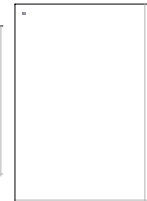




**Society for Neuronal Regulation**  
**9<sup>th</sup> Annual Conference**  
**Monterey, CA 27-30 October 2001**



## Scientific Presentations & Papers

Listed in alphabetic order of lead presenter. These are all given in general sessions or as poster presentations.

### **TASK RELATED SLOWING: DEACTIVATION, OR COGNITIVE PROCESSING DEVIATION?**

#### **Student Scholarship Winner: Efthymios Angelakis & Joel F. Lubar**

University of Tennessee, Knoxville

**BACKGROUND:** Rhythmic slow-wave 4-8 Hz. (theta) EEG activity has traditionally been considered as a correlate of drowsiness or attention deficit disorder (e.g. Makeig, Bell, Jung, & Sejnowski, 1996; Lubar & Lubar, 1999), and rhythmic very slow-wave 0.5-4.0 (delta) EEG activity has been considered as a sign of either deep sleep or brain pathology (Niedermeyer, 1999). However, several recent studies have associated slow-wave brain activity with working memory and stimulus detection functions. For example, Klimesch and colleagues have suggested that 4-8 Hz. activity is correlated to working memory functions and may manifest cyclic reciprocal communication between the cortex and the hippocampus (Klimesch, 1998). Schuerman and colleagues relate the "delta" component (0.5-3.5 Hz.) of the P300 ERP to decision making and matching during cognitive tasks like detection of auditory stimuli close to the hearing threshold (Schuerman et al., 2001).

One of the goals of this study was to determine if slow-wave EEG reflects only brain deactivation during reading. If so, areas responsible for the different reading modalities should show decreased amplitude of slow-wave EEG during reading when compared to a resting baseline. If, on the other hand, slow-wave EEG during reading reflects cognitive processing, then brain areas involved should show increases in slow-wave amplitude. Another purpose of the present study was to explore the potential of slow-wave QEEG to identify topographically differential cortical activity during different reading tasks that selectively engage the visual, phonetic, and semantic modalities of reading. It was hypothesized that different processing modalities may manifest as EEG activity at relevant cortical areas.

**METHODS:** The present study explored the slow-wave EEG amplitude differences between resting and reading states in a group of 19 non-clinical young adults (12 male, 7 female). EEG was recorded during an eyes-open resting baseline, and three different reading tasks selectively engaging the visual, phonetic, and semantic reading modalities.

EEG was recorded with a Lexicor NeuroSearch 24 analog to digital system, and all data were stored and visually artifact rejected using a Pentium 120 MHz computer, and Lexicor's v41e software. Nineteen-channel electrode caps using the 10/20 international electrode placement system by Electro Cap Inc. were used, with linked ear lobe references. The EEG data were collected with a band-pass filter set at 0.5-32 Hz. for 128 samples per second recordings and at 0.5-64 Hz. for 256 samples per second recordings. Fast-Fourier Transformation (FFT) processed digital EEG with cosine tapering (Hanning window). Frequency spectra between 0.5 and 8.0 Hz. were analyzed in two frequency bands, 0.5-4.0 Hz. (delta) and 4.0-8.0 Hz. (theta).

**RESULTS:** Multiple t-test analyses comparing the three reading tasks with the baseline showed significant amplitude increases during reading mostly in the 0.5-4.0 Hz. and some in the 4.0-8.0 Hz. band. These changes were topographically different among the three reading tasks. During visual reading, amplitude increased at C3, C4, T3, T4, & T5 for the 0.5-4.0 Hz. band, and at T5 & T6 for the 4-8 Hz. band. During phonetic reading, amplitude increased at T3, T4, F3 & F7 for the 0.5-4.0 Hz. band, and at T5 & FP1 for the 4-8 Hz. band. During semantic reading, amplitude increased at T3, T4, C3, C4, F3, F7, F8, CZ & FZ for the

0.5-4.0 Hz. band and at T5 for the 4-8 Hz. band.

**DISCUSSION:** The present data support previous studies that relate amplitude increases in slow-wave EEG with cognitive processing. This suggests that, during reading tasks in awake, non-clinical young adults, increased amplitude in slow-wave EEG may illustrate cognitive processing. We propose that slow frequency EEG is a form of brain activity, rather than inactivity. The form of slow-wave EEG being different between pathology/sleep and healthy cognitive functions supports this conclusion. In the first case (pathology/sleep), slow waves are dominant, rhythmic and of high amplitude. In the latter case (healthy cognitive functions), however, slow waves are non-dominant, arrhythmic and of low amplitude.

**CONCLUSIONS:** Amplitude increases in slow-wave EEG are part of the normal reading process and it appears at scalp electrodes close to cortical areas expected to be involved according to different reading modalities. Implications for neurofeedback involve tentative models for cognitive processes.

*References:*

- Klimesch, W. (1998). EEG alpha and theta oscillations reflect cognitive and memory performance: a review and analysis. Brain Research Reviews, 2-3 (29), 169-195.*
- Lubar, J. F. & Lubar, J. O. (1999). Neurofeedback assessments and treatment for attention deficit/hyperactivity disorders. In J. R. Evans and A. Abarbanel (Eds.) Introduction to Quantitative EEG and Neurofeedback. San Diego: Academic Press.*
- Makeig, S., Bell, A. J., Jung, T. P., & Sejnowski, T. J. (1996). Independent component analysis of electroencephalographic data. In D. Touretzky, M. Mozer (Eds.), Advances in neural information processing systems 8, (pp.145-151). Cambridge, MA: MIT Press.*
- Niedermeyer, E. (1999). Maturation of the EEG: Development of Waking and Sleep Patterns. In Niedermeyer, E., & Da Silva, E. L. (Eds.) Electroencephalography: Basic principles, chemical applications, and related fields, (4th ed., pp.167-191). Baltimore: Williams & Wilkins.*
- Schuerman, M., Basar-Eroglu, C., Kolev, V., & Basar, E. (2001). Delta responses and cognitive processing: Single trial evaluations of human visual P-300. International Journal of Psychophysiology, 39, 229-239.*

#### **PREMENSTRUAL DYSPHORIC DISORDER AND CHANGES IN PREFRONTAL ALPHA ASYMMETRY**

**Elsa Baehr**

NeuroQuest, Inc. and Northwestern University, Evanston, IL

This paper will present new research on the relationship between premenstrual dysphoric disorder (PMDD), and changes in frontal alpha asymmetry. It has been found that some women, with a history of depression, have abnormal hormone changes prior to their menses. Abrupt shifts in mood, often with suicidal ideation, are associated with the onset of menstruation.

We will present several case studies of patients being treated for depression with a combination of psychotherapy, neurotherapy and audio-visual stimulation. Using the Alpha Asymmetry protocol, we have documented changes in frontal alpha asymmetry that are associated with monthly hormonal cycles.

#### **QEEG AND MMPI-2 CHARACTERISTICS OF A SAMPLE OF TWELVE PERSONS WITH CHILDHOOD SEXUAL ABUSE**

**Lisa M. Black, M.S., Alicia L. Townsend, B.A., and Genie Bodenhamer-Davis, Ph.D.**

A group of outpatient adults who reported a history of childhood sexual abuse were compared on measures of quantitative electroencephalographs (QEEG) and the Minnesota Multiphasic Personality Inventory - 2 (MMPI-2) with a matched group of outpatient adults who did not report a history of childhood sexual abuse. Preliminary findings suggest diverse elevations in MMPI-2 patterns similar to those in research with dissociative identity disorder and other disorders which have a high prevalence of childhood sexual abuse. QEEG analysis suggests excess seven to ten hertz alpha across the head. Visual analysis of the raw waves using remontaging techniques suggest seven to ten hertz alpha temporally. Due to these alpha excesses, the appropriateness of alpha-theta protocols is questioned. Possible protocol rationale is discussed as is the necessity of remontaging techniques as part of QEEG analysis.

#### **THINKING NONLINEARLY ABOUT BRAIN SYSTEM DYNAMICS**

**Invited Speaker: Michael E. Brandt**

Neurosignal Analysis Laboratory and Center for Computational Biomedicine

School of Health Information Sciences, University of Texas Health Science Center, Houston, TX 77030

When we consider brain structure/function interrelationships today, there remains an ingrained tendency toward scientific conceptualizing that is both reductionistic and linear. Such conceptualizing is characteristic of the analytical functions of the brain itself that tend to be localized in the left hemisphere in many individuals. The tendency to probe the brain down to ever-increasingly smaller scales and to assume that the knowledge obtained generalizes to higher levels of scale is very subtle and strong. While it is important to understand the molecular and cellular biology of neurons and glia, we must overcome the inertia of the long-held belief on the part of some sectors of the neuroscience community that more probing into the machinery of the neuron will unlock all the secrets of the brain.

We are just beginning to appreciate the complex and nonlinear dynamical nature of the brain. A further shift in our “consciousness” about neural dynamics is needed in order to take the next steps in brain research. We need to be able to utilize in a more reflexive manner what we have already learned about the complex, nonlinear dynamical nature of the brain in order to “bootstrap” our own thinking processes about neural science itself. It is clear from developments in neural network theory in general that we must employ tools that enable us to understand how neurons interact with each other in small, intermediate, and large scale networks. At each of these levels different tools and strategies may be required. We need not only a bottom-up approach, but also a top-down one. Such tools must allow us to “see the forest for the trees” without at the same time blinding ourselves to the details of the neuronal apparatus.

We will present a few recent examples of this from the cognitive neuroscience literature. We will review briefly the concepts of nonlinear dynamical systems (NDS) and complexity (C) of pertinence to this work. We will address the question “(how) can we embrace even further NDS and C in brain research?” and discuss models and applications of NDS and C in neuroimaging studies (including fMRI/EEG/MEG) from the author’s own and other’s research. A related question is “(how) can we use our whole brain (both left and right hemispheres) to better understand the whole brain?” We will also explore some potential lessons that may be drawn in this regard from energy/matter physics, and hope to offer some take-home ideas for our own research and clinical practices.

**THE MEAN OF THE MEDIAN: A NEW METRIC FOR TARGETING IN CLINICAL NEUROFEEDBACK?****Valdeane W. Brown**

Zengar Institute & Neurofeed.com, Port Jefferson, NY

In order to explore the role of “variability” around targets during Neurofeedback, NeuroCare Pro® software was used to measure the emergent median values of each of the targets employed during Period 3 training, as well as in post-hoc analysis of other data. These median values were concurrently subjected to a 16 times per second averaging procedure to derive a dynamic measure of the “variability” of the emergent “central tendency” of each of the targets during clinical training. This “Mean of the Median” (or MoM) measure was used to derive the actual triggering of feedback events in re: to calculated divergence within a neighborhood around this dynamic measure. An 80% “inclusion” criterion was used for determining the size of the neighborhood for each target. For inhibit targets, feedback was enabled and/or produced when the emergent median remained within that neighborhood, whereas feedback for all targets was disabled by excursions beyond this neighborhood for any inhibit. The same basic procedure was used for augment targets except that excursions outside of an augment’s neighborhood had no effect on any other target.

