinusitis was not known. Mayo Clinic researchers have identified the cause of most chronic sinus infections -- mold. Or more precisely, Allergic Fungal Sinusitis (AFS), a delayed immune reaction to mold.

Method

Six hundred twenty-four (624) patients were treated over 14 years. Patients were treated that were diagnosed by other physicians with arthritis, CFS, MPS, FM, and other immune system diseases.

The treatment approach included environment testing for colonies of fungus and subsequent cleanup, surgery where structural problems existed, and medications to remediate polyps and infections. Where the environmental conditions were not cleaned up, the CRS persisted as did the symptoms of the medical conditions listed above.

When the environment was improved to a standard of four fungal colonies or fewer identified per hour, the medical conditions improved significantly. Endoscopic photography and CAT scans were used to identify polyps and other structural abnormalities. Neurofeedback was attempted without success on several patients before environmental cleanup was accomplished and the CRS resolved.

Results

Neurofeedback training is largely ineffective when chronic fungal sinusitis is present. The underlying physical and environmental conditions must be addressed. These are key questions:

- Is heater location damp?
- Is heater located in dirt and/or wet crawl space?
- Is there a humidifier on furnace?
- Has there ever been a leak anywhere - roof, basement, water heater, sink, washer?
- Is there a noticeable musty smell?

- Do co-workers feel bad at the office?
- Do you feel better away from home or office?
- Do you feel better at beach or clean air environment?
- Do you smell musty odor when turn on car air conditioner?
- Is heater located in attic with blown in insulation?

Conclusion

The majority of CRS patients can experience long-term wellness by applying these principles:

- Treat CRS as always with medications, ESS when needed, and allergy treatment
- When the disease persists, obtain sinus and environmental mold cultures
- Use environmental treatment pack (ETP) to get the mold count below five (5) colonies in all areas that the patient spends most time
- Use saline nose irrigation
- Use antimicrobial nose sprays
- Boost the immune system with thymus vitamins as needed
- If not successful refer patient to W/U for possible underlying malignancy, autoimmune disease, immune deficiency, or endocrine disorder

If a client has CRS, that condition must be remediated before neurotherapy will accomplish the needed central nervous system "re-normalization."

Fear and FPO2: The Implications of a New Protocol

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Introduction

Although it is increasingly apparent that many psychopathologies are driven by fear, there is no direct reference to fear in the DSM-IV. Fear or fear-based memory, however, is a common factor in most serious psychological disorders including: PTSD, anxiety disorders, Reactive Attachment Disorder, Borderline Personality, Dissociative Identity Disorder, Asperger's and most addictions. The amygdala is responsible for generating fear. LeDoux (1996) postulates that the amygdala plays a central role in fear-based memory. Employing neurofeedback then, specifically targeting the amygdala, suggests a mechanism to address fear-based disorders.

Method

There are significant efferent pathways from the amygdala to the pre-frontal cortex. Schore (1994) and Siegel (1999) both speak about the pre-frontal orbital cortex as part of the amygdaloid system. The hypothesis tested was the value of training on the pre-frontal cortex, at a site off the 10/20 system designated as FPO2. Data is drawn from the training of 28 individuals at this site, in a clinical setting with a range of reward frequencies.

Results

Patients report a reduction in fear as well as a sense of calm and well-being after training at FPO2. This change in affect appears to persist over time. In addition to the positive outcomes of the 28 patients treated at FPO2 by the author, there is a substantial body of anecdotal experience provided by other practitioners confirming the efficacy of training at this site, particularly in fear-related disorders.

Conclusion

Neurofeedback training at the FPO2 site provides a new protocol for significantly reducing fear level, as well as reducing the negative affect associated with fear-based memory.

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Forehead Infrared Emissions: Feedback Training for Migraine Headache and Observations about the Signal

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Introduction

The question addressed in this study is whether the training protocol and equipment designed by Jeffrey Carmen (Toomim & Carmen, 1999), using infrared feedback from the center of the forehead to ameliorate migraine pain, can be replicated.

Method

Severe migraineurs (at least three/month) were recruited by flyer for an IRB approved, 8, 45-minute session, non-blinded, study in which the dependent variable was self report of migraine severity. With Carmen's method, infrared emissions are displayed in units of .01 degree F. on a visible bank of LEDs. Participants also watch a videotape of a film of their choice and are encouraged to raise the intensity of their infra red emissions. A threshold is set and the videotape is paused if emissions fall below threshold. The video resumes when emissions exceed threshold.

Results

The study is ongoing and this report is about the first 12 participants to complete the protocol. All participants learned how to raise their emissions in the first session. All but two reported decreased or no headaches for a period of two to five months. Two participants were migraine free at follow-up six months after their last session.

Discussion

Within the limitations of a non-blinded study there is evidence that increased infrared emissions from the forehead often inhibit migraine pain. Because of the position of the sensor, it appears that the orbital-frontal cortex is being affected by the feedback loop. It is not known why the effects are more enduring in some cases and less enduring or non-existent in others. Progress in increasing efficacy will depend on research which clarifies the underlying function tapped by the infrared signal. Toward this end, a study will be reviewed which suggests that the signal studied is part of a frontal lobe attention-arousal system.

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Memory, Music and Attention: Validating Neurofeedback

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In contrast to peripheral biofeedback, electroencephalographic (EEG) self-regulation is an undervalued application of psychophysiology in mainstream science and medicine. One reason for failure to meet acceptance and realize potential is the lack of formal validation of efficacy. While this has been demonstrated assiduously for slow cortical potentials over the years by Birbaumer and colleagues, and is well established in the case of peripheral biofeedback applications, it remains much of an open book for EEG frequency spectrum training, though widely applied for clinical and optimal performance purposes. In this presentation some attempts in my department will be reviewed. These focus on controlled studies evaluating conventional protocols designed to elevate theta, alpha, 'SMR' and beta frequencies. Outcome measures consisted of : cognitive measures including attention, memory, mental rotation and cognitive cortical evoked potentials; psychometry including anxiety and activation questionnaires; music performance; phenomenological report (Egner & Gruzelier, 2001, 2003 a, b, c, d; Egner, Strawson, & Gruzelier, Egner, Valentine & Williamson, 2002; Gruzelier et al, 2002; Vernon et al, 2003).

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Central 12 - 15 Hz Activity in ADHD

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Introduction

Twelve to fifteen Hz increase training is a common practice in the neurofeedback treatment of ADHD. This study was undertaken to determine the percentage of patients in a private clinic practice exhibiting elevated, normal, and decreased relative power in the 12-15 Hz range over the motor strip: C3, CZ, C4.

Method

The charts of 50 unmedicated, randomly chosen ADHD diagnosed patients were reviewed using the Thatcher NeuroGuide relative power 1 Hz bin maps, eyes-open and eyes-closed. Patients were male and female, child and adult, with the majority having comorbidities. Only 12-15 Hz at C3, CZ, and C4 were examined for elevations (1 SD or more) or deficits (-1 SD or less), or normal (within +1 to -1 SD).

