

**Volume 8 (2003-2004)**

**Summary of Contents with Abstracts**

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*No 3 mailed March 2005, No 4 due May 2005*

**NUMBER 1**

**EDITORIAL**

**A Proactive Position on qEEG in Neurotherapy**

*David L. Trudeau, MD, Editor*

**Position Paper**

**Standards for the Use of Quantitative Electroencephalography (QEEG) in Neurofeedback: A Position Paper of the International Society for Neuronal Regulation**

*D. Corydon Hammond, PhD*

*Jonathan Walker, MD*

*Daniel Hoffman, MD*

*Joel F. Lubar, PhD*

*David Trudeau, MD*

*Robert Gurnee, MSW*

*Joseph Horvat, PhD*

**Background.** This paper presents the findings of an interdisciplinary committee on standards for quantitative electroencephalography (QEEG) in neurofeedback which has been unanimously accepted by the International Society for Neuronal Regulation (ISNR) Board as a position paper of ISNR.

**Method.** The committee reviewed current standards for quantitative encephalography in other specialties as well as scholarly literature on QEEG.

**Results.** The panel reached the following conclusions:

**The Temporal Dynamics of Electroencephalographic Responses to Alpha/Theta Neurofeedback Training in Healthy Subjects**

*Tobias Egner, PhD*

*John H Gruzelier, PhD*

**Background.** It has been shown recently that accurate feedback of alpha and theta electroencephalographic (EEG) activity, as employed in the commonly used "alpha/theta protocol," induced linear increments in within-session theta-over-alpha ratios in comparison to non-contingent feedback in a healthy sample. These data verify that alpha/theta feedback can facilitate within-session operant control over the EEG signature targeted by the training protocol. However, it is neither known whether any between-session theta/alpha ratio changes do reliably occur, nor what kind of temporal dynamics between the alpha and theta band amplitudes characterize within-session and/or between-session theta/alpha ratio changes.

**Method.** In order to address these issues, analyses of an extensive data set (n = 48) of alpha/theta training in healthy volunteers were carried out. Specifically, alpha, theta, and theta/alpha ratio EEG dynamics were contrasted between groups of subjects that engaged in 10 sessions of training at PZ (n = 28), five sessions of training at PZ (n = 10), and 10 sessions at FZ (n = 10).

**Results.** For alpha/theta training at PZ, significant within-session increments in theta/alpha ratios were mediated by slightly less pronounced decrements in theta than in

1. Although clinical research indicates that a full 19 channel QEEG does not appear necessary for conducting successful neurofeedback training, an increasing number of clinicians are using comprehensive QEEG evaluations to guide their neurofeedback training.

2. An impressive body of peer reviewed scientific literature attests to the utility of the QEEG in providing a scientifically objective and clinically practical assessment of a wide range of psychiatric, psychological and medical conditions.

3. Many of the significant contributions to the field of QEEG have come from psychologists and the Board of Professional Affairs of the American Psychological Association has concluded that QEEG is within the scope of practice of psychologists trained in this specialty.

4. Unlike neurology and psychiatry, where QEEG is principally used for purposes of diagnosing medical pathology, neurotherapists who use QEEG primarily do so to guide EEG biofeedback training.

5. It is not necessary for a physician to screen raw EEG data as part of a QEEG evaluation for neurofeedback training.

**Conclusions.** For the purpose of encouraging high standards, recommendations are made for areas of training and study in this specialty, for certification, for equipment/software, and for procedures in data collection and analysis.

**KEYWORDS.** QEEG, quantitative EEG, neurofeedback, EEG biofeedback

## SCIENTIFIC ARTICLES

### **Changes in Frontal Brain Asymmetry Associated with Premenstrual Dysphoric Disorder: A Single Case Study**

*Elsa Baehr, PhD*

alpha activity during the sessions. The traditional alpha/theta protocol at PZ was nevertheless associated with significant theta activity increments across the training process. For training at FZ, no significant within- or between-session changes in theta, alpha, or theta/alpha ratio values were found, but a progressively higher rate of within-session theta/alpha ratio modulation was evident across sessions. Furthermore, in contrast to the PZ groups, any changes in theta/alpha ratio at FZ were mediated by increases in theta relative to alpha amplitudes.