This procedure was used for active training of clients (N > 50), as well as for post-hoc analysis of pre-existing data obtained from other, successful Neurofeedback cases (N > 200) using different feedback paradigms, equipment and/or software.

Several interesting results have begun to emerge from these preliminary investigations:

- 1- Clinical improvements appear to be correlated with decrease in both negative and positive divergence for all inhibit targets. This reflects a kind of “regression to the mean” re: inhibits during renormalization.
- 2- Renormalization of the inhibits may be an indicator of resilience in the CNS, or what Pribram refers to as efficiency.

- 3- Clinical improvements appear to also be correlated with a decrease in the number, duration and intensity of negative divergences for all augment targets but do not seem to be particularly correlated with any form of positive divergence for the same targets. Thus, it appears that it is not increases in augments per se that are important, but lack of decreases.
- 4- Renormalization of the augments may be an indicator of flexibility in the CSN, or what Pribram refers to as effectiveness.
- 5- This procedure may yield some useful metrics for successful training regardless of the approach used.

### **NON-LINEAR DYNAMICS PANEL: EEG, NEUROFEEDBACK AND NON-LINEAR, DYNAMICAL APPROACHES: EXPLORATIONS INTO THE CHAOS AT THE CUTTING EDGE OF CLINICAL PRACTICE AND RESEARCH**

**Moderator: Valdeane W. Brown**  
Zengar Institute & Neurofeed.com

Data acquisition and “real-time” analysis continue to be a central issue in the rapidly emerging field of Neurofeedback. Fundamental questions concerning the characteristics of the EEG signal itself directly affect equipment manufacturers, researchers and clinicians. These questions can not be avoided any longer - with the easy availability of advanced computing platforms and sophisticated statistical packages, the average practitioner can reasonably address these concerns within the confines of his/her own office. In this panel we will discuss many of the current issues concerning the role that Non-Linear, Dynamical or NLD approaches to data analysis play in the field of Neurofeedback. Chaos theory, as these approaches are also known, has been applied successfully to many other scientific domains including biology, economics, hydraulics, aerodynamics, cognitive science and meteorology. In fact, virtually every other field of inquiry has benefited greatly from the insights and techniques afforded by this revolutionary and essentially interdisciplinary approach to scientific inquiry. Thus, there is a clear difference in paradigm implied by a shift to NLD or Chaos Theory and the question really is: Is there any reason to make this shift in paradigm?

Some of the other questions to be addressed by this panel include:

- 1- What are the differences between linear, non-linear and random processes and which best fits the data we see with EEG?
- 2- If EEG can be easily contaminated by artifact, and in fact looks like rough sinusoidal waves, isn't it just noise?
- 3- What is the significance of signal to noise ratio in EEG and what techniques are available to alter it to make our data acquisition more meaningful?
- 4- What value does NLD analysis add to Neurofeedback? And what is the cost of that value? Is it worth the effort?
- 5- What is the value of traditional linear statistics in analyzing EEG?
- 6- How can non-linear techniques be used to provide “real-time” feedback to clients?
- 7- What alternative hypotheses, techniques and approaches to training are suggested by NLD?

### **PRACTICE MANAGEMENT PANEL**

Moderators: **Tom Brownback** and **Linda Mason**  
Brownback and Mason Associates  
Presenters: **Joel and Judith Lubar**

This panel discussion will focus on advanced concepts and techniques that master clinicians have developed in order to enhance neurotherapy treatment outcome.

### **AVS (AUDIO-VISUAL STIMULATION) EFFECTS IN AN ALZHEIMER'S PATIENT AS DOCUMENTED BY QEEG AND LORETA**

**Tom Budzynski (1) & Leslie Sherlin (2)**  
(1) University of Washington (2) University of Tennessee, Knoxville

It is known that AVS can induce a frequency following response in the EEG as measured on the scalp, but can AVS produce changes in the subcortical areas of the brain of an Alzheimer's patient? A baseline QEEG was followed by 20 minutes of AVS (a pseudo-random program with a frequency range over 9 to 22 Hz). A

second QEEG was taken during the AVS and then another at 15 minutes after termination of the AVS. A final AVS was carried out after the patient had received 30 sessions of AVS over a six-week period. The QEEG analysis of the data included the use of the LORETA imaging procedure. The presentation will involve a discussion of the EEG effects of the AVS at the cortical and subcortical level.

### **PASSIVE INFRARED HEMOENCEPHALOGRAPHY: A THREE-YEAR CASE SERIES**

**Jeffrey A. Carmen**

Olde Barn Technologies, Manlius, NY

Passive Infrared Hemoencephalography (pIR HEG). A discussion of the evolution of the technology, combined with a discussion of a three-year set of case studies, predominantly focused on treatment of migraine headaches.

As of the date of SNR 2001, Passive Infrared Hemoencephalography is now only three years old, and is still in its infancy. Passive Infrared Hemoencephalography (pIR HEG) is a conceptual outgrowth of Hershel Toomin's Near Infrared Spectrophotometry Hemoencephalography (NIRS HEG) system. pIR HEG relies on thermal output from brain activity as the primary measure. In most cases, patient responses to the pIR HEG system appear to be similar to the responses seen with NIRS HEG, although there also appear to be some subtle differences, which need to be considered when comparing data.

Both systems share a freedom from eye movement and muscle artifacts. All systems do have artifacts that do not represent real data. pIR HEG is no exception. Sources and characteristics of these artifacts will be discussed.

The reason HEG initially caught my interest was that 70% of my practice represents work with migraine patients. Although the precise etiology of migraine headaches has yet to be determined, there is universal agreement that the cerebrovascular system is intimately involved in the process (Bednarzyk, Remier, Weikert, Nelson & Reed, 1998; Moskowitz, 1998). Because of the vascular theories regarding migraine headaches, my original work using pIR HEG with migraines was directed at attempting to retrain the vascular system. This turned out to be unproductive. The process evolved into one that uses the pIR HEG signal to train increases in frontal brain activity as measured by increases in the pIR HEG signal. These increases appear to correlate with increased inhibitory functions that serve to act to prevent migraines and also to abort them in progress.

While migraines represent the main focus, tension type headaches, cluster headaches, medication rebound headaches and conversion headaches will also be discussed.

Individual case studies will be presented. Supporting data will include infrared video images with and without headache activity. Summary data will be presented on response patterns using change in headache activity as the predominant dependant variable, with psychophysiological correlates as secondary dependant variables.

#### *References:*

*Bednarzyk, E., Remier, B., Weikert, C., Nelson, A. & Reed, R. (1998). Global cerebral blood flow, blood volume, and oxygen metabolism in patients with migraine headache. Neurology, 50, 1736-1740.*  
*Moskowitz, M. (1998), Migraine and Stroke: A review of cerebral blood flow. Cephalalgia, 18(22), 22-25.*  
*Toomim, H., Remond, A., Toomim, M., Marsh, R. & Lerk, R. (1999) Cerebral circulation feedback with infrared light scalp transducer. In. Jean Claude Vouakouanitou & Hershel Toomim (Eds.). Conscience du Comportement et Biofeedback Ponderal*

### **INTENTION AND CONSCIOUSNESS IN NEUROFEEDBACK**

**Tom Collura**

BrainMaster Technologies, Inc., Oakwood Village, OH

This talk will address the roles of intention and consciousness in the effectiveness of neurofeedback training, and the relationships between volitional and nonvolitional methods.

The issue of conscious versus unconscious processing is essential, because some stimuli (including subliminal audio or visual) have an identifiable effect on the EEG regardless of the intent of the trainee, while others (conventional displays) must be perceived and interpreted consciously and with good intent, for training to occur.

Through what neurophysiological mechanisms do the intentions, beliefs, and motivations of a trainee affect the outcome of EEG training? Experiments reveal that the perception of the intent to perform a voluntary action actually follows in time the irreversible brain processes that lead to that action. This sheds light on the role of intent in consciousness, and how intent is brought to bear in neurofeedback.

Differences exist between volitional and nonvolitional training methods. Hybrid systems that use multiple approaches are suggested, producing integrated feedback. These provide multi-pathway training, wherein diverse feedback loops may be exercised simultaneously. Conscious and unconscious processes can thus be combined, providing potential improvements in training efficacy.

## **LOGISTIC REGRESSION DISCRIMINANT FUNCTIONS FOR QEEG**

### **Student Scholarship Winner: Marco Congedo & Joel F. Lubar**

University of Tennessee, Knoxville

Neurofeedback treatments are designed to normalize abnormal quantitative EEG (QEEG) features. Typically the patient's brain map is compared to a normative database in order to quantify the patient's deviance from normative values. Sometimes a clear diagnosis helps deciding the most appropriate protocol for the case. Combining the initial diagnosis with the database information offers the most reliable procedure to decide the most appropriate neurofeedback protocol. Discriminant functions are a tool to quantify the probability that the patient's QEEG features are typical of either one of two groups. One of the two groups is generally chosen to be normative, while the other is a homogeneous clinical group. Normative databases can detect deviation from normality, but cannot indicate if the QEEG pattern is commonly observed in a particular clinical condition. On the other hand, discriminant functions answer these kinds of questions. With the availability of software able to compute the maximum likelihood estimations, logistic regression recently became a popular tool for this purpose. Logistic regression is a generalized linear model in the LOGIT of a binary response. For our purposes let the response be the membership in a normal group ("failure") or in a clinical group ("success"). Then, allow a set of QEEG or LORETA features to be the predictors of the response. This set will be a sub-set of all QEEG or LORETA features extracted. Given that the model holds, the set of QEEG or LORETA features will discriminate between normal and clinical individuals. The LOGIT of the response is the natural logarithm of the odds of success, which is defined as the ratio between the probability of success and the probability of failure. For a binomial response there is no linear model available, however modeling the LOGIT of the response yields a linear model with intercept and slopes estimations. This makes the interpretation of the model straightforward. Once the logistic regression curve has been established on large samples, the probability for a new individual to belong to the clinical group can be assessed with a point estimate (from 0 to 1.0) and a confidence interval. As an example, consider a discriminant function aiming to assess the probability that a new individual belong to the ADHD group (probability of success) as opposed to the Normal group (1-probability of success). Suppose we have 100 normal subjects and 100 ADHD subjects to build the discriminant function. Also let us suppose that for QEEG the best regression model include the theta/beta power ratio at CZ, i.e., this predictor alone yield a well-fitting logistic regression model for which the slope is significantly greater than zero. For any new individual the theta/beta ratio is considered. A direct estimation (with confidence interval) of the individual's probability to be ADHD can now be computed. For LORETA, similarly, the predictor can be the alpha, theta, etc. current density over a particular neocortex region. Logistic regression models are powerful tools for performing discriminant analysis. The aim of this research is to develop a methodology suitable for QEEG and LORETA data. In this respect the major problem to overcome is the selection of the best set of predictors. In both QEEG and LORETA experiments the number of measurements largely exceeds the number of subjects. For instance there are hundreds of coherence pairs in QEEG and thousands of voxels in LORETA. Furthermore, measurements are strongly correlated. In building a discriminant function on these data the task is to select the most parsimonious model with sufficient discriminant power. In the case of LORETA data smoothing in three-dimension and-or cluster analysis will be required as well. These issues will be addressed and an example of this type of discriminant function will be shown.