Results

Of the 50 cases selected for this review 56% had one SD or more of 12-15 Hz activity at C3, CZ or C4 in either the eyes-open or eyes-closed condition. Twenty-four percent were less than +1 SD or -1 SD; 16% were equal to or greater than -1 SD; and 4% were mixed.

Conclusion

A majority (56%) of the ADHD subjects exhibited elevated 12-15 Hz relative power over the motor strip. These findings would suggest that up training these frequencies further may be contraindicated. This may also be the case for a subset of individuals with normal levels. If normalizing of QEEG abnormalities is part of what guides treatment, then one might theorize that down training 12-15 Hz may contribute to a reduction in symptoms and this is what has been observed from this clinician's experience. Further research is needed in this area.

Eyes-Closed and Eyes-Open QEEG Data: Similarities and Differences

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Introduction

Many QEEG-based neurofeedback therapists possess only eyes-closed (EC) databases and do most of their training in the eyes-open condition (EO). In this study 50 ADHD patients were evaluated for relative power EC and EO similarities and differences in these two conditions of relative power Z scores.

Method

Fifty cases were randomly selected at an ADHD private outpatient clinic who met the criteria for a diagnosis of ADHD and no current medication. EC and EO linked-ear, 1-Hz bin, relative power maps utilizing the Thatcher NeuroGuide database were obtained and reviewed for similarities or differences. A difference was defined as the need to train different frequency bands by a 2 Hz or greater increment and/or different locations by more than two locations (e.g., FZ to PZ, but not FZ to CZ). The Hudspeth NeuroRep database was used for corroboration with adults.

Results

Sixty-six percent of the patients were found to be "different" so that training for EC and/or EO would require different frequency bands and/or different locations.

Conclusion

The difference between EC and EO QEEG topographic maps of 66% in this sample suggests the possibility that different frequency bands and locations for intervention for EC and EO training may be indicated. It is this clinician's experience that training in both conditions, in only the bands and locations that are deviant, leads to improved treatment response.

Neurofeedback for Balance & Incontinence: Three Case Reports

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Introduction

Margaret Ayers discovered a neurofeedback protocol that assists in the rehabilitation of centrally mediated problems with physical balance and incontinence. This protocol, utilizing her Neuropathways digital equipment, places electrodes just barely above the inion ridge, directly below electrode sites O1 and O2.

Method

The protocol consists of inhibiting 4-7 Hz while rewarding 15-18 Hz. The amplitudes of the EEG are very small at this location, and thus the thresholds need to be adjusted accordingly. The use of this protocol with three cases will be described. All the cases involved problems with physical balance associated with stroke or head injuries.

Results

In addition to problems of balance, one of the cases also involved problems with urinary incontinence, but the author kept the treatment partially blinded by only telling the patient that this protocol was designed to improve physical balance. Nonetheless, improvements occurred in this case not only with balance, but the frequency of incontinence went from three to four accidents daily to only an infrequent accident as confirmed by both the patient and her mother. Balance improved in all cases and objective pre and post measures were collected in one of the cases.

Conclusion

The Ayers protocol for balance/incontinence appears promising and warrants further research. It was particularly impressive that patients commonly noted improvements within three sessions and total treatment may often be in the range of 10-15 sessions.

In Support of Neuroplasticity: All Digital Real Time EEG Biofeedback with Coma

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Introduction

Currently, there is very little if any effective treatment available, other than palliative care, for patients that remain in a coma for an extended period of time. This paper will present an overview of coma with an emphasis on the Glasgow Coma Scale (GCS) commonly used to measure depth of coma. On this scale three is the lowest ranking with the least chance of recovery and 15 is the highest level. This will be followed by data from three patients in comatose states subsequent to injuries received in motor vehicle accidents (MVA) and one with injuries from a subdural hematoma. Data presented using All Digital Real Time EEG Biofeedback (BFB) tracings will include changes in patterns of EEG activity, changes in ratings on the GCS, changes in levels of functioning, and discussion of implications for further research into coma recovery.

Method

All Digital Real Time EEG BFB (Neuropathways) was used to assess and train three coma patients over two or three weekends and another in the office on a weekly basis. Initial assessment was at C4T4, F4T4, C3T3, F3T3, O1O2, F4O2 and F3O1. Training consisted of numerous sessions over three days each weekend or for an hour in the office. Session length was determined by the brainwave pattern. Each session was terminated when there was a drop in Beta at 15-18 Hz. Session times ranged from forty seconds to ten minutes. Training involved inhibition of Theta (4-7 Hz) while monitoring Beta (15-18 Hz). Feedback to the patient consisted of verbal from the therapist and their families, audio from the BFB equipment, and vibrations from two speakers placed on their clavicles.

Results

Patient 1 was assessed by the physician at the start of training as GCS 5-6. EEG BFB training resulted in observable behavioral changes as well as changes in the EEG tracings. After two weekends of training the

patient was able to stand with assistance, push a cart, and say "Hello" and to swallow level 2 baby food. This was one-year post MVA. Patient 2 was assessed by the physician at GCS 3-4 initially and at GCS 8-9 several months after training. This was one-year post MVA. Patient 3 (GCS 7) and six years post MVA, has demonstrate an increase in control of head and eyes and well as an increased ability to swallow. Patient 4 (GCS 6) moving to GCS 11 is responding to verbal commands and reports the ability to see. All patients demonstrated an increase in the amplitude of Beta, a decrease in amplitude of Theta as well as an increase in the overall brainwave pattern.

Conclusion

This exploratory treatment resulted in decreases in the depth of coma and was accompanied by apparently long-lasting positive changes in the EEG activity and patient functioning. The apparently lasting shifts in EEG amplitude and frequency strongly suggest that the changes in brain function may be the result of changes in brain structure (neuroplasticity) that have been documented to occur as a direct result of the brains on going experience. If the brain can be taught to change with EEG BFB and the changes can result in such functioning changes as decreases in depth of coma, then the implications for future work with EEG BFB with this population in hospitals and long-term care facilities are almost unlimited. It should be remembered that at this time there are no known effective treatments available for this population.

Coherence Training

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Introduction

This presentation will give an overview of coherence and the advantages of its use. It will also discuss the effects of coherence training on follow-up quantitative electroencephalograms (QEEGs) and the changes produced by neurofeedback in the QEEG.

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 show that coherence training significantly changes several measures on the QEEG and, to a lesser degree this research shows that non-coherence protocols are 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.

Controversial EEG Patterns that Correlate with Behavioral and Neuro-Vegetative Symptoms

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The first of the controversial EEG patterns to be reviewed will be the positive spike pattern at 6-7 and 14/sec. The history starts with the Gibbises presenting this pattern in 1951 at the American EEG Society, followed by hundreds of papers, demonstrating that its appearance is mainly in teenagers with neuro-vegetative symptoms like headaches, dizzy spells, blackouts, etc., and behavioral disorders, especially impulsive acting-out behavior. The pattern became controversial for many reasons, especially from one study by an eminent pediatric neurologist who reported on a relatively small number of boys at a well-known New England private school. The most recent studies, mainly from the Orient, will be reviewed.