**Conclusions.** These data elucidate the dynamics underlying the within-session theta/alpha ratio increments associated with posterior alpha/theta training, and document an increase in theta activity across 10 sessions of training, offering further evidence for a neurophysiological impact of this training protocol. In addition, the contrasting EEG characteristics associated with frontal versus posterior alpha/theta training underline the heterogeneous nature of these frequency components across varying scalp sites.

**KEYWORDS.** Alpha/theta neurofeedback, alpha, theta, theta/alpha ratios, neurofeedback learning

### **Case Study of Trigeminal Neuralgia Using Neurofeedback and Peripheral Biofeedback**

*Andrea Sime, LCSW*

**Background.** Trigeminal neuralgia is characterized by brief episodes of extremely intense facial pain often radiating down the jaw. These episodes can occur spontaneously or be triggered by light touch, chewing or changes in temperature. The pain can be so intense as to be completely disabling. This case study concerns a 46 year-old nurse with a 15-month history of trigeminal neuralgia. She had been maintained poorly on Propoxyphene/apap100/650 mg (100 mg Darvocet with 650 mg Acetaminophen) over the previous year. Her neurologist's next planned intervention was to sever the trigeminal nerve.

*Laura Miller, MD  
J. Peter Rosenfeld, PhD  
Rufus Baehr, PhD*

**Background.** In a pilot study Baehr (2001), states changes in frontal cortical alpha asymmetry during the luteal phase of the menstrual cycle were documented in five depressed women who also experienced Premenstrual Dysphoric Disorder (PMDD). In this paper detailed data is presented for one of these subjects and two comparison subjects who were part of the first study. The goal was two-fold: (a) to study how patterns of mood changes during the luteal phase of the menstrual cycle correlated with changes in frontal alpha brainwave asymmetry, and (b) to determine whether treatment strategies, tailored to ameliorate symptoms, would be reflected in brainwave changes.

**Method.** Neurofeedback, medical interventions and prospective charting were collected over a period of six months for one patient. This data was compared with data collected for two monthly cycles from two non-PMDD comparison subjects.

**Results.** The patient responded well to the neurofeedback protocol for depression, and was normalizing her scores by the second week in treatment except for setbacks which occurred during the luteal phase of her menstrual cycle. Extreme mood changes correlated with negative changes in brainwave asymmetry during this period. A combination of neurofeedback and medication worked to stabilize her mood swings and asymmetry scores.

**Conclusion.** This case study demonstrated how brainwave changes in frontal alpha asymmetry occurred during the luteal phase of the menstrual cycle in a woman who suffered from PMDD. Two comparison subjects, who were undergoing similar treatment for depression but did not suffer from PMDD, had stable alpha asymmetry scores during the entire menstrual cycle. Anomalies in serotonergic and/or gabergic function in the luteal phases of PMDD are pinpointed as possible underlying factors in this disorder.

**Method.** Over a period of nine months, this client had 10 peripheral biofeedback training sessions (including dynamic EMG biofeedback) and diaphragmatic breathing in conjunction with a program of stress management and counseling. She also received 29 sessions of neurofeedback (including T4, C3, C4, C3-C4 and T3-T4). C3 seemed to be the most effective placement for sleep maintenance issues and T3-T4 seemed to be the most effective placement for pain issues.

**Results.** The client experienced a substantial reduction in pain and bruxism as well as improvement in sleep quality. Symptom reduction fluctuated with life stress issues and with adjustment in both peripheral and neurofeedback protocols. The success of this treatment allowed the client to avoid radical surgery (severing of the trigeminal nerve) and to discontinue use of Propoxyphene/apap 100/650 mg. In a 13-month follow-up, the client reports having an active life style and managing her pain quite well on 20 mg of tramadol hydrochloride (Ultram) every 12 hours as long as she uses her self-regulation techniques.