## **A PRE-POST ANALYSIS OF A SUCCESSFULLY TREATED CASE OF TOURETTE'S SYNDROME**

**Raymond M. Daly**

University of Windsor & Neuro-Biofeedback Wellness Centre, Windsor, Ontario, CANADA

The presentation will focus on the analysis of pre-post treatment data obtained from an eight-year-old boy who had been diagnosed with Tourette's syndrome. The client was referred by his family physician in his home city to a major teaching hospital in a neighboring city where specialists in this disorder completed the initial work-up, diagnosis, and conducted a follow-up evaluation six months later. These professionals were totally unaware of the assessment and treatment that transpired during the interim period.

At the pre treatment stage the boy exhibited numerous simple and complex tics, and multiple comorbid conditions including attention-deficit/hyperactivity disorder, obsessive-compulsive behaviors, and a sequel of behavioral problems at home and at school. Uncontrolled bouts of rage and aggressive behavior were a common occurrence. Symptomatic behavior was first reported at age five and had steadily increased in severity and complexity. Numerous behavioral and pharmacological treatments failed to improve his condition.

The pre treatment assessment data included the following: 1) medical diagnostic information, 2) multi-modal psychological measures, 3) behavioral analyses across multiple contexts, 4) psycho-educational achievement measures, and 5) a QEEG evaluation. The post treatment assessment repeated the majority of the pre treatment measures.

After 35 one and a half-hour NeuroBioFeedback sessions, administered over a 15-week period, all the presenting symptoms were eliminated. The young man has remained symptom free for eight months.

The successful treatment outcome provides an invaluable opportunity to investigate the multi-level and multi-modal changes in brain and behavior relations that occurred between the pre-post treatment periods. Special consideration will be given to the analysis of QEEG data obtained from two normative databases and complimentary LORETA analyses.

## **COMPARISON OF VIDEOGAME & STANDARD EEG BIOFEEDBACK WITH AD/HD CHILDREN: RESULTS OF THE FIRST CONCEPT STUDY**

**Roger J. deBeus, PhD, Olafur S. Palsson, PsyD, Alan T. Pope, PhD, John D. Ball, PhD, Marsha J. Turner, MA**

Riverside EEG Biofeedback Services (RJD), Mindspire, LLC. (OSP), NASA Langley Research Center (ATP), Eastern Virginia Medical School (JDB & MJT)

**Objectives:** This project was a randomized and controlled technology concept study, funded by NASA's Langley Research Center. The study assessed whether a new videogame biofeedback technology developed at NASA Langley Research Center was as effective as traditional neurofeedback in treating Attention Deficit Hyperactivity Disorder (ADHD), and whether there were significant differences in its appeal as a clinical method compared to standard neurofeedback treatment.

**Participants:** Twenty-two children with ADHD of the hyperactive-impulsive subtype (DSM-IV criteria plus physician diagnosis) participated. The age range was 9-13 years and there were 3 girls and 19 boys. All the children were on short-acting medications for ADHD. The children had to be of at least normal intelligence, and have no history of affective problems or learning disabilities.

**Design:** The children were randomized into treatment groups: videogame (n=11) vs. standard neurofeedback (n=11). Children in both groups completed 40 individual treatment sessions, usually seen once or twice a week. The children came for one test session before and after treatment, where they completed a QEEG, TOVA and neuropsychological tests. BASC Monitor data was collected pre-and post-treatment and every ten sessions. Children in both groups were trained with a single active Cz electrode, with reference electrode and ground attached to the earlobes.

**Equipment:** The videogame group equipment consisted of J&J I-330 EEG hardware, NASA-built modulation unit and a modified game controller used with a standard Playstation console. Training displays were EEG-influenced off-the-shelf Sony Playstation games. The standard group equipment consisted of Thought Technology ProComp+ hardware and Multitrace Software. Displays were bar graphs and simple figures representing changes in SMR, beta and theta bands.

**Results:** BASC Monitor and TOVA scores indicated similar significant improvements in both groups. No significant difference in treatment change was seen in between-group comparisons. Parents' subjective appraisal of treatment effect on ADHD was more positive for the videogame group. The videogame treatment was rated significantly more enjoyable by both parents and children. Trends on pre-post QEEG change maps indicated that the videogame training may have advantages in creating more quantitative EEG effect in the therapeutic direction.

**Conclusions:** We conclude that the videogame biofeedback technology, as implemented in the NASA prototype tested, produced equivalent results to standard neurofeedback in effects on ADHD symptoms. Both the videogame and standard neurofeedback improved the functioning of children with ADHD substantially above the benefits of medication. The videogame technology provided advantages over standard neurofeedback treatment in terms of enjoyability for the children and positive parent perception, and possibly has stronger quantitative post-treatment effects on EEG.

### **QEEG-BASED VERSUS RESEARCH-BASED EEG BIOFEEDBACK TREATMENT WITH CHEMICALLY DEPENDENT OUTPATIENTS: PRELIMINARY RESULTS**

**Roger deBeus, PhD, Holly Prinzel, MS, Adrienne Ryder-Cook, LLD, Lynn Allen, RN**  
EEG Biofeedback Services, Riverside Health System, Newport News, Virginia 23606

**Introduction:** In the EEG biofeedback treatment of chemical dependency most studies have focused on Alpha/Theta training with some variations. One of these variations is the addition of Beta/SMR training to generate physiological stability before proceeding with Alpha/Theta training, also known as the Scott-Peniston protocol. No studies to date have used quantitative EEG (QEEG) to guide EEG biofeedback treatment decisions. The present study examines the difference between QEEG-based treatment, research-based (Scott-Peniston) treatment, and wait-list control for chemically dependent outpatients. This presentation will focus on preliminary results in personality change and abstinence rates.

**Methods:** Participants were recruited from an outpatient substance abuse program and were required to remain in the outpatient program during EEG biofeedback treatment. The study consisted of four phases: (1) pre-treatment assessment, (2) EEG biofeedback sessions, (3) post-treatment assessment, and (4) follow-up sobriety measures. The pre- and post-treatment assessments were performed blind to group membership. The assessments included a structured clinical interview, IQ, academic achievement, personality, AD/HD rating scales, continuous performance test, and a QEEG.

After the intake procedure was performed, each participant was randomly assigned to one of three groups: (1) QEEG-based EEG biofeedback, (2) Scott-Peniston-based EEG biofeedback, or (3) wait-list control. In the QEEG-based group, QEEG's were analyzed using the NX-Link Neurometric database, and participants received 40 sessions of EEG biofeedback based on these results. In the Scott-Peniston-based group treatment protocols were based on a symptom checklist for the initial 10 to 15 Beta/SMR sessions, followed by the participants receiving 30 Alpha/Theta sessions. Sessions included 30 minutes of EEG biofeedback. Both types of EEG biofeedback occurred four times per week compared to 10 sessions per week in the original Scott-Peniston research. A script based on Peniston's protocol was read at the beginning of each session for both treatment groups. Talk therapy was not included as part of treatment. The wait-list control group returned after three months, completed post-assessments, was offered treatment, and randomly placed in one of the two treatment groups if desired.

Post-treatment measures included personality measures, AD/HD rating scales, continuous performance test, and QEEG. Follow-up information will include sobriety at one-month, six-months, and one-year post-treatment. At the one-year follow-up participants will be retested using the pre-treatment assessment battery.

Results: To date, seven participants have completed in each group. Both EEG biofeedback treatment groups showed improvements in personality change and maintenance of abstinence. The wait-list control group showed minimal improvements on outcome measures. Data from the Personality Assessment Inventory (PAI) were submitted to nonparametric Wilcoxon matched pairs tests. Of the eleven PAI clinical scales, the QEEG group showed six significant pre-post differences, the Alpha/Theta group showed four differences, and the control group showed two. Of the five PAI treatment scales, the QEEG group showed three significant pre-post differences, the Alpha/Theta group showed two significant differences, and the control group showed no differences. All of the treatment participants have remained abstinent up to six months following treatment termination, compared to 71% of control group participants remaining abstinent.

Discussion: Although this study will be in progress until 30 participants complete each condition, the preliminary results are promising. Historically, Alpha/Theta training has been the accepted approach in treating chemical dependency. This study suggests QEEG-based training is a viable alternative, demonstrating similar outcomes for personality change and abstinence rates. Future directions include determination of those likely to benefit from one of the particular treatments or a combination of the two and analysis of long-term abstinence rates.

### **QEEG EXPLORATIONS OF CHILDHOOD EXPRESSIVE DYSPROSDY**

**John W. DeLuca**, (1) and **Ray Daly** (2)

(1) Mind Stuff; Wayne State University School of Medicine

(2) University of Windsor; Neuro-Biofeedback Wellness Centre

This case study presents a nine-year-old boy who was referred for neuropsychological assessment in order to rule out Asperger's or Nonverbal Learning Disability syndromes. While the latter diagnoses were not supported by the data, the results confirmed expressive dysprosody, alexithymia-like symptoms, and problems in verbal abstraction. The latter occurred within the context of rather well developed visual spatial, executive function and nonverbal reasoning skills. A QEEG was done in order to facilitate differential diagnosis. In addition to baseline eyes-open and eyes-closed conditions, this youngster was subjected to four challenge conditions: videotape test of nonverbal communication (i.e., the Child and Adolescent Social Perception Test), the Counting and Emotional Counting Stroop tests (used in recent fMRI studies of the anterior cingulate gyrus), and a finger localization measure of inter-hemispheric transfer.

QEEGs were recorded using a Lexicor NeuroSearch-24 and V151 software with an appropriate size electrocap. EEG activity was sampled from 19 scalp electrode sites in the standard International 10-20 montage with reference to ear lobes and ground just forward of site FZ.