Next is the pattern of small sharp spikes, also called benign epileptiform transients of sleep (BETS). Studies have shown that the younger the patient and the larger the number of these spikes, the more likely the patient will have clinical seizures.

The third pattern is the 6/sec spike and wave. The review will show that there are two forms. One is called WHAM, referring to the pattern seen in the waking record: high in amplitude, anterior in location, and seen mainly in males. This form is clearly associated with seizures. The second form is called FOLD, referring to the high prevalence of females, occipital in location, low in amplitude, and seen in the drowsy state. The FOLD form is usually seen in patients with neuro-vegetative and psychiatric complaints.

Finally, the Rhythmic Mid-Temporal Discharge (RMTD) pattern will be reviewed, appearing in young adults with neuro-vegetative symptoms, often with bizarre behavior, and at times, with complex partial seizures.

Neurofeedback Training in Chronic Pain Syndrome

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Introduction

Peripheral biofeedback was used for more than 40 years in the treatment of various pain conditions. Neurofeedback has proved beneficial in Epilepsy, Attention Deficit Disorder, and in other disorders. This paper brings new data about the use of neurofeedback in chronic pain.

Method

Since 1996, 147 patients were referred to us for biofeedback training for different chronic pain syndromes such as headaches, back pain, Fibromyalgia, and Complex Regional Pain Syndromes. Patients were previously treated with other modalities without complete resolution of pain. Stress tests and depression/anxiety scales were taken periodically to monitor progress. Electrodes were set in varied positions according to 10/20 system, and based on the type or location of pain in each individual case. Sessions were 45 minutes long, and VAS pain scale was used pre- and post-training. The neurofeedback was done as

“simple neurofeedback” (audio-visual NF), and/or as neurofeedback enhanced by light or electromagnetic closed loop EEG (CL-EEG) neurofeedback. For example, Myofascial Pain Syndrome responded well to “simple neurofeedback” versus Fibromyalgia that required CL-EEG-Neurofeedback. Patients with different pain syndromes required different numbers of neurofeedback sessions.

Results

Out of 147 patients, only 74 completed 20 or more neurofeedback sessions. Out of 74, 68 cases (92%) reported improvement in their pain perception that was sustained for more than five years. We previously reported other longitudinal studies.

Conclusion

Neurofeedback training can permanently modify pain perception and pain affect. The effects obtained through neurofeedback training are based on operant conditioning. Birbaumer, Flor, Lutzenberger and Elbert (1995 and Rainville, Duncan, Price, Carrier and Bushnell (1997) have shown that pain has cortical and sub-cortical representation. Neurofeedback training addresses directly those areas corresponding to pain perception, memory, and affect. Neurofeedback training was enhanced by light or electromagnetic stimulation CL-EEG and the effects obtained were faster, greater, and longer lasting than those obtained through “simple neurofeedback.” We hypothesize that the neuromodulation obtained through enhanced neurofeedback may produce deeper neurophysiological regulations. To confirm this, further investigations are warranted.

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To Seam or Not to Seam: Evaluating Two Techniques for Eliminating Artifact

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Introduction

Artifact undermines the validity and reliability of quantitative EEG analysis. How we identify, minimize, and eliminate artifact in an EEG record can alter our findings and interpretations. Artifact in spectral analysis can be handled in the temporal or spectral domain (e.g., Croft & Barry, 2000; Janacek & Swift, 1993). In zero-crossing seaming, a popular temporal domain technique for handling artifact, contaminated data are eliminated from a time series and the time series is revised or refashioned by juxtaposing (connecting) uncorrupted data segments from either side of the artifact, often at the nearest zero-crossings. This technique is evaluated against a spectral domain technique based on averaging and multiple overlapping windows known in our lab as clipping. In clipping, the time series remains intact and the temporal positions

of contaminated data are noted. Spectral analysis is performed across the unaltered time series, ignoring spectral contributions of any period judged to contain significant amounts of artifact. This technique assumes that neighboring segments of artifact-free data represent the corrupted data to some reasonable degree.

Method

Seaming and clipping techniques were compared using pure sine waves and a variety of EEG records. One file of 5- and 10-Hz sine waves was used to evaluate techniques. Also, 17 data segments of increasing lengths in three EEG files were analyzed using multiple overlapping windows (98% overlap) for 19 channels and 24 single Hz bins (1-24 Hz). Finally, five randomly selected data segments in a 60-second file were designated artifact and analyzed using the approaches above. This process was repeated 16 times.

Results

In the pure sine wave analysis, spurious spectral components emerged as a result of seaming but not with clipping (as would be expected, as clipping does not alter the time series). Seaming-based spectral estimates were 20-40% less accurate than clipping-based estimates. Empirical evaluations revealed that both techniques were less accurate when artifact lengths grew large, as should be expected (e.g., averages are always less accurate the more the data are lacking). Nevertheless, clipping provided better spectral estimates than seaming in every record investigated. On average, clipping distorted magnitude estimates about 1-3 %, seaming 3-5 %. Seaming was even less favorable when calculating spectral variability, distorting standard deviations 40-100% more than clipping. Neither technique interacted with frequency band.

Conclusion

Artifact will always be with us. Clipping and seaming are both reasonable techniques, and each has its disadvantages. Although seaming is less accurate and prone to generating spurious frequency components, clipping requires a minimum of uncorrupted contiguous data (e.g., $\frac{1}{2}$ to 1 s). When using either technique, signal stationarity should always be considered. Finally, the seaming technique has the additional burden of matching phase between two artificially-juxtaposed signals.

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The Functional Meaning and Possible Physiological Basis of Theta and Alpha Oscillations for Cognitive Performance

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Introduction

Studies from our laboratory and other investigators indicate that different frequency bands in the theta and alpha range are associated with different types of cognitive processes. Whereas event-related changes in the theta band appear to be related to encoding and retrieval processes of a complex working memory system, the upper alpha frequency range responds selectively to sensory-semantic memory processes of a complex long-term memory system and the lower alpha band attentional processes.

Method

In a series of memory experiments spectral estimates for a resting period (resting power) and ERD/ERS during task performance were calculated. In addition, phase locking and evoked oscillations were measured by wavelet analyses.

Results

Findings from several experiments indicate that cognitive performance is superior when alpha ERD and resting power is large, but when theta ERS is large and resting power is small. Most interestingly, we have found a similar relationship for evoked oscillations and ERP components. In addition, recent results indicate that increased theta and alpha phase-locking is related to improved cognitive performance.

Discussion

The reported findings suggest that cognitive performance may be based at least in part by an interplay between the synchronous activation of three neuronal network systems: a working memory, attentional, and semantic memory system, each operating with a different frequency, the first in the theta (about 6 Hz), the second in the lower alpha (about 8 Hz), and the third in the upper alpha (about 12 Hz) frequency range. The implications of this theoretical framework are discussed by considering phase sensitive measures to analyze local and large scale integration processes between different neural networks.

Event Related De/Synchronization (ERD/S) Based Neurofeedback

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Introduction

Event related de/synchronization (ERD/S) is a current EEG power computed for a given frequency band in response to a sensory stimulus or movement and in relation to a pre-stimulus or pre-motor time interval. This parameter reflects changes in the oscillating state of the cortex associated with a given event. In contrast to stationary spectrograms, ERD/S shows how the brain reacts to a certain behavioral task at different time intervals after stimulus presentation or motor action.