**Conclusion.** This case study suggests that a multi-modal approach of neurofeedback, peripheral biofeedback, stress management and counseling was clinically efficacious in treating the symptoms of this difficult and painful condition.

**KEYWORDS.** Trigeminal neuralgia, neurofeedback, peripheral biofeedback.

#### **NEWS FROM OTHER JOURNALS AND WEBSITES**

**David Kaiser, PhD, Editor**

#### **BOOK REVIEW**

*The Therapist's Notebook for Families: Solution-Oriented Exercises for Working with Parents, Children and Adolescents*, Bob Bertolino and Gary Schultheis  
*Reviewed by John Nash, PhD*

#### **EUROPEAN CHAPTER CONFERENCE**

**Submitted Abstracts of Scientific Papers**

<p><b>KEYWORDS.</b> Premenstrual dysphoric disorder, alpha asymmetry, neurofeedback, depression, EEG biofeedback</p>	<p><b>Presented at the 2003 Inaugural Conference, ISNR, European Chapter, Udine, Italy</b>                  Contents                  Abstracts</p>
<p><b>NUMBER 2</b></p>	
<p><b>EDITORIAL</b></p> <p><b>Financial Support for Scholarship from the Journal of Neurotherapy and the International Society for Neuronal Regulation (ISNR)</b>  <i>David L. Trudeau, MD</i></p> <p><b>SCIENTIFIC ARTICLES</b></p> <p><b>Neurofeedback for Elementary Students with Identified Learning Problems</b></p> <p><i>Peter C. Orlando, PhD</i>  <i>Richard O. Rivera, BS</i></p> <p><b>Introduction.</b> The goal of this research was to ascertain whether basic reading, reading comprehension, the reading composite, and IQ scores could be improved using neurofeedback. Pre-test and post-test reading and cognitive assessments were administered to sixth, seventh and eighth graders identified as having learning problems. Control and experimental groups were chosen at random. With the exception of three students, every student in the control and experimental group had previously been diagnosed with Specific Learning Disabilities or as Other Health Impaired according to State and Federal guidelines for special education services. The three students were medically diagnosed as having ADHD and were on a 504 Accommodation Plan.</p> <p><b>Method.</b> The research began in late August 2001 with securing administrative and parental permissions. Student participation began during the last week in September and lasted through the last week in April. A day was set aside to administer QEEGs (also called “brain maps”) to the students in the</p>	<p><b>CLINICAL CORNER</b></p> <p><b>Neurofeedback for Cerebral Palsy</b>  <i>Margaret E. Ayers, MA</i></p> <p><b>Neurofeedback with Cerebral Palsy and Mental Retardation: A Case Report</b>  <i>Alan Bachers, PhD</i></p> <p><b>A Neurologist’s Advice for Mental Health Professionals on the Use of QEEG and Neurofeedback</b>  <i>Jonathan Walker, MD</i></p> <p><b>ISNR CONFERENCE</b></p> <p>Summaries and Abstracts of Student Scholarship Presentations, Poster Presentations and General Conference Presentations Presented at the 2003 International Society for Neuronal Regulation (ISNR) 11th Annual Conference, Houston, Texas</p> <p>Editorial Note: Introduction to ISNR Conference Abstracts, 2003</p> <p><b>Student Scholarship Presentation Abstracts</b></p> <p><b>Effects of Childhood Sexual Abuse on Brain Function as Measured by Quantitative EEG, Neuropsychological, and Psychological Tests</b>  <i>Lisa Black, MS</i></p> <p><b>Limbic Activation and Low Resolution Brain Electromagnetic Tomography: Can Hippocampal and Other Limbic Lobe Activity Be Recorded Accurately and Changes Differentiated By LORETA in</b></p>

experimental group. Protocols were developed by following the brain maps and by using clinical judgment after staffing the students with their teachers on a regular basis; their psychoeducational evaluations were also used to plan the protocols. Following the statistics on the biofeedback machines also influenced protocol decisions. Neurofeedback training was provided to the participants of the experimental group only. Both the experimental group and the control group had their Individualized Educational Plans (IEP) or 504 Plans plus their general curriculum plans. Neurofeedback training lasted approximately 30 to 45 minutes within each one-hour time block. The sessions were conducted weekly for the seven-month period. Some students received more sessions than others because of absences, field trips, testing and other natural rhythms of home and school life. The average number of sessions per student was 28.