Sampling rate was 128 Hz. with 32K gain. Data analysis was completed using NeuroRep Version 4.0 software (Hudspeth, 1999), which incorporates the Adult QEEG Reference Database (Hudspeth, 1999) and the Thatcher Lifespan EEG Reference Database (Thatcher, et al., 1987). EEG waveforms were inspected offline and artifacts eliminated.

Measures of coherence, phase, and amplitude asymmetry were computed in four frequency bands among all combinations of left and right intrahemispheric sites and between homologous interhemispheric sites. Relative power for each of the frequency bands was calculated. Each of the conditions was also analyzed using LORETA. QEEG results are presented and discussed within the context of the neuropsychological and behavioral questionnaire results. A course of neurofeedback treatment is also discussed.

### **THETA/ALPHA TRAINING IN APPLICATION TO ENHANCEMENT OF MUSICAL PERFORMANCE**

**Student Scholarship Winner: Tobias Egner & John Gruzelier**

Dept of Cognitive Neuroscience & Behavior, Imperial College School of Medicine, LONDON

Neurofeedback aimed at facilitating a quasi-hypnagogic state has been found an efficacious complimentary treatment for substance abuse and post-traumatic stress disorders. This has involved rewarding an increase of theta over alpha activity during wakeful eyes-closed conditions. The present study integrated theta/alpha training with other techniques aimed at enhancing musical performance skills in conservatoire students. One

group took part in neurofeedback training only (n = 9), another was additionally engaged in a regime of physical exercise and a sports psychology mental skills program (n = 12), and another was a control group (n = 14). All students were required to perform two pieces of music of their own choice of approximately 15 minutes duration both before and after the training process. Performances were videotaped and subsequently assessed on a range of criteria by two musicians of international renown external to the conservatoire, and blinded to group membership and order of performances.

Students receiving only neurofeedback were judged to have improved on virtually all criteria at levels approaching statistical significance, while no trend towards improvement was detected in the other groups. More importantly change scores in musical performance correlated significantly with indices of successful theta/alpha feedback learning. The progressive linear theta/alpha ratio regression across sessions predicted improvements on eleven out of thirteen criteria including rhythmic accuracy, stylistic accuracy, communication of emotional commitment and conviction, and interpretative imagination ( $p = .003$  to  $p = .037$ ). This could not be attributed to reduction in pre-performance state anxiety levels. It is suggested that repeated facilitation of a meditative or hypnagogic state through theta/alpha training may significantly benefit live musical performance including artistic expression.

#### **DIFFERENCE BETWEEN COHERENCE AND SPECTRAL CORRELATION DURING AUDITORY AND VISUAL STIMULATION AT DOMINANT ALPHA FREQUENCY**

**Student Scholarship Winner: Jon A. Frederick & Joel F. Lubar**

University of Tennessee, Knoxville

Thirty college students received five-minute auditory, visual and combined audiovisual stimulation at the dominant alpha rhythm (DA) while a 19-channel 10-20 standard EEG was recorded. The three stimulation conditions were presented in counterbalanced order, after a five-minute eyes-closed baseline from which the DA at O1 was determined. A four-minute post-stimulation eyes-closed baseline was recorded after each stimulation condition. Coherence and spectral correlation (SC) differences from the initial baseline were evaluated among all locations at 0.75-2, 2-4, 4-8, 8-12, 12-21, 21-31 Hz, and at each participant's DA, and tested for significance with Wilcoxon's sign rank test. Very few (consistent with type I error) significant effects were observed during auditory stimulation or during the post-stimulation baselines. During the visual and combined conditions, widespread, significant amplitude increases were observed in the DA, 8-12, 12-21 and 21-31 Hz. bands. These conditions also increased coherence and SC frontally, interhemispherically, and in the long-range longitudinal projections in the DA and 8-12 Hz. bands. Both coherence and SC increased interhemispheric coherences in the 12-21 Hz. band. However, the following decreases in coherence were observed which were either not observed in SC, or observed at negligible or near-negligible levels: (a) 0.75-2 Hz., widespread (visual and combined); (b) 2-4 Hz., widespread (combined); (c) DA and 8-12 Hz., among occipital and parietal short-range longitudinal projections (visual and combined). Coherence also showed a much broader pattern of frontal and longitudinal increases at 12-21 Hz., while SC was more broadly and diffusely increased in the DA band. This study suggests limits to the validity of comparisons, which are frequently made between these two analytical measures. However, direct statistical tests between the two measures will be presented which are not included in this abstract.

#### **OBSESSIVE COMPULSIVE DISORDER: QEEG SUBTYPES AND TREATMENT IMPLICATIONS**

**Robert Gurnee**

ADD Clinic, Scottsdale, AZ

This is preliminary research involving 15 to 20 cases of OCD. Most have comorbidities of ADHD, Depression or other disorders. Patterns are emerging that corroborate other neuroimaging research implicating the cingulate and orbital frontal lobe over activation. Treatment implications will be presented for the emerging subtypes.

Approximately 90% have clear LORETA confirmed cingulate excesses of Delta, Theta, Alpha, Beta or any combination thereof, including all four bands. Approximately 70% have excessively elevated EO or EC Beta, often but not always, over the orbital frontal lobes. The excessive Beta was sometimes quite fast and above the normal data base cutoffs (22Hz. and 25 Hz.) and only discernible by counting Beta in the raw EEG and using NeuroRep's 1 Hz. bins z-score maps which go up to 30 Hz.

We are having success with even “intractable OCD” with QEEG individualized treatment interventions, which usually involve midline down training and Beta down training.

### **MAJOR DEPRESSIVE DISORDER: QEEG SUBTYPES AND TREATMENT IMPLICATIONS**

#### **Robert Gurnee**

ADD Clinic, Scottsdale, AZ

I will present my research involving approximately 75 children, adolescents and adults who were sequential intakes at the ADD Clinic with Major Depressive Disorder. Most have coexisting ADHD; some have other comorbidities also. Ten subtypes have clearly emerged:

- Central Alpha
- Left Frontal Alpha
- Alpha Left > Right asymmetry
- Central Theta
- Left Frontal Theta
- Theta Left > Right asymmetry
- Midline Abnormalities overlying the cingulate
- Lack of Left Frontal activity
- Beta Right > Left asymmetry
- Frontal Theta and/or Alpha hypercoherence

Most have two or more subtypes present. Treatment has proven highly successful when based on individual subtype combinations. Treatment has required complex carefully prioritized interventions.

### **THE QEEG: EVERYTHING YOU NEED TO KNOW IS IN THE WAVEFORMS**

#### **Keynote Speaker: William J. Hudspeth**

Neuropsychometric Laboratory, Los Osos, CA

It would seem that we have come to expect that quantitative analyses of EEG signals can resolve most of our questions about brain state and, thereby, lead us directly to satisfactory NF treatment protocols. Accordingly, we can then assert the circular validity that; "we only treat deviations in QEEG results (i.e., the maps)".

The validity of this assertion depends on several factors: (a) a sufficiently large number of analytic methods that can describe the relevant features in brainwave data; (b) clear evidence that numerical features relate to a common set of brain states described by signal amplitude (magnitude or power) waveform similarities (correlations, coherence, phase and perhaps co-modulation) and (c) the ability to create wide/narrow band results for each numerical index.

Visual inspection of EEG waveforms, and their sequential differences (re-montaged), provides evidence for magnitude and waveform disturbances we associate with neuropathology. Unfortunately, standard amplitude, power, asymmetry, correlation, coherence and phase measurements do not often converge onto the same foci to identify pathological conditions. This presentation shows how neuroelectric images (NEIs) and single-band weighted average (SBWA) topographies serve to integrate waveform and amplitude measurements in a variety of pathologies.

### **RELATIONSHIP BETWEEN EPILEPSY AND ADHD, LEARNING DISABILITY AND MENTAL RETARDATION**

#### **Invited Speaker: John Hughes**

Director, Epilepsy Center, Professor of Neurology, University of Illinois Medical Center, Chicago, Illinois

One theory for the understanding of ADHD is the under-activity of the mesolimbic orbital frontal area, (i.e., a "lazy" frontal lobe). Data show that uncontrolled seizures cause a decline in school results, even when the seizures are short lasting, with subtle manifestations. A recent study shows a relatively high incidence of discharges in ADHD. Seizures cause difficulty, especially in sustained attention and adversely affect IQ. The decrease in IQ can be seen in children with HD and epilepsy, especially in those with intractable attacks.

Even in "benign epilepsy of childhood", decreased scores can be seen in tests measuring many different abilities.

The effect of Ritalin on children with seizures is significant if recent attacks have occurred. A very important phenomenon is the "transient cognitive impairment", seen with only single interictal discharges, not requiring ictal or seizure patterns. The incidence of seizures in mentally retarded patients is 20-50%, depending on the ages of the patients. Factors like family history, presence of cerebral palsy, and recurrence of seizures are also important. Various syndromes, like Angelman's and Lennox-Gastaut Syndromes are associated with retardation.

If seizures occur, or even only interictal discharges are seen in the EEG, anti-epileptic medication is appropriate.

## **EFFICACY OF NEUROFEEDBACK FOR AUTISTIC SPECTRUM DISORDERS**

**Betty Jarusiewicz**

Atlantic Research Institute, Atlantic Highlands, NJ

The purpose of this study was to characterize, quantify and document efficacy of neurofeedback for individuals in the Autism spectrum. Neurofeedback, a process of neuro-regulation based on operant conditioning of EEG spectral features, has been proven to assist many with behaviors similar to those seen in the autistic spectrum. This methodology has been used successfully with those exhibiting ADHD behaviors, anxiety, sleep disorders, and addiction. Preliminary work with individuals in the autistic spectrum has shown promise. The neurofeedback protocol of augmenting specific frequencies in the 4-20 Hz. region, while inhibiting excess amplitude in the lower and higher-frequency regions, challenges the brain toward more optimal functioning in terms of both physiological arousal generally, and emotional regulation specifically.

The study involved a comparison of 16 individuals trained with neurofeedback with 16 individuals who did not receive training, but continued other ongoing therapies. Eighty-eight percent of those trained reduced their levels of autistic symptoms within months, as assessed using the ATEC behavioral checklist of the Autism Research Institute. The average reduction in symptoms severity was 26% compared with a control group average of less than 5%. Before and after videos (Greenspan method) were also used for comparison purposes. There were significant improvements on average in the areas of speech (30%), socialization (34%), sleep (29%), anxiety (29%), tantrums (29%), and cognitive awareness (16%). When compared with other treatment modalities using the Rimland Treatment Effectiveness Survey, neurofeedback is rated on a par with occupational therapy, and is surpassed to date only by behavior modification and speech therapies, even in this early-stage comparison.

## **TECHNOLOGY OVERVIEW: BISPECTRAL ANALYSIS**

**Jack Johnstone**

Q-Metrx, Inc.