Method

The paper presents an overview of the ERD/S method in relation to neurofeedback. In particular, the method of wavelet decomposition (that gives an EEG power-time-frequency representation of the cortical

response) will be described. The method will be compared with ERP (event-related potentials) approach.

Results

The results of the author's study of ERD/S in response to GO/NOGO stimuli in ADHD children will be presented. Using the wavelet analysis we studied 19-channel EEG responses measured for GO and NOGO stimuli in normal (n=30) and ADHD (n=120) groups. Our data show that event related de/synchronization in alpha band as well as event-related synchronization in beta band correlate with age and task performance. These reactions are smaller in young children in comparison to older ones, and in the ADHD group in comparison to the normal group. Twenty sessions of relative beta EEG training improved the quality of performance (decrease of omission and commission errors) and led to significant changes in ERD/S.

Conclusion

This study indicates a high diagnostic power of ERD/S in discriminating executive dysfunctions. It also shows that the ERD/S method provides a powerful tool for prescription of individually tailored neurofeedback protocols.

QEEG Changes in the Recipients of Ceremony and Prayer

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Introduction

Studies are accumulating showing that prayer affects physiological conditions, including recovery from myocardial infarction and survival in the coronary care unit. Markers are needed to indicate when prayer is working and to help explain how intent and thought (non-physical information) interact with matter (the human body).

Method

The subjects' QEEG is recorded at 256 Hz with Lexicor equipment. Relative power, absolute power, and cordance are calculated. Hierarchical linear modeling techniques are used for statistical analysis. A control condition duplicates the sensory experiences of a Native American prayer ceremony, but without the actual intent to pray or the use of the sacred. Subjects are blindfolded. The actual ceremony is conducted with sacred objects, a Native American healer, and traditional songs.

Results

Using the control ceremony as baseline, significant differences are observed during the real ceremony, including increases in left prefrontal cordance in both delta and theta, right temporal cordance in delta and theta, central alpha cordance, and right occipital alpha cordance. Relative power increases are seen for delta and theta in the left prefrontal cortex, the right temporal cortex, and for alpha in the right occipital cortex. Absolute power decreases overall by 20% during the ceremony. Subjects report both ceremonies feel authentic and have powerful spiritual experiences in either ceremony. The largest changes occur during

the point in the ceremony in which the first sacred song is sung and during the time in the ceremony when the formal prayer occurs.

Conclusion

QEEG markers may exist to indicate when a subject is actually the recipient of prayer. An interaction may occur in the brain's biofield to indicate interaction of spirit and matter. Further studies are underway to determine if the healer must be in the room with the recipient of the prayer, or if distant prayer will show similar phenomena.

Update of EEG-Biofeedback Treatment of Anxiety Disorders

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In 2000 the author published a review of the EEG-biofeedback treatment of anxiety disorders (Moore, 2000). Only controlled studies in peer-reviewed journals were included. Enhancement of alpha, theta and alpha-theta were effective treatments. Alpha suppression was also effective, but less so. Perceived success in carrying out the task played an important role in clinical improvement. It was concluded that research was needed to find out how much more effective these treatments were than placebo, and which variables were important for efficacy. Variables needing study were: duration of treatment, type and severity of anxiety, number and type of EEG waveforms used, pre-treatment with other kinds of biofeedback, position and number of electrodes, and presence of concomitant medication. Analysis of a further three years of publications has been carried out, and an update on progress will be presented.

Reference

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Effects of Audio-Visual Stimulation (AVS) on the Hemoencephalographic (HEG) Response

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Introduction

Previous research with audiovisual stimulation (AVS) has demonstrated that repetitive fixed-frequency visual stimuli have measurable and reliable influences on the EEG. This study extends investigation of these effects to a different response modality, regional blood flow as measured by Toomim=s method of hemoencephalography (HEG).

Method

Adult subjects participated in multiple sessions consisting of three-minute periods of AVS stimulation alternated with baseline periods of no AVS. Stimulus conditions were initiated only at times when the HEG

response demonstrated no systematic downward or upward trend. AVS consisted of red light delivered to closed eyes at an illumination level determined to be comfortable by the individual. Each individual was exposed to three frequencies of visual stimulation: 0.5 Hz, dominant alpha frequency, and 18 Hz, presented in random order across the series of sessions. The HEG response at Fpz was recorded throughout each session; individuals received no feedback regarding their HEG levels. HEG levels immediately following each stimulus period were compared to the preceding no-AVS baseline.

Results

AVS produced reliable elevations in HEG levels. Higher frequency stimuli tended to produce larger changes in the HEG. Elevations generated by AVS tended to be short-lived after termination of exposure to the stimulus, however.

Conclusion

Implications of these findings for potential therapeutic effects of AVS will be discussed. The possibility of a combined modality which includes both AVS and HEG neurofeedback will also be considered.

Neglected Neurobehavioral Areas of Traumatic Brain Injury

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TBI is a process occurring at a patient's developmental stage, whose outcome is dependent upon the baseline, the nature of the brain and somatic injury, and environmental support, opposition, or neglect. Its phases can be conceptualized: Primary: Neurotrauma at the moment of injury caused by kinetic forces; Secondary: Pathophysiological processes initiated by primary trauma: hemorrhage; ischemia; neurotoxic, etc.; Tertiary: Late physiological dysfunctioning consequent to damage to the hypothalamic-pituitary-endocrine axes; hyper- and hypo-arousal related to stress; Quaternary: Late neurological conditions (e.g., seizures; dystonia; neurodegenerative diseases); Special problems of children.

The range of potential dysfunctions reflects human adaptation: (a) Neurological (consciousness, body schema; sensorimotor, cerebral personality disorders); (b) Cognitive (mental ability cognition; memory; communications; mental control, information processing, executive functions); (c) Mood and affect (psychodynamic mood and reactions to impairment and injury); stress reactions (initial anxiety and persistent unhealed wounds): morale and world view; "distracting" symptoms and their effects (e.g., pain and headaches); (d) Integrative (autoregulation; identity); (e) Adaptive (social and affiliative; restitutive capacity).

Some neglected and poorly conceptualized areas merit research and clinician care: Lack of an accepted definition of TBI reflecting different intensities of injury (e.g., the vague definitions of "mild" TBI or concussion) and the unknown significance of the presence or absence of altered consciousness.

Head injury is frequently ignored in the emergency room, subsequent clinical consultations, and schools. The patient or parent may conceal it, and symptoms may not be known to be TBI, or taken seriously. Assessment of status, treatment, and outcome focus on symptoms, but not on deficiencies of adaptation

and dysregulation. Not considering physiological and neurochemical interactions with the CNS consequent to unhealed somatic wounds, which affect cerebral function. Dysfunctions are mis-attributed to TBI or not considered: allostatic load (disturbance of homeostasis after chronic adaptive failure; stress system; locus ceruleus-noradrenergic system; hypothalamic-posterior pituitary; circadian and other rhythms significant for endocrine secretion; inflammatory system (wound repair); immune system wound detection (i.e., not-self); ignoring the contribution of TBI to other disorders. I have a series of 14 cases of chronic fatigue syndrome in which 12 individuals had a prior minor or major concussion. Eleven apparently had neurotoxic exposure.