**Results.** Neurofeedback was more effective in improving reading tests than no neurofeedback training. There were significant interactions between neurofeedback and time on basic reading. Wilks' lambda (?) = .69,  $F(1, 23) = 10.32$ ,  $p < .01$ , on reading comprehension,  $\eta^2 = .75$ ,  $F(1, 23) = 7.62$ ,  $p = .01$ , and on reading composite scores,  $\eta^2 = .65$ ,  $F(1, 23) = 12.59$ ,  $p < .01$ .

Neurofeedback training was more effective in improving both the Verbal and Full Scale IQ scores than no neurofeedback training. There was a significant interaction between neurofeedback and time on Verbal IQ,  $\eta^2 = .62$ ,  $F(1, 21) = 12.71$ ,  $p < .01$ , and on Full Scale IQ,  $\eta^2 = .56$ ,  $F(1, 21) = 16.50$ ,  $p < .01$ . However, there was not a significant interaction between neurofeedback and time on Performance IQ,  $\eta^2 = .87$ ,  $F(1, 21) = 3.00$ ,  $p = .10$ .

**Discussion.** The results support the hypothesis that biofeedback training is effective in improving reading quotients. Limitations of the study and ideas for further research are presented. Neurofeedback may be an effective supplement to special education in improving IQ and reading performance.

**Affective Memory Acquisition?**

*Rex Cannon, BA*

**Increasing Individual Upper Alpha Power by Neurofeedback Improves Cognitive Performance**

*Simon Hanslmayr*

**QEEG Analysis of Cranial Electrotherapy: A Pilot Study**

*Richard Kennerly, MA*

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**Obsessive Compulsive Dimension Localized using Low Resolution Brain Electromagnetic Tomography (LORETA)**

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*Alicia L. Townsend, BA*

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**Effects of Neurotherapy on Attention and Impulsivity in Crack Cocaine Addiction: A Controlled, Single-Blind Study**

*V. Shannon Burkett, MA, John M. Cummins, PhD, Robert M. Dickson, LPC, and Malcolm H. Skolnick, PhD, JD*

**Quantitative EEG Phase Evaluation of Transcendental Meditation**

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*Richard Kennerly, MA*

**Combined Effects of Neurofeedback and Pulsed Electromagnetic Fields**

*Martha S. Lappin, PhD*

**Combining ROSHI and BrainMaster: Three Case Studies**

**KEYWORDS.** Neurofeedback, EEG biofeedback, learning problems, reading scores, IQ scores, school psychology

## **EEG Changes of Traumatic Brain Injured Patients after Cognitive Rehabilitation**

*Stamatina Stathopoulou, PhD  
Joel F. Lubar, PhD*

**Background.** Little research has addressed cognitive rehabilitation and changes in the electroencephalogram (EEG) following training of traumatic brain injured (TBI) patients suffering from attention deficits because of their injury. This study focuses on changes in relative and absolute power in frontal, central and posterior regions of the TBI patients' brain following training on attention skills using a software program called Captain's Log.

**Methods.** The five participants - aged 20 to 45 years - received 22 sessions of training on their attention skills. Their attention skills were assessed at the beginning and end of the research study through a variety of psychometrics as well as through scaled self-reports. Their EEG was also recorded before and after training, during eyes-open resting baseline, eyes-closed resting baseline, eight cognitive tasks and a post-tasks eyes-open resting condition. Only the first two baselines were analyzed in the present study. (The rest of the conditions will be analyzed in another study.) The hypotheses that the participants' delta, theta, and alpha relative and absolute power would decrease and that their beta power would increase following training were analyzed.

**Results.** Although there were significant post-task changes in four out of the five case studies in relative and absolute power, both in eyes-closed and eyes-open conditions, the most systematic change was the decrease of alpha in the eyes-closed condition.