Most evaluation of the EEG signal utilizes spectral analysis, which yields information about the amplitude of the EEG for each frequency band. Coherence estimates often are also generated representing the relationships among different channels for each frequency band. Bispectral analysis is an advanced signal processing technique, which is sensitive to non-linear aspects of brain function. The bispectrum quantifies the degree of phase coupling between every possible frequency pair combination. This results in a more comprehensive description of the EEG signal and is thus able to detect more subtle changes than routine spectral analysis. Measures based on the bispectrum are now used to assess altered cerebral function such as administration of anesthetics and neuroactive drugs, ischemia, and hypothermia. Potential new applications for this technology will be discussed.

## **USE OF QEEG IN PREDICTING RESPONSE TO MEDICATION**

**Jack Johnstone**

Q-Metrx, Inc.

This presentation is a review of work using QEEG features to predict medication response in individuals with neurobehavioral disorders. Suffin and Emory (1995) published an important study showing that specific EEG features could be identified in patients with either affective or attentional disorders, and that the presence of certain features are predictive of responsivity to specific medications. Related work has been published by Chabot, Merkin, Wood, Davenport & Serfontein (1996) and Leuchter et al. (2001). These studies will be reviewed and new work on these topics will be discussed.

*References:*

Chabot, R., Merkin, H., Wood, L., Davenport, T., & Serfontein, G., (1996). *Sensitivity and specificity of QEEG in children with attention deficit or specific developmental learning disorders. Clinical Electroencephalography, 27(1), 26-34.*

Suffin, S.C. & Emory, W.H., (1995). *Neurometric subgroups in attentional and affective disorders and their association with pharmacotherapeutic outcome. Clinical Electroencephalography, 26, 76-83.*

## **RETHINKING STANDARD BANDS**

### **David Kaiser**

Rochester Institute of Technology, Rochester, NY

An argument is made for customizing EEG frequency bands to address unique characteristics of each person's cerebral organization. Individual alpha frequency (Klimesch et al, 1998; 1993), one approach to accommodating individual differences in quantitative analysis, is evaluated. Approaches for other bands are proposed. Individual differences may be the product of genetic and maturational variability or they may be indicative of cerebral pathology. Abnormal sleep spindle rhythms were identified in two autistic children. Slow spindle frequency may signify cerebral disorganization well before any behavioral symptoms emerge. The motor system's prominent role in neuro regulation is discussed.

## **PICTURE A CHANGING MIND: THE USE OF ARTWORK TO SHOW NEUROLOGICAL TRANSFORMATION**

### **Juliet King**

NeuroDynamix, Inc and Hahnemann University, Philadelphia, PA

This research explores the use of art productions as a vehicle to measure the impact and effectiveness of neurofeedback treatment. Art products are a valid diagnostic and assessment tool (Hammer, 1967; Levick, 1993; Gerber, 1997) and are therefore a useful method of measuring change following neurofeedback treatment. This study shows that neurofeedback can elicit changes in artwork throughout the course of treatment. The subjects, all of whom are clinically diagnosed with ADHD, will complete the Brief Art Therapy Screening Evaluation (BATSE) (Gerber, 1997) at the beginning and end of their neurofeedback tx. Each client protocol determined will address (at least) three specific treatment goals, which will be correlated with the artwork, and used as a vehicle for expressing change. The drawings will be reviewed by credentialed blind raters who will assess the drawings from the beginning and end of treatment for indicators of change in the artwork that may suggest a shift in brain physiology that is representative of the proposed treatment goals. The data from the artwork will be statistically analyzed, the results of which will aim to explore and interpret the correlational relationship between the artwork and neurofeedback therapy.

*References:*

Gerber, N. (1997). *The brief art therapy screening evaluation (BATSE). Unpublished manuscript, MCP Hahnemann University.*

Hammer, E. F. (1967). *The clinical application of projective drawing. Springfield, IL: Charles C. Thomas.*

Levick, M. F. (1993). *They could not talk and so they drew: Children's styles of coping and thinking. Springfield, IL: Charles C. Thomas.*

## **AUDIO-VISUAL ENTRAINMENT AND NEUROFEEDBACK**

### **Student Scholarship Winner: Sharon Koberna & Brent Maguire**

Walden University, Mesa AZ

Audio-Visual Entrainment (AVE) is often used in conjunction with neurofeedback as a priming stimulus. Recent research supports the hypothesis that AVE entrains endogenous EEG rhythms. One of the questions still remaining is whether AVE, neurofeedback training alone, or a combination of both AVE and neurofeedback is most effective to entrain EEG rhythms. A clearer understanding of this issue would allow clinicians to choose the most effective modality to enhance neurofeedback training and thus, possibly, expedite the training.

This experimental study will examine various modalities of how individuals learn to control their alpha brain waves using neurofeedback training and visual entrainment (VE). The null hypotheses for the study are: (1) There is no significant difference in baseline alpha recordings when VE is used with neurofeedback and when VE is not used with neurofeedback. (2) There is no significant difference in training performance when VE is used with neurofeedback and when VE is not used with neurofeedback. (3) There is no significant difference among individuals regarding their responsivity to neurofeedback. (4) There is no significant difference among individuals regarding their responsivity to VE.

The neurofeedback will be provided using the ProComp by Thought Technology and the VE will be provided using the DAVID Paradise XL by Comptronics, which produces semi-sine wave stimulation. The study will incorporate four groups, a control group and three experimental groups. There will be ten participants in each group. Each of the experimental groups will use a different combination of neurofeedback and visual entrainment for five separate training sessions spanning a three-week period. The control group will have baseline frequencies recorded at the beginning of the study and again three weeks later. Each training session will consist of baseline recordings, both with eyes open and eyes closed, three ten minute training trials with eyes-closed recordings taken after each trial, and a post-training recording both with eyes open and eyes closed - a post-training baseline.

One of the experimental groups will have three trials of neurofeedback with no visual entrainment. Another group will have neurofeedback only during trial one and three; during trial two they will have neurofeedback with visual entrainment set at their dominant alpha frequency. The dominant alpha frequency will be determined during baseline and rounded to the nearest full hertz (for example, a reading of 10.23 will be rounded down to 10hz). The final experimental group will have neurofeedback only during trial one and three; during trial two they will have neurofeedback with visual entrainment set at one hertz above their dominate alpha frequency.

As a measure of treatment effect, the following percentage differences between each experimental group will be calculated: (a) initial baselines; (b) final training session recordings (session five), trial number three; and (c) post training session (session five). The control group will be included in the initial baseline calculation and the post training calculation. To assess the significance of entrainment effects, a within-subject t-test will be calculated between each experimental group's initial baseline and their final training session (session five) trial number three. Repeated measures analysis of variance for each frequency band (theta, alpha, beta) will be used to determine if the stimulation conditions had differential effects. If F is significant, post hoc tests will be calculated.

Data for this study will be collected during the month of June. Findings will be shared at the SNR Conference in October.

## **QEEG FINDINGS AMONG CHRONIC PAIN PATIENTS WITH SUSPECTED MILD TBI**

**Edward Kravitz, Mark Thimineur, Mark Aarons & Annette Macannuco**

Comprehensive Pain and Headache Center, Connecticut Spine and Pain Center, Derby, CT

The use of QEEG findings in the differential diagnosis of mild TBI has been greatly advanced with the Thatcher database. This diagnostic test can prove particularly useful in a chronic pain population where mild TBI has been suspected as a correlate diagnosis. The first two authors of this paper have previously presented clinical data on over 300 patients, in which thermal-sensory, neurologic, and psychometric data were used to differentiate a subpopulation of mild TBI chronic pain patients. All of these patients had negative MRI findings despite displaying cognitive, sensory, and personality changes. Most presented with multifocal body pain quite disproportionate to standard physical exam. Many of these patients had also been previously accused of exaggerating their complaints and drug seeking. The present investigation examined QEEG and neuropsychological test results in two groups of chronic pain patients; those suspected of having mild TBI according to the criteria used above and those without. These findings will be presented with discussion of the possible legal and financial impact to the patient.

## **ERPs IN GO/NOGO PARADIGM IN ADHD CHILDREN DURING EEG-BASED BIOFEEDBACK TRAINING**

**Juri D. Kropotov**

Institute of the Human Brain, Russian Academy of Sciences, St. Petersburg, RUSSIA

Attention Deficit Hyperactivity Disorder (ADHD) is the most common mental dysfunction affecting about five to fifteen percent of all children. It is not a homogeneous disorder. A modern neurobiology oriented approach considers ADHD subtypes to be associated with the impairment of different neuronal circuits in the frontal lobe-basal ganglia-thalamic executive system (Castellanos, 1997; Kropotov, 1997). To differentiate between impairments of different executive operations (engagement and disengagement operations, in particular) we measured late (in the range of 300 ms after stimulus) positive GO and NOGO components of event-related potentials (ERPs) associated with these operations in a continuous performance task in normal (N=16) and ADHD (N=84) groups. Our data show that the amplitude of GO and NOGO components correlates with both age and task performance. They are smaller in young children in comparison to older ones, and in an ADHD group in comparison to a normal group. Twenty sessions of EEG training improved the quality of performance (decrease of omission and commission errors) and led to a significant increase of amplitude of GO and NOGO components. We performed factor analysis in the multi-dimension parameter space with vectors characterized by amplitude and scalp location of GO and NOGO components, event-related desynchronization, EEG spectral characteristics and task performance scores. The results of this analysis and its relation to subtypes of ADHD and biofeedback training will be discussed.

### **ELECTROPHYSIOLOGICAL CORRELATES OF MOTOR INHIBITION IMPAIRMENT IN CHILDREN WITH ATTENTION DEFICIT/HYPERACTIVITY DISORDER**

**Olga Kropotova**

Institute of the Human Brain, St. Petersburg, RUSSIA

Auditory event-related potentials (ERPs) were recorded from 38 attention-deficit hyperactivity disorder (ADHD) and 30 normal 12-year-old subjects. Subjects performed a modified GO/NOGO paradigm, co-called two-stimulus task. In this task a high tone (H) of 1300 Hz. and a low tone (L) of 1000 Hz. were used as stimuli constructing four kinds of pairs (LL, LH, HL, and HH) with a one-second interval between tones in a pair. These pairs were presented randomly and equiprobably whereas the subjects were required to press a button to HH pairs as accurately as possible. The difference between ERPs elicited by the second stimulus in HH and LH pairs was called GO component (analog P300 component) while the difference between ERPs elicited by the second stimulus in HL and LL pairs was called NOGO (N400). The NOGO cue elicited a fronto-central positive activity that was distinct from the centro-parietal positivity evoked by the GO stimulus. Both GO and NOGO components were reduced in ADHD children. The reduction of the NOGO component (supposedly associated with motor inhibition) in the ADHD group supports the hypothesis that ADHD children have deficits in response inhibition and motor impersistence. This dysfunction could be underlying the fronto-striatal system failure that results in the reduction of the NOGO component in ADHD subjects in comparison with control.