Assessment errors include: not considering personal characteristics: genetic and constitutional conditions; pre-existing conditions; age at injury (including further brain development until adulthood); possibility of late-developing symptoms; sense of identity; stress resistance, including hardiness, coping capacity, and resilience; not utilizing comparison with an estimated pre-injury baseline; too narrow a range of examination, so that dysfunctions are missed, leading to mis-diagnosis, lack of treatment and incorrect assessment of outcome; mis-attribution of symptoms to cerebral injury rather than somatic injury or peripheral nerve damage (motor aprosodia; headaches consequent to referred pain from neck and shoulders); insufficient interviewing (missing partial seizures; missing mood disturbances so that dull affect is misinterpreted as patient insincerity instead of motor aprosodia or organic depression).

Visual Neurophysiology for the Neurometric Clinician

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Introduction

Anecdotal reports and limited studies have suggested possible clinical utility of QEEG and neurofeedback for visual problems (Colson, 2001; Ordmandy, 2003). This paper will provide a comprehensive review of the epidemiology of central nervous system(CNS)-based visual dysfunction among the populations most frequently encountered by neurofeedback practitioners, functional visual neuroanatomy, published studies using QEEGs and neurofeedback for rehabilitation of CNS-based visual dysfunction, and case presentations to demonstrate several clinical areas of current research.

Method

A literature review and case presentation will address the use of QEEG and neurofeedback in cases of oculomotor dysfunction in ADHD, amblyopia, binocular vision dysfunction in TBI, "blindsight"/hemianopsia in CVA, and visual hemispatial neglect syndrome.

Results

Attendees will receive a thorough review of the emerging field of visual neuro-rehabilitation and the role of visual stimulation in guiding neural cognitive processes.

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Brain and Consciousness Re-Assessed

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Contrary to what is the current opinion in philosophical circles my view is that consciousness makes communication between organisms MORE accessible. There are some problems to this view which are summarized by two philosophical positions: (1) that consciousness is an epiphenomenon, and (2) that consciousness supervenes directly on brain processes. Both of these positions are, in themselves, wrong but can be rescued when both are seen to have a place in the time course of the brain processes that make conscious experience possible. The details will make up the keynote presentation.

Case Study: Ten Year Old Male with Asperger's Syndrome

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Introduction

The purpose of this study was to explore the effectiveness of neurotherapy in the treatment of Asperger's Syndrome. A comparison was performed using neurological and behavioral data of a 10-year-old boy with Asperger's Syndrome before and after 40 sessions of neurotherapy conducted over the course of a year.

Method

An electronic QEEG was recorded using a Lexicor 19 channel system with eyes closed, eyes open, and two tasks: reading and math. This was performed before and after 40 neurotherapy treatment sessions using Neurocybernetics training equipment. The QEEG data were analyzed using the SKIL Topometric analysis program. In addition, a modified version of the Australian Scale for Asperger's Syndrome was filled out by the child's mother before treatment and again after 40 sessions. A structured intake format with behavioral ratings was performed prior to treatment and an analogous form was filled out by the child's mother after 40 sessions. A comparison was made between the pre- and post-treatment analyzed QEEGs, modified Australian Scale for Asperger's Syndrome and behavioral ratings.

Results

After 40 sessions of neurotherapy the subject showed an approximate 2/3 improvement in behavioral

ratings. The post-treatment QEEG showed significant reductions in elevated 6-9 Hz slow wave activity in the medial and central-parietal regions with eyes open. There was also a dramatic reduction in the magnitude of elevated 9-12 Hz activity in the parietal and occipital regions with eyes open while reading and while performing math.

Conclusion

The subject, who was 11 years old at the time of reevaluation, experienced significant improvements in both neurological and behavioral functioning after 40 sessions of neurotherapy administered over the course of a year.

A Comparison of QEEG Characteristics in Pediatric Asperger's Syndrome and Attention Deficit Disorder

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Introduction

The purpose of this study was to evaluate the QEEG characteristics of seven children with Asperger's Syndrome and to compare them to seven children with Attention Deficit Disorder. Each group consisted of six males and one female ranging in age from five to fifteen years.

Method

Electronic QEEGs were recorded on each subject using a Lexicor 19 channel system during eyes closed, eyes open, and two tasks: reading and math. The data were analyzed using the SKIL Topometric Analysis Program. A comparison was made between the analyzed QEEG data from the Asperger's Syndrome and the Attention Deficit Disorder populations.

Results

The QEEGs of the Asperger's Syndrome subjects showed common functional features including: elevation of 4-7 Hz activity in the posterior regions, slowing at the vertex and regulatory dissociations between anterior and posterior regions of the cortex. In contrast, Attention Deficit Disorder subjects showed elevations of 4-7 Hz activity in the anterior and central regions, slowing at the vertex, and an absence of regulatory dissociations between the anterior and posterior regions of the cortex.

Conclusion

Although people with Asperger's Syndrome often present for treatment for symptoms associated with Attention Deficit Disorder, they show a marked difference in QEEG characteristics.

Informed Consent & Liability Protection in Neurotherapy

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Competent performance of neurotherapy requires adherence to ethical and legal norms that protect the therapist and the patient. New theories developed by attorneys suggest the wisdom of utilizing additional procedures of risk management that are easy to implement and serve as a valuable safeguard against potential liability. Informed consent in using quantitative EEGs and neurofeedback will be discussed and a sample informed consent form will be explained.

The Neurobiology of Childhood Trauma

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Introduction

Child welfare agencies in the USA receive more than three million reports of child abuse and neglect annually, one million of which are confirmed. It is generally thought that treating child abuse is primarily a matter of psychological intervention and that healing the wounded child within is possible through these means. Recent research by Teicher and Andersen are finding that cortisol releases from childhood trauma may cause permanent damage to the cerebellar vermis, hippocampus, amygdala and other limbic structures within the left hemisphere. Damage to these structures has been linked to manic-depression, schizophrenia, autism, ADHD and anxiety disorders. Because of this neurological damage, adult survivors of child abuse often show borderline personality disorders and have difficulty interacting socially. Studies by Teicher using coherence measures show dysregulation of these structures.

Method

The Mindset, a 16-channel QEEG system (with modified input amplifiers) was used to collect data in eyes closed, eyes open, reading and math conditions. The data was analyzed using the SKIL brain-mapper and normative database. Data was analyzed in the following categories: magnitude in 1 Hz bins and Acomodulation. @ Comodulation is unique to the SKIL software (cross-correlation of spectral analysis over time) but has similarities to coherence (cross-correlation of phase angle over time). Both systems are a measure of association between the various cortical regions based to the 10-20 system of electrode placement.