### **SYMPOSIUM, SLEEP IN MOOD DISORDERS (ECNS - CONJOINT PANEL)**

**Moderator: Clete A. Kushida**, Lecturers/Discussants: **Matthias Lee, Tracy Kuo, Leah Friedman**

*Stanford University Center of Excellence for Sleep Disorders*

This symposium will focus on current diagnosis and treatment of sleep problems and disorders associated with mood disorders. The presenters have extensive experience in treating patients with psychiatric disorders and sleep complaints. In addition, they currently are involved in research studies studying subjects with sleep disorders influenced by mood states. Dr. Matthias Lee will discuss the diagnosis and differential diagnosis of the major sleep disorders that are affected by mood disorders. Dr. Tracy Kuo will describe the psychophysiological markers of mood disorders, with an emphasis on depression. She will also highlight sleep-related EEG changes influenced by mood disorders. Lastly, Dr. Leah Friedman will discuss non-pharmacologic treatment for sleep problems related to mood disorders. These behavioral techniques represent the most effective treatments for patients with sleep disorders such as psychophysiological insomnia.

### **EFFECTS OF A PULSED ELECTROMAGNETIC THERAPY ON MIGRAINE HEADACHES**

**Martha S. Lappin**

Energy Medicine Developments, Burke VA

The goal of this research was to evaluate the potential effects of a pulsed electromagnetic therapy (Enermed therapy) on migraine headache frequency and severity.

The Emermed therapy consists of exposing migraine patients to very weak (50 to 100 milliGauss) electromagnetic fields pulsed at four frequencies between .5 and 25 Hz. The electromagnetic pulse generator is a small, portable device designed to be worn by the patient up to 24 hours a day. The frequencies the device is programmed to emit are patient specific. They are determined by an analysis of the patient's bioelectromagnetic field. The bioelectromagnetic field analysis (BFA) detects subtle energy fields emitted by the individual and through a fast Fourier transformation, converts these signals into a power spectrum that can be displayed on a computer screen.

In this NIH funded study we compared the effects of placebo devices, devices programmed to emit a 2 Hz. field, and devices programmed with four frequencies based on the individual bioelectric frequency analyses. The primary dependent variable was the change in the average number of migraines suffered per month.

Parametric and nonparametric statistical analyses showed that the group receiving the individually programmed devices had a significant reduction in the average number of migraines they experienced.

The paper will discuss pulsed electromagnetic therapies in general, methodological issues in this kind of research, and the results of this preliminary study.

## **PILLS, POLITICS AND PLACEBOS REVISITED PANEL**

### **Moderator: T. J. La Vaque**

The Stress Clinic, Green Bay, WI

This is a follow up to and extension of the "Pills, Politics and Placebos" paper presented last year and which is currently in press in the Journal of Neurotherapy. This examines recent modifications (strengthening) of the international medical ethics document (Declaration of Helsinki) and the position of the FDA and NIMH. The paper examines the ethical standards and debate, the conditions in which placebo (sham) controlled studies may be carried out and when it is questionable. There are gray areas as evidenced by research in psychopharmacology based upon moral issues of harm and statistical and methodological issues of assay sensitivity between experimental and control conditions. This will serve as a helpful introduction to the panel regarding efficacy studies and methodology.

## **ANTERIOR ALPHA ASYMMETRY IN ANXIETY AND DEPRESSION**

### **Robert Lawson and Eugenia Bodenhamer-Davis**

University of North Texas, Denton, TX

Many studies have found that people with depression have less activity in the left frontal region than healthy normals. An EEG correlate of this relative reduced activity is left side alpha asymmetry. It is not known, however, if there are frontal alpha asymmetry variations between individuals with depression only compared to persons with anxious depression. This exploratory study compared QEEG records of frontal alpha of a group of seven depressed persons with those of a group of nine anxious depressed. Based on clinical observations, it was hypothesized that the depressed group would have more left side alpha asymmetry than the anxious depressed group.

Membership in the depressed group was defined as having an MMPI2 Scale 2 Depression score  $\geq 60$  and a Scale 7 Psychasthenia score  $\leq 60$ . The anxious depressed group membership consisted of individuals whose MMPI2 Depression scores were  $\geq 60$  and Psychasthenia scores  $>60$ . Asymmetry was calculated with the following equation:  $(F3-F4)/(F3+F4)$  (magnitude, not power, voltage was used). EEG data were recorded on a Lexicor NRS 24 with a linked ear reference and remounted to a Cz reference.

Results of comparing the QEEG records of the two groups of individuals revealed that 85% of the depressed only group and 55% of the anxious depressed group had left side asymmetry. The depressed only mean asymmetry =  $-.043$ ; the anxious depressed mean asymmetry =  $-.0052$ . The depressed only group had significantly more left side asymmetry ( $p=.023$ ). A surprising finding was that the anxious depressed group had higher alpha on both sides than did the depressed only group ( $p=.029$ ). The mean frontal alpha,  $(F3\ \text{alpha} + F4\ \text{alpha})/2$ , of the depressed only group was 11.8, and 18.0 for the anxious depressed group. This increased alpha suggests that, relative to the depressed only group, persons who are anxious depressed have reduced frontal activation in both hemispheres.

## **A COMPARISON OF NORMATIVE EEG DATABASES AND MILD HEAD INJURY DISCRIMINANTS**

### **Robert Lawson (1), Richard Herrington (2), William Hudspeth (3), Marvin Sams (4)**

(1), (2) University of North Texas, Denton, TX

- (3) Neuropsychometric Laboratory, Los Osos, CA
- (4) Quest for Excellence, Bedford, TX

Many practitioners of EEG biofeedback use EEG normative databases to help guide protocol selection. There are several of these databases currently available. Little has been published about the concurrent validity of these databases. This presentation will compare different versions of the Life Span database with each other and with the NYU database. It will also compare the MTBI discriminant functions from the NYU and the Life Span databases.

There have been at least three versions of the Life Span Normative EEG Database. The first was sold by Lexicor as DataLex until the mid-nineties. The second was a revision of Version 1 and was sold with NeuroRep EEG report software. The third is also a revision of Version 1. Lexicor uses it in their QEEG report service. Nothing has been published comparing Revision 2 to 3. This paper will report on correlations between these two versions. As there are a large number of variables in the databases and the comparison sample is small, four composite variables will be created and correlations between these variables will be reported. These variables will be relative power, coherence, phase, and asymmetry.

There are two discriminant functions that use QEEG to differentiate between healthy normal individuals and those who have experienced a recent mild traumatic brain injury (MTBI). E. Roy John and his team at NYU developed one of these discriminants; Robert Thatcher developed the other. This study will compare the results from each of these discriminants for 10 individuals who have experienced head trauma without loss of consciousness in the last year.

### **QUANTITATIVE EEG NORMATIVE DATABASES: A COMPARATIVE INVESTIGATION**

**Tamara Lorensen & Paul Dickson**

Queensland University of Technology, AUSTRALIA

As quantitative EEG technology has developed so too has the number of QEEG databases offering services to clinicians and researchers. The wider range of choice has meant that professionals in this field are faced with the decision of exactly which database to use and whether interpretations of the data are appropriate and accurate. In addition to these dilemmas there is no clearly defined or even a universally accepted approach that can be used to determine the suitability of one database over another. Furthermore, there is a diversity of computational and methodological approaches each of which is vigorously defended by its proponents and often poorly understood by many practitioners. This fragmentation of approaches begs for the evaluation of some of the QEEG databases currently available and provides a compelling set of reasons for formulating a reliable and valid set of criteria to assess database suitability. This paper initiates this investigation and proposes a set of criteria or standards with the aim of facilitating further discussion and development of universal standards of QEEG databases and analyses.

### **NEUROCARDIAC DYNAMICS: THE RELATIONSHIP BETWEEN HEART-BRAIN SYNCHRONIZATION AND COGNITIVE PERFORMANCE**

**Rollin McCraty**

Institute of HeartMath, Boulder Creek, CA

Physiologists have studied the homeostatic functions of the cardiovascular afferent nerves for years. However, it is well established that these afferent systems also have functions beyond those classified as homeostatic, and can influence emotional, cognitive, auditory and visual processing. In previous studies we have found that emotional states affect heart rate variability (HRV) patterns, and techniques that elicit positive emotional states lead to a distinct mode of physiological function known as physiological coherence. This mode is characterized by a sine wave-like pattern in the HRV waveform (heart rhythm coherence), entrainment of major bodily systems and a shift in autonomic balance towards increased parasympathetic activity.

While specific rhythmic breathing methods can induce coherence for brief periods, our research indicates that individuals can produce extended periods of physiological coherence by actively self-generating a sustained positive emotion. Using a positive emotion to drive the coherent mode allows it to emerge naturally and typically makes it easier to sustain positive emotions and physiological coherence for longer periods, even during challenging situations.

This study investigated the relationship between physiological coherence, heart-brain synchronization and cognitive performance in 30 healthy individuals. Subjects performed an auditory discrimination task (ADT) before and after practicing an emotional refocusing technique intended to instill a positive emotional state and increase physiological coherence. Heart rhythm coherence (derived from the ECG), respiration, pulse transit time and

heartbeat evoked potentials were measured. It was found that EEG alpha activity is highly synchronized to the cardiac cycle and that the degree of alpha synchronization significantly increases during periods of high heart rhythm coherence. Increased heart rhythm coherence was also associated with significant improvements in cognitive performance (decreased reaction times). Additionally, there was a significant relationship between heart rhythm coherence and reaction times across all conditions.

This study suggests that techniques that increase heart rhythm coherence provide an efficient means to positively influence brain processes that regulate the autonomic system, emotional experience and cognitive function.

## **MALINGERING INDICATORS ON THE CONNERS' CPT-II**

**J. Trevor Milliron**

Lee University, Cleveland, TN

Due to legislation such as the Americans with Disability Act, college students that can document certain types of disabilities such as Attention-Deficit / Hyperactivity Disorder (AD/HD) can request accommodation from their education institutions. Such accommodations usually include increased time limits on tests and free tutoring services. These accommodations can become a tempting incentive for some students to feign or at least exaggerate symptoms of inattention. Likewise, some students will feign symptoms of AD/HD in hopes of obtaining psycho-stimulant medications that can be illegally marketed on campus. Continuous performance tests (CPTs) are usually included in most AD/HD evaluations as an objective behavioral measure of inattention symptoms. Unfortunately, there is little information in the literature or the test manuals to help a clinician identify evidence of a malingering attempt in the CPT results.

This study involved 100 college students (ages 17-25) that had no previous history of AD/HD symptoms. Each student completed the Conners' CPT-II twice after being read a brief description of AD/HD. Before one administration each student was asked to complete the task to the best of their ability. For the other administration, the student was encouraged to alter responses to simulate someone with AD/HD. The order of these administrations was counterbalanced. The results of this study review different malingering approaches contrasted with both normal and AD/HD profiles. Results are supportive of using additional objective measures less susceptible to malingering, such as a QEEG, as part of regular AD/HD evaluations.

## **NEUROFEEDBACK FOR THE BIPOLAR CHILD**

**Siegfried Othmer**

EEG Spectrum International, Encino, CA

Bipolar Disorder used to be a rare diagnosis in childhood. Recent research has elevated the importance of Bipolar Disorder as an issue in perhaps 20% of children formally diagnosed as ADHD. The medical management of these children is problematic, tending to involve anti-convulsants and neuroleptics rather than stimulants and anti-depressants. Neurofeedback can be very helpful with this condition. In fact, this population has probably been heavily represented in the ADHD clinical population seen by neurofeedback therapists over the years because of poor outcome with standard treatment.

This presentation will cover our historical approach to Bipolar Disorder in children and adults. Prior to the current prominence of this diagnosis, children with this condition might have been identified alternatively with Impulse Control Disorder, Tourette's Syndrome, Temporal Lobe Epilepsy or Complex Partial Seizures, Obsessive-Compulsive Disorder, Intermittent Explosive Disorder, or simply anxiety and depression. Much of our historical clinical experience with these conditions is still relevant upon the reclassification of this clinical population.

The current clinical approach takes as its point of departure that the fundamental issue in these disorders is the inability of the brain to maintain stability, and that neurofeedback can enhance overall stability in cerebral state regulation. The condition is characterized by hemisphere-specific failure modes, with the left hemisphere tending toward depression, whereas the right tends toward mania. This duality can account for the fact that symptoms of depression and mania can be simultaneously prominent. The specific neurofeedback approach that has been found most effective is to address the issue of bi-hemispheric communication by challenging communication linkages between them, and then to optimize the functioning of each hemisphere.

Case histories will be discussed in the context of the formal models, and data on adults will also be drawn upon to complete the picture.

## LORETA

### **Invited Speaker: Roberto Pascual-Marqui**

The KEY Institute for Brain-Mind Research, University Hospital of Psychiatry, Zurich, SWITZERLAND

## **NEUROPHYSIOLOGY AND NON-LINEAR DYNAMICS OF OBJECT PERCEPTION**

### **Karl Pribram, MD**

During the 1970s and 1980s evidence (mainly from micro-electrode studies) showed that the correlational brain processing necessary to sensory perception is dependent on transforming the input into the spectral domain. The process is linear and invertible, the inverse transform composing an image. The procedure is similar to that used in tomography, image construction through PET scans and MRI.

The perception of objects demands a different procedure. Objects are invariant over images obtained under various perspectives. Experiments were performed in Russia, Sweden and Cornell University with persons outfitted in black leotards with white dots placed on their joints. When the persons became active the dots were perceived as forming groups. During the 19th century, Lie "invented" continuous mathematical groups to correctly describe the perception of objects.

Dots can be created through nystagmoid movements of the eyes. These pendular movements converge on point attractors. The process is a non linear dynamic.

Groups can be either linear or non-linear depending on the homogeneity of the group process.

Evidence for all these statements will be provided and discussion entertained.

## **EFFECTS OF HEG TRAINING AT THREE PREFRONTAL LOCATIONS UPON EEG RATIOS AT CZ**

### **Robert Sherrill, Jr.**

New Mexico Psychological Services, Farmington, NM 87401

This is a single-case study of a 15-year-old, right-handed male with a history of moderate delay in development of speech, continuing mild articulation problems and poor spelling. He was treated with 20 sessions of combined HEG/EEG biofeedback. The primary emphasis was on increasing HEG, although EEG bands of 4-8 Hz. and 15-18 Hz. from a referential recording at CZ were also displayed. Feedback in each session was conducted in three trials, with the HEG optodes placed at FP1, mid-forehead, and FP2 locations for ten minutes each. Order of placement was counterbalanced across trials. Changes in HEG levels within each trial were computed, and plotted across sessions, as was the 4-8 Hz./15-18 Hz. ratio.

At all three locations, the slope of HEG increases within trials improved modestly across sessions. The ratio of 4-8 Hz./15-18 Hz. at CZ decreased clearly over sessions only in response to HEG training at mid-forehead.

## **EEG CHANGES ON TBI PATIENTS DURING COGNITIVE TASKS AFTER COGNITIVE REHABILITATION**

### **Student Scholarship Winner: Stamatina Stathopoulou & Joel F. Lubar**

University of Tennessee, Knoxville

**PURPOSE OF THE STUDY:** The rationale is that while EEG Biofeedback apparently constitutes a direct way of normalizing one's EEG, computerized cognitive rehabilitation achieves the same results, but in a more indirect way. The purpose of this study is to test the relationship between cognitive rehabilitation and changes in the EEG patterns in TBI patients with attention deficits. It has already been shown that after training patients portray decreased Theta and Alpha relative and absolute power and increased Beta relative and absolute power as well as decreased D/B ratios in eyes-open and eyes-closed recordings. Based on existing literature of EEG on Attention Deficit Disorders during implementation of cognitive tasks, the same results are expected also for TBI patients.

**PARTICIPANTS:** Five TBI participants, out of medication and at least one year after their accident.

**METHOD:**

Psychometrics\*\* : IVA, Digit Span, Digit Symbol, Pasat EEG\* \*: EO\*, EC\*, Recording during 8 cognitive tasks on attention of Captain's Log (level beginner -1), EO\*

Questionnaire\*\* : 32 questions (scale 1-5) Training: 24 sessions of Captain's Log (scale 1-5), (40 min. each)

Psychometrics+ : IVA, Digit Span, Digit Symbol, Pasat EEG+ : EO\*, EC\*, Recording during 8 cognitive tasks on attention of Captain's Log (level beginner -1), EO\*.

EEG+ : EO\*, EC\*, Recording during 8 cognitive tasks on attention of Captain's Log (level advanced -3), EO\*.

Questionnaire+ : 32 questions (scale 1-5)

EO\* : eyes-open, EC\* : eyes-closed, \*\* : Pre-training measures, + : Post-training measures

**RESULTS:** The psychometrics show improvement in the following skills-with at least one standard deviation difference, with order of improvement (from most to least improved) being: Sustained Attention, Alternating Attention, Selective Attention, Divided and finally Focused Attention. Auditory Working memory-through Pasat-, auditory short-term memory and sequential processing-through Digit Span- and visual short- term memory as well as visual-motor coordination -through Digit Symbol- constitute the last psychometric measures which show improvement. Improvement seems to be equally divided into the visual and auditory field for all five case studies.

In their self-report they scored higher by one point (indicating improvement) in Choice-Reaction Time (3 Ss), Divided Attention (3 Ss), Selective (2 Ss), Confusion (2 Ss), Simple-Reaction Time (2 Ss), Alternating Attention, Verbal Memory Impairment and Non-Verbal Memory Impairment, in Long-Term Memory, Sustained Attention and Anterograde Memory.

As far as the EEG is concerned, for three out of five cases significant changes (p-value less than 0.004) were portrayed in the Theta, Alpha and Beta frequencies in the Eyes-Closed Absolute Power after training, in frontal, central and posterior areas. In Eyes-Closed relative Power, significant changes after training were also portrayed in the three out of five cases in Frontal and Posterior areas in Alpha frequency and in Posterior areas in Beta frequency. Two out five cases show significant changes before and after training in Delta-Central and Posterior areas- as well as in Alpha, in the Central region.

Although not yet statistically analyzed, in the Eyes-Open, out of the five cases, four after training, show a decrease in the D/B ratio, three a decrease in the D/A ratio, as well as a decrease in A/B ratio. In the Eyes-Closed out of five cases, in four of them there is an increase in D/B ratio, in three of them an increase in T/A ratio, as well as a decrease in A/B ratio.

There are still tentative results about the EEG recording during cognitive tasks.

**CONCLUSIONS:** It is through the psychometrics that improvement in attention and mainly in sustained, alternating and selective attention- can objectively be seen. Moreover, their self-reports coincide with the outcome of the psychometrics. The hypothesis that after training, TBI patients with attention deficits would show lower D/B ratios, as well as lower Delta and Theta relative power, in frontal and central regions has been confirmed both in eyes-open and eyes-closed conditions. Moreover, lower D/B ratios as well as decreased Delta and increased Beta seem to occur not only in frontal and central but also in posterior regions both in eyes-open and eyes-closed. There are still tentative results for the EEG recording during cognitive tasks before and after training. An extended number of participants are needed though in order to confirm the results.

## **QEEG-GUIDED NEUROFEEDBACK IN THE TREATMENT OF EPILEPSY: AN UP-DATE FOR THE NEW MILLENNIUM**

**M. Barry Sterman**

UCLA, School of Medicine

Neurofeedback had its origins in animal studies documenting protection against drug-induced seizures following EEG operant conditioning. These were normal animals being trained to enhance a naturally occurring sensorimotor EEG pattern associated with a unique state of motor inhibition. The extension of this work to human seizure disorders disclosed a host of problems not encountered in the animal work. Patients had variable neuropathology, complex anticonvulsant drug regimens, and different personal histories. While compared to non-epileptics, seizure disorder patients were found to be statistically deficient in the human equivalent of the sensorimotor EEG pattern trained in animals; these patients also had other abnormalities clearly apparent in the EEG. Accordingly, starting with our earliest group studies, we collected EEG data from as many cortical sites as the computer equipment of the period allowed. We felt from the start that multi-channel QEEG analysis was essential for proper assessment and outcome evaluation. This perspective will be reviewed and brought into the present day context with examples from current cases.

## **EEG BIOFEEDBACK FOR DYSTONIA PARKINSON'S: CASE IN PROGRESS**

**Lynda and Michael Thompson**

ADD Centre, Mississauga, Ontario, CANADA

This talk will briefly outline the history, presentation, and current treatments for dystonia. We will present a rationale for neurofeedback treatment of symptoms of both dystonia and Parkinson's disease based on current knowledge of muscle spindle involvement, its double innervations, the relationship to the thalamus, and the production of sensorimotor rhythm.

We will give a case example of a woman who was severely disabled due to constant movements and who was no longer able to read a book. After 24 sessions she was able to give presentations before large audiences without freezing or excessive movement and was once again able to enjoy reading novels. We will present results after 1 1/2 years and discuss findings with other clients with movement disorders.