Results

In some cases alpha slowing was observed, but the comodulation measure showed the most striking results. A large degree of dissociation was observed in posterior regions of the brain. In particular, T5 showed dissociation. All participants also expressed difficulty with learning a second language such as French (which is taught in Canadian schools). They also reported difficulty in remembering people's names, and most had a general dislike of crossword puzzles and activities relating to language.

Conclusion

These observations, although preliminary, appear to be a reliable diagnostic tool for assessing the Asignature@ of childhood trauma. These results support Teicher's observations using coherence.

The Neurological Basis of Eating Disorders. I: EEG Findings and the Clinical Outcome of Adding Symptom-Based, QEEG-Based, and Analog/QEEG-Based Remedial Neurofeedback Training to Traditional Treatment Plans.

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Introduction

Eating disorders are associated with the highest mortality of any DSM-IV diagnosis (Fichter & Quadflieg, 1999). Despite dedicated efforts, intervention has proven only modestly effective. Because of this resistance to treatment, neurofeedback was added to the more traditional treatment modalities to determine if clinical outcomes could be improved. Previous EEG research in those with eating disorders revealed significant generalized abnormalities and unstable responses to hyperventilation (Crisp & Fenton, 1968), and inappropriate Theta activity in the right parietal region, both before and after weight gain (Grunwold & Ettrior, 2001). Our study was designed to further evaluate the EEG findings in those with eating disorders, report the clinical benefit of adding neurofeedback to traditional medical and psychological treatment modalities, and compare the initial results of three different approaches to neurofeedback training.

Method

Personality, stress indices, and attentional screening tests were administered to 120 patients being admitted to a residential treatment center. One third of the treatment group received pre-QEEG evaluation prior to neurotherapy interventions.

The neurofeedback protocols used were from one of three basic clinical approaches: (a) symptom-based, (b) QEEG-based, using traditional neurofeedback protocols, and (c) task-activated, analog/QEEG-based training using research-confirmed training protocols.

Results

In all three neurofeedback approaches, BDI scores, neuroticism scores, and EDI scores demonstrated significant change. Weight changes were in the desired direction.

EEG/QEEG findings will be reviewed, but, in summary, right brain dysfunction and significantly increased Delta slow wave activity with cognitive challenge were common.

The initially determined difference in the three neurofeedback training approaches is that the research-designed training protocols are statistically more likely to reduce or eliminate the need for medication.

Conclusion

Our study confirms that EEG abnormalities are commonly present in those with eating disorders. Importantly, adding neurofeedback to traditional treatment protocols to address these neurological issues significantly enhances treatment outcome.

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Sequential Electroencephalographic Comodulation: Analysis of Spatial-Temporal Reorganization of the Brain during Transients and Transitions

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Introduction

Analysis of the moment-to-moment correlation in spectral magnitude trends in a given frequency between pairs of electrode sites has been labeled "comodulation." Mathematical analysis has shown that this measure is both accurate and valid for data samples as brief as one to two seconds. This fact was exploited here in an evaluation of relatively brief and sequential changes in spatial-temporal organization accompanying abnormal EEG transients or transitions between functional states.

Method

Standard 10/20 EEG data were obtained with linked ear reference from 10 clinical patients who displayed either abnormal EEG transients or sustained, recurrent state changes during recordings. Transients were noted with eyes closed or open, and during tasks, while state changes involved transitions into and out of drowsiness and sleep with eyes closed. EEG transients lasting two to five seconds were averaged and compared to associated baseline data. State changes were processed as sequential five to ten second samples across transitions. Using the SKIL program, digitized data streams were subjected to spectral transform and between-site correlation analysis in relevant frequency ranges. Findings were compared statistically to a normative database.

Findings

Comodulation analysis in the posterior dominant frequency band showed a range of relatively normal to mildly attenuated correlation patterns in patients with closed head injuries and behavioral disorders. Analysis of the slower frequency bands identified during abnormal transients disclosed a significantly disturbed pattern of correlations, with frontal areas showing generalized dissociation and posterior areas excessive comodulation. Patients with head injuries showed a generalized posterior hyper-comodulation,

while behavioral disturbances showed hyper-comodulation that was more localized to temporal and left posterior quadrant areas. State transitions were characterized by a relatively abrupt hyper-comodulation between frontal and occipital regions in the dominant frequency band, and then between frontal and parietal areas in slower theta and delta frequency bands. These changes were reversed with transition to resting wakefulness.

Conclusions

These preliminary findings provide only for speculation at this point. The transient patterns evaluated here in closed head injury and behavioral disorders were generally associated with disturbances in executive integration and related (consequent?) loss of perceptual differentiation. This effect was most diffuse in head injury patients. Transitions to and from periods of sleep suggested an initial loss and then recovery in the frontal executive regulation of first occipital and then parietal activities. Further analysis is under way.

Cranial Electrotherapy Stimulation for the Treatment of Centrally Mediated Disorders.

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Introduction

Cranial electrotherapy stimulation (CES) is a non-pharmacological therapy involving the application of a small amount of current, usually less than 1 milliampere, through the head via ear clip electrodes. It was developed in the Soviet Union in 1954, and its use spread to the U.S. in the late 1960's. Until recently, it was little known to the neurofeedback community. A recent series of studies by Hefferman (1997) proposed the use of spectral smoothness as a model to evaluate the effectiveness of CES in treating pain. This paper will present a state of the art review on CES and its potential benefits to neurofeedback providers.

Method

A literature review of the research on CES was conducted using the standard databases, including PubMed and PsychInfo.

Results

Reviews of 126 human studies and 29 experimental animal studies indicate that CES has been used to successfully treat a variety of centrally mediated conditions including insomnia, stress-related disorders, anxiety, depression, pain (including fibromyalgia), and addiction. It has also been shown to potentiate the effects of analgesia, psychotropic medications, biofeedback and psychotherapy. Several mechanisms of action have been proposed including stimulation of the hypothalamic-pituitary axis, normalizing brain functions and neurotransmitters, and stimulation of the pain neuromatrix.

Conclusion

CES is effective for the treatment of many centrally mediated disorders including stress, depression, anxiety, insomnia, addiction, fibromyalgia and other pain conditions. It has the ability to potentiate

analgesia, psychotropic medications, biofeedback and psychotherapy. Future research should investigate the synergistic benefits of systematically combining and/or integrating the use of CES in EEG biofeedback.

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EEG Discriminant Analyses of Children with Learning Disabilities

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Introduction

To evaluate the ability of the qEEG to discriminate between age-matched normal children and children diagnosed as learning disabled and to correlate the qEEG with school achievement and neuropsychological test scores.

Method

The EEG power spectrum was measured in resting eyes closed from 19 scalp locations in two groups of children: (a) children diagnosed as learning disabled by being two grade levels or more below average in school achievement tests, and (b) an age-matched normal control group (N = 282) with no history of learning disabilities or problems in school. EEG coherence, phase, anatomical power ratios, absolute power, relative power and relative power ratios were the qEEG variables. T-tests and factor analyses were used to select a reduced set of qEEG variables to enter into discriminant analyses. The behavioral dependent variables were the Wide Range Achievement Test (WRAT) to measure school achievement and the WISC-R sub-tests to measure cognitive function in all of the 356 children.

Results

Cross-validated qEEG discriminant sensitivity was 94.59%, specificity 99.3%, ppv 94.59%, and npv 98.62%. Eight of the nine discriminant variables were EEG power differences. Theta/Beta ratios from specific electrodes were important in the analyses and EEG coherence and EEG phase were comparatively weaker.

Conclusion

Temporal lobe EEG amplitude frontal EEG amplitude and 2-posterior EEG amplitude frontal EEG amplitude is linearly related to good school performance and discrimination between learning disabled children and age matched normal controls.

Eyes Open and Eyes Closed EEG Difference Norms

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Introduction

The problem under study is the statistical validity of eyes-open vs. eyes-closed EEG norms.

Method

EEG was acquired in the eyes-closed alert condition and the eyes-open alert condition from four hundred and seventy seven individuals (N = 477) ranging in age from 3 years to 82 years of age with no history of neurological disorders and performing at grade level and/or otherwise normal. Neuropsychological tests including the WRAT and WISC-R were measured in 233 of the subjects. FFT Power spectral analyses were performed on edited samples of EEG from all of the subjects in the eyes-closed and eyes-open conditions. Differences between eyes open and eyes closed were calculated for all spectral measures and the means and standard deviations for four different age groupings were computed in four different age groupings: (a) Three years to 4.99 years; (b) 5 years to 9.99 years; (c) 10 years to 12.99 years, and (d) 13 years to 82 years. Measures of skewness and kurtosis were computed and transforms applied in order to approximate gaussian distributions for each age grouping. Gaussian cross-validation was then performed by computing a Z score for each measure and each subject and testing for gaussianity and from this computing sensitivity measures. The difference norms for eyes open and eyes closed were then correlated with neuropsychological measures.

Results

The results of the analysis demonstrated close approximation to gaussian distribution and adequate levels of sensitivity and clinical correlation.

Conclusion

This study showed that eyes-open vs. eyes-closed differences are statistically and clinically valid and help to further define the nature of brain dynamics and the allocation of resources between these two states.

Asperger's and ADD Differences and Similarities- Preliminary Observations

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Introduction

Autistic spectrum disorders are characterized by primary deficits in the ability to interpret, initiate and maintain social interactions, handle anxiety, and sustain external attention. Asperger's do not have the language delays that are characteristic of autism. They exhibit the classic symptoms of Attention Deficit Disorder and are often diagnosed first as ADHD. In Asperger's, anxiety in social situations appears to be at the core of their difficulties. In ADD, anxiety can be a protective factor that can result in the child doing well

academically and not acting out.

Findings

Preliminary observations concerning the EEG in Asperger's appears to be showing slowing (theta and alpha) in the right parietal and temporal areas (P4, T6) and, at times, frontally at F3 and F4. There are also findings of comodulation (spectral correlation) differences including hyper-comodulation between P4, C4 and F4 and a comodulation 'disconnect' between the right cerebral hemisphere sites and the left frontal area. However, these children also show the characteristic patterns seen in ADD with slowing at C3, Cz and C4, and/or at F3 and Fz with a 'dip' in 13-15 Hz (SMR) across the central region (C3, Cz and C4).

On intellectual and academic testing Asperger's children often show excellent verbal and reading capacities (left hemisphere strengths) and they tend to have symptoms of non-verbal learning disabilities (right hemisphere problems). The ADD children, on the other hand, may perform well on non-verbal performance tasks but demonstrate increased incidence of preschool speech disorders (Love & Thompson) and reading difficulties in the early school years.

Discussion

In Asperger's and ADD 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. In Asperger's 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.

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The Effects of Response Predictability on HD-ERP and RT Measures across Studies of Deception

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Introduction

High-density brain event-related potentials (HD-ERPs) and reaction times (RTs) related to deception were examined. Previous ERP studies of deception manipulated recollection of past events to study waveforms associated with deceptive responses (Boaz, Perry, Raney, Fischler, & Shuman, 1991; Dionisio, Granholm, Hillix, & Perrine, 2001). This manipulation potentially confounds the ERP results of deceptive responding. To circumvent the memory issue, three experiments were undertaken in which participants were directed to lie or tell the truth (deception) by agreeing or disagreeing (congruity). Response predictability was modified between studies; each study provided fewer predictive cues than the previous study.

Hypotheses: We expected that: (a) increased preparedness to lie would be associated with decreased RTs, (b) deceptive responses would have longer RTs than truthful responses, (c) RTs would be longer for incongruent than congruent responses, (d) a larger N4 for incongruent responses, (e) a larger N4 for deceptive stimuli, and (f) changes in the P3 related to deception, response congruity, and test difficulty.

Method

Participants included 105 right-handed undergraduate students (ages 18-43, $M=21$, $SD=5.77$) with normal vision and no known medical disorders.

Participants viewed a series of color-coded statements that were obviously true or false (e.g., I am human.) followed by a second stimulus (e.g., TRUE). During presentation of the second stimulus, participants pressed a key to indicate whether the second stimulus agreed or disagreed with their answer to the first stimulus. Participants were randomly assigned the stimulus color to which they would respond deceptively; another color cued truthful responding.

In the first experiment, both stimuli were color-coded to cue participants to respond truthfully or deceptively and whether or not to respond congruently. In the second study, the color of the first stimulus predicted only deception, while the second stimulus provided cues to both deception and congruity. In the third study, neither deception nor response congruity was cued by the first stimulus; only the second stimulus provided deception and congruity cues.

Results

Our data show that response demand predictability affects both reaction time and ERP measures in the detection of deception. Significant effects were noted for the effects of deception, congruity, and predictability on the P3a, P3b, and N4 waveforms, as well as on reaction time. ERP and RT measures consistently identified deception across paradigms.

Conclusions

Three waveforms with similar spatio-temporal distributions were investigated in the three paradigms: an early positive component (P3a) related to attentional switching, a subsequent centro-parietal positivity (P3b) related to workload, and a late-occurring negativity (N4) related to response congruity. The ERP findings support a theory of deception in which early attentional processes are followed by evaluative and decision-making processes, and then by a final reanalysis. In addition, the RT data indicate that decreasing response predictability increases task difficulty, resulting in longer reaction times. Modified ERP response, coupled with reaction time data, consistently identify deception across paradigms. This suggests that both measures can be used as markers to identify deceptive responding. These data provide further evidence of the applicability of ERP measures in real-world detection of deception.

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Quantitative EEG of Convicted Murderers

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Introduction

Quantitative electroencephalographic (qEEG) data were collected from 71 men convicted of murder and sentenced to death and 23 brain-damaged sex- and age-matched controls. The literature consistently shows that brain damage is more common in violent offenders than nonviolent offenders (Mednick, Brennen, & Kandel, 1988; Lewis, Lovely, Yeager, & Femina, 1989; Weller, 1986). This study examines the qEEG of individuals sentenced to death who presumably committed extremely violent acts; information about these individuals= characteristics should especially valuable for research into the etiology of violence.