## **QEEG, SPECIFIC COGNITIVE ABILITIES & THE EMOTIONS OF LOVE, HAPPINESS AND SADNESS: THE EMPLOYMENT OF SPECIFIC EMPIRICAL PROTOCOLS DESIGNED FOR MAXIMUM EFFECTIVENESS.**

**Kirtley Thornton, PhD**

Dr. Thornton will discuss his 4 year/200 subject research effort which addressed the relationships between QEEG variables and effective cognitive functioning - what makes it work better for some people. Results will be presented for adults and children. The specific cognitive tasks employed were auditory memory (for paragraphs, word lists), memory for reading material, visual figures and names of faces. Results presented will include the input stage, the immediate and delayed recall task for these tasks. Also addressed were spelling ability, mathematical ability (multiplication tables, two digit addition), visual and auditory attention, silent pronunciation of nonsense words, recalling where objects are put, recalling a "to do" list, problem solving and intelligence (Ravens Matrices). Additional topics include developmental changes in the effective parameters, effects of brain injury on QEEG variables, the effects of Lyme's disease in one subject and the correlates of love, happiness and sadness. Data was obtained for all the tasks up to the 64 Hertz range and in one case up to the 128 Hz range.

Also to be discussed will be the rationale guiding interventions (designed by comparison to reference group on relevant variables) and empirical results obtained with normals, learning disabled subjects, brain injured (with and without structural damage).

The 1997 IDEA act, its implications for Neurotherapy in the United States school system, juvenile delinquency and effective legal approaches towards program implementation will be discussed.

## **HEG PANEL**

**Moderator: Hershel Toomim**

**Participants: Hershel Toomim (1), Frank Diets (2) and Jeff Carmen (3)**

(1) BioComp Research Institute, (2) Focused Technology, (3) Olde Barn Technologies

The three most experienced workers in this field plan a conversation with the audience. Each presenter will provide a short introduction featuring his experience with HEG technology followed by answers to questions posed by those interested audience members.

## **TASK-RELATED EEG ALPHA DESYNCHRONIZATION DURING A COGNITIVE FLEXIBILITY TASK IN GOOD VERSUS POOR PERFORMERS**

**Student Scholarship Winner: Edwin Verstraeten & Raymond Cluydts**

Dept. of Cognitive & Physiological Psychology, Vrije Universiteit Brussels, BELGIUM

**OBJECTIVES:** Alpha oscillations during cognitive performance have mostly been studied in memory and/or (basal) attention tasks. The present study investigates task-related alpha power desynchronization (TRD) in a cognitive flexibility test requiring higher executive attentional control. Alpha power responses are also studied in good versus poor performers.

**METHODS:** Participants were 23 paid volunteers (12 males and 11 females, age 46.4 years, education 12.6 years).

Since the verbal flexibility task measured executive attentional control, the EEG was recorded at AF3 (according to the expanded 10-20 system). Horizontal and vertical eye movements were measured simultaneously. In order to follow the same rationale as in ERD/ERS research, task-related power decrease/increase relative to an eyes-open resting baseline (EO) was calculated during a computerized cognitive flexibility task that required a steady-state task performance, (i.e., with repetitive cognitive challenges within a time window of less than 2000 msec.). Two subtests with different task difficulty were used: a two-choice RT digit test (50 trials) and a flexibility test in which attention needed to be alternated between letters and digits (100 trials). Measures used were median RT, SD of the RT (performance variability), and the number of errors. Subjects were divided in two groups based on their normative performance for each of the three mentioned parameters. Good performers scored above average, superior or very superior. Poor performers scored below average or borderline abnormal. All groups but one were matched for age and educational level. The number of years of education was significantly higher ( $p=.044$ ) in the stable performers (13.7 years) compared to the variable performers (10.6 years). Previous research has suggested functional differences in the lower alpha band (8-10 Hz.) and upper alpha band (10-12 Hz.). Therefore, alpha power changes were studied in the 8-12 Hz., 8-10 Hz. and 10-12 Hz. ranges. Test scores on other neuropsychological tasks (WAIS-R Digit Span: forward and backward, Symbol Digit Modalities Test, Trail Making, Five-Point Test, Wisconsin Card Sorting, and Critical Flicker Fusion Frequency), administered within the same session, were compared between good and poor performers on the Flexibility Test and with respect to their alpha EEG reactivity. Between-subject analyses were performed using Mann-Whitney tests, and for within-subject comparisons Wilcoxon matched pairs tests were used.

**RESULTS:** Good performers, who made no errors (only one of them made one error) ( $N=12$ ) during the flexibility task, showed in the difficult task relative to EO a significant TRD in the 8-10 Hz. range ( $p=.034$ ). They also tended to produce such a TRD in the difficult task relative to the easy one ( $p=.084$ ). In contrast, in those who made between six and eleven errors ( $N=5$ ) a task-related synchronization (TRS) appeared in the 10-12 Hz. range relative to EO during both the easy task ( $p=.043$ ) as well as during the flexibility task ( $p=.043$ ). Moreover, the good performers had a greater backward digit span ( $p=.051$ ). Critical flicker fusion frequency, measuring CNS activation, also tended to be higher in these good performers ( $p=.105$ ). With respect to the median RT, the group of fast responders ( $N=7$ ) generated a TRD in the 8-10 Hz. range during the difficult task relative to EO ( $p=.018$ ). Slower performers ( $N=9$ ) did not show significant alpha responses during task conditions. No significant differences in the other neuropsychological test scores were found. A different 8-10 Hz. reactivity between stable performers ( $N=7$ ) and variable performers ( $N=5$ ) during the difficult task relative to the easy one ( $p=.007$ ) was the result of a TRD in stable performers ( $p=.018$ ). In addition, stable performers drew more unique designs in three minutes ( $p=.047$ ) indicating a better design fluency that may be explained by their higher level of education. Furthermore, they also tended to perform better on the Trail Making Test - part A ( $p=.068$ ), the SDMT ( $p=.103$ ), and the Critical Flicker Fusion Frequency Test ( $p=.092$ ).

**CONCLUSIONS:** Significant task-related 8-10 Hz. desynchronization was found only during the difficult flexibility test and only in good performers. In contrast, poor performers, who made at least six errors during the flexibility task, hypersynchronized in both the easy and the difficult task within the 10-12 Hz. range, probably reflecting cognitive overload. Slow or variable performers generated no significant TRD. In line with previous research, the differential alpha responses considered together with their related neuropsychological test profiles, may indicate functional differences. Interpreted within the framework of attentional functioning, the 8-10 Hz. band appears to be more associated with alertness and information processing speed, whereas the 10-12 Hz. range seems to be more related to attentional control.

## **QEEG REFERENCE DATABASE EVALUATION OF ADULT ADHD**

### **Student Scholarship Winner: Noland White & Joel F. Lubar**

University of Tennessee, Knoxville

In a recent study of adults with Attention Deficit Hyperactivity Disorder (ADHD), it was discovered that approximately 50% of the ADHD sample demonstrated greater impairment than their colleagues as evidenced by at least two of the three Attention Quotient scores on the Intermediate Visual and Auditory Continuous Performance Test (IVA) (White, 2001). Furthermore, these same individuals with greater impairment on the IVA demonstrated significantly higher theta/low-beta power ratios at Fz as compared to their ADHD colleagues during other neuropsychological tasks. Overall, these ADHD individuals demonstrated higher theta/low-beta ratios across all three tasks and concurrently demonstrated greater attentional impairment on the IVA. This finding speaks to potential diversity in the manifestation of this disorder in relatively high functioning adults and the need for the examination of possible QEEG variations within this diagnostic category.

One method used to identify potentially pathognomic QEEG variations is the incorporation of a QEEG reference

database. There are several such databases available, but to date, a comparison of databases has not been performed in the attempt to identify a specific clinical population. As such, to further evaluate the ADHD subjects described above, the current investigation will compare the results of analyses from two such databases. The databases that will be used in the present study are those associated with the NeuroRep QEEG Analysis and Report System (Hudspeth, 1999) and the SKIL Topometric Software Package (Serman & Kaiser, 1998).

**METHOD: Participants:** The study sample consisted of 10 adults with ADHD (6 males and 4 females), ranging in age from 21 to 47 years old. Informed consent was obtained per the University of Tennessee, Office of Compliances, Institutional Review Board guidelines. Inclusion criteria required that participant be formally registered with the Office of Disability Services at the University of Tennessee with a diagnosis of ADD or ADHD. Participants were also required to demonstrate clear characteristics of the disorder as measured by personal endorsement of at least six of nine hyperactive-impulsive items or at least six of nine inattentive symptoms as indicated from diagnostic criteria on a DSM-IV symptom checklist for ADHD.

Exclusion criteria included: (1) an obtained standard score less than 85 on the Peabody Picture Vocabulary Test - 3rd Ed. (PPVT-III), (2) a history of neurological disorder, head injury, or substance abuse, and (3) previous diagnosis of specific learning disabilities, as assessed through the health history questionnaire and personal interview. To control for medication effects, ADHD participants being treated with stimulant medication were evaluated after a medication-free period of at least 12 hours.

**Electroencephalograph (EEG) Recording:** The quantitative referential EEG was recorded from 19 electrodes in an array following the International 10-20 Placement System (Jasper, 1958) with linked earlobe references. Standardized preparation procedures involved all electrode impedances being maintained at or below 5 KOhms. The raw EEG was collected using a Lexicor NeuroSearch-24 Electroencephalograph with a sampling rate of 128 samples per second.

**PROCEDURE:** Participants reported to the Brain Research and Neuropsychology Laboratory in order to obtain informed consent, completion of the screening measures, and EEG recordings with all tasks completed in a single, two-hour appointment. All data collection was performed between the hours of 8 AM and 1 PM. EEG Recordings were made using a fitted electrode cap (Electro Cap Inc.). There were additional bipolar recordings at the outer canthus of each eye and above and below the left eye to monitor horizontal and vertical eye movements, respectively.

All participants completed five quantitative Electroencephalograph (QEEG) recordings during two baselines and the three different test conditions. The conditions included a three-minute eyes-closed EEG baseline, 3-minute eyes-open EEG baseline, administration of the PASAT, administration of the WCST: CV3, and administration of the IVA. The order of administration remained standard for all participants.

**Data Analysis.** Following artifact rejection using the EEG Editor (Nova Tech EEG, 2000) EEG data review and editing package, data files for the eyes-closed and eyes-open resting baselines for each participant will be submitted for analysis to both the NeuroRep QEEG Analysis and Report System and the SKIL Topometric Software package. Database comparisons will be generated for each package following established guidelines. The results of the respective analyses will then be compared and contrasted including a synopsis of the unique characteristics of each package.

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