Method

QEEG assessments of convicted murderers were completed on several different occasions over a multi-year period. During the same period, qEEG was collected on controls in hospital and private-sector settings. Study 1 included data from 46 convicted murderers and the 23 controls. Study 2 included data from a different sample of 25 convicted murderers compared to the original controls. Approximately three minutes of EEG activity was sampled from 19 scalp electrode sites during two eyes-closed conditions in both studies.

Following artifact correction, mean magnitude was calculated for the following frequencies: low-theta (3.5-5.45 Hz), high-theta (5.5-7.45 Hz), low-alpha (7.5-8.45 Hz), mid-alpha (8.5-11.45 Hz), high-alpha (11.5-13.45 Hz), beta-13 (13.5-16.45 Hz), and beta-16 (16.5-19.45 Hz). Coherence and peak frequency were calculated for all sites for delta, theta, alpha, and beta frequency bands.

Results

In both studies, convicted murderers consistently had significantly lower mean peak-to-peak magnitudes than controls, except for low-theta and mid-alpha bands.

In Study 1, theta coherence in both conditions was significantly lower at FP1 and FP2 in convicted murderers than controls. In Study 2, this effect was identified only in the second eyes closed condition. At T6, theta coherence was higher in the second eyes closed condition of study 1, and in both conditions of Study 2. In Study 1, theta coherence was higher for O1 and O2; this effect was not replicated in Study 2. Beta coherence was greater for convicted murderers than controls at F2, T6, O1, and O2 across all conditions of all studies and greater for F1 in all but the first eyes closed condition of study 2. This essentially replicates the findings of Evans and Park (1997).

In Study 1, convicted murders had a significantly lower peak frequency in the theta band than controls during both the first eyes closed $t(67) = -2.06$, $p = .043$, and the second eyes closed conditions $t(52) = -3.11$, $p = .003$. In the second study there was a similar trend in the theta band for both conditions [$t(45) = -1.82$, $p = .076$ and $t(42) = -1.98$, $p = .054$, respectively].

Conclusions

These findings suggest the potential value of including qEEG assessments in comprehensive forensic neuropsychological evaluations. Clinicians in the field of neurofeedback are demonstrating that one's learning of voluntary control over EEG parameters via appropriate feedback can lead to remission of symptoms of various disorders, including the symptoms of traumatic brain injury. Diminished mean peak-to-peak magnitude has been correlated with age-related changes (Breslau et al, 1989). However, other potential explanations exist.

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Long-term Remediation of Seizures in Refractory Epilepsy with QEEG-Guided Neurofeedback Training

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Introduction

A 31-year-old man had recurrent partial complex and secondarily generalized seizures and frequent episodes of status epilepticus. Treatment with nine different anticonvulsants singly, and in combination, did not control his seizures or prevent status episodes. He was not a surgical candidate because depth electrode monitoring revealed independent foci of onset in the left and right temporal lobes. A vagal nerve stimulator was implanted and did not reduce his seizures or prevent episodic status epilepticus.

Method

A QEEG (John database) revealed an increase in absolute theta at F7 and T4 and increased relative theta at FP1, FP2, F7, and F8. Decreased coherence of theta was found at T3/T5, O1/O2, and C3/C4. Decreased beta coherence was found at O1/O2. Training was done three times per week. First, theta coherence was down trained at T3/T5 (10 sessions), then O1/O2 theta coherence was down trained (5 sessions). Next, beta coherence was down trained at O1/O2. Then theta coherence was down trained at C3/C4. Finally, theta was down trained and SMR (12-15 Hz) was up trained at T3.

Results

Since completion of the first protocol, there have been no further episodes of status epilepticus. Generalized seizures decreased to one per week after the first protocol and none have occurred since the second protocol was done. Partial complex seizures decreased to 10 per week after the first protocol, to 5 per week after the second, and 1 per week after the third. When an increase in seizure frequency was noted with the fourth protocol, it was discontinued and the fifth protocol was done. Training was completed December 1, 1998. The patient has had no more seizures. He was able to return to work full time and to begin driving again. Phenytoin was discontinued in October of 1998. His speech is no longer slurred and his memory is improved. He chose to continue his other medication, not wanting to risk a seizure while driving.

Conclusion

This case illustrates the powerful potential of QEEG-guided neurofeedback in the management of severe epilepsy. The training is noninvasive and was effective in a relatively short time. The cost is quite low compared to epilepsy surgery or vagal nerve stimulation. It may prove to be particularly important for drug resistant epilepsy. The combination of coherence training with traditional power training may work better than either approach alone.

Splitting the Normal Brain

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Introduction

The split brain serves as a model system for modularity in the human mind/brain (Zaidel, Clarke & Suyenobu, 1990). Each cerebral hemisphere is an independent, if different, cognitive system, including its own perception, memory, language and sense of self. The two hemispheres can process information independently and in parallel. And yet, the split brain patient appears normal in everyday behavior, possessing a seemingly unified consciousness. How is that possible?

Methods

We review the latest findings from split brain research with special reference to right hemisphere language, unified and divided systems of attention, interhemispheric transfer, interhemispheric control, and the unity of consciousness. We next use the split brain as a model to operationalize hemispheric independence in the normal brain.

Results

Several systems of attention regulate interhemispheric interactions in the split brain. Some are split and regulate information processing in one hemisphere, whereas others are unified and permit interhemispheric coordination. Indeed, certain interhemispheric attentional effects, normally inhibited by the corpus callosum, are magnified in the split brain (Iacoboni, Ptito, Weekes, & Zaidel, 2000). A surprising amount of cognitive information can transfer between the hemispheres subcallosally and unconsciously, and this is subject to individual differences (Zaidel, 1994).

The language repertoire of the disconnected right hemisphere is surprisingly rich, especially in comparison with residual language following aphasiogenic left hemisphere lesions. Some disconnected right hemispheres even exhibit speech (Zaidel, 2001). However, effective error monitoring requires interhemispheric cooperation and is impaired in the split brain (Kaplan & Zaidel, submitted).

Many lateralized behavioral tasks follow the split brain model. Thus, lateralized lexical decision with target words and pronounceable non words reveals independent hemispheric profiles, with a remarkably rich language competence in the normal right hemisphere, exceeding the language repertoire of the disconnected right hemisphere (Iacoboni & Zaidel, 1996). By contrast, dichotic listening to stop consonant-vowel (CV) syllables, which calls for phonetic analysis, shows exclusive specialization in the left hemisphere (LH), so that the left ear (LE) score reflects both callosal relay and LH processing (Zaidel et al., 1990).

Conclusion

Each disconnected hemisphere is capable of adaptive problem solving, has feelings, and possesses a distinct concept of self, complete with a sense of past (Schiffer, Zaidel, Bogen, & Chasan-Tabor, 1998), present and future (i.e., each is conscious; Zaidel, Iacoboni, Zaidel, & Bogen, 2003). We argue that the same is true of the normal brain.

The normal right hemisphere is adept at visual word recognition but not at phonetic analysis. It is selectively sensitive to error feedback during lateralized lexical decision (Iacoboni, Rayman, & Zaidel, 1997; Kaplan & Zaidel, 2001). This suggests a division of labor: the left hemisphere is specialized for certain language processes; whereas, the right hemisphere is specialized for monitoring those processes.

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