**Conclusion.** These new findings link training in cognitive processes with EEG changes.

*George Martin, MA*

## **QEEG Guided rTMS** *Steven T. Padgitt, PhD*

**Examining the Relationship between EEG Data and Neuropsychological Measures**  
*Patricia C. Post, PsyD, and Gregory R. Anderson, PhD*

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*Anat Barnea, DSc*

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*Donald Bars, PhD*

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*Donald R. Bars, PhD*

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*Eugenia Bodenhamer-Davis, PhD and Tonya Callaway, MS*

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*Valdeane W. Brown, PhD*

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

*V. Shannon Burkett, MA, John M. Cummins, PhD, Robert M. Dickson, LPC, and Malcolm*

**KEYWORDS:** Traumatic brain injury, EEG, cognitive rehabilitation, attention deficits, software programs

**Neurofeedback as a Treatment for ADHD: A Methodological Review with Implications for Future Research**

*David Vernon, PhD  
Ann Frick, MSc  
John Gruzelier, PhD*

Attention deficit/hyperactivity disorder (ADHD) represents one of the most common psychiatric disorders in childhood, resulting in serious impairment across a variety of domains. Research showing that a high proportion of children with ADHD exhibit a dysfunctional electroencephalogram (EEG), relative to aged matched peers provides a rationale for the use of neurofeedback as an intervention. The aim of neurofeedback training is to redress any EEG abnormality, resulting in a concomitant improvement in the behaviour and/or cognitive performance of these children. This review focused on studies using neurofeedback to treat children with ADHD, with particular emphasis on the methodological aspects of neurofeedback training. Specifically, the review examined the modality of feedback provided, the different training parameters and their underlying rationale, and the particular montages used. In addition, the review also focused on the duration, frequency and total number of training sessions required to obtain a positive effect in terms of a change in the individual's EEG, behaviour and/or cognitive performance. Finally, the long-term effects of neurofeedback and the potential negative side effects were reviewed. Throughout, the review provides a number of directions for future research.

**KEYWORDS.** ADHD, EEG, quantitative EEG, neuro-feedback, methodology

*H. Skolnick, PhD, JD*

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

*Jeffrey A. Carmen, PhD*

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

*Marco Congedo, PhD, Joel Lubar, PhD, and David Joffe, MS*

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**Attention Training with ADHD Children: Preliminary Findings in a Double-Blind Placebo-Controlled Study**  
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**Special Issue: New Developments in Blood Flow Hemoencephalography**

**EDITORIALS**

**Our Second Special Issue**

*David L. Trudeau, MD*

**Blood Flow Hemoencephalography**

*Tim Tinius, PhD*

**SCIENTIFIC ARTICLES**

**Intentional Increase of Cerebral Blood Oxygenation Using Hemoencephalography (HEG): An Efficient Brain Exercise Therapy**

*Hershel Toomim, ScD, William Mize, MD, Paul Yeekwong PhD, Marjorie Toomim, PhD, Robert Marsh, AA, Gerald P. Kozlowski, PhD, Mary Kimball, PhD, Antoine Remond, MD*

Intentional enhancement of regional cerebral blood oxygenation (rCBO<sub>2</sub>) in specific cerebral locations was studied as a brain exercise. A review of literature showed the effect of brain exercise on brain physiology. Hemoencephalography (HEG), a graphic analog of brain blood flow of oxygenated hemoglobin indicated by non-invasive infrared spectroscopy, was used to guide intentionally increasing rCBO<sub>2</sub>. A musical note and visual graphic keyed to changes in cortical blood oxygenation was provided to the participant. A primary aim of this study was to demonstrate the capacity of subjects with brain disorders to increase oxygenation of selected brain tissue using HEG and test the hypothesis that multiple repetitions of these brain exercises improved sustained attention measured with a continuous performance test. The impulsivity score for subjects in the exercise group was in the normal range after 10 sessions. In a small set of subjects, low arousal SPECT images showed increased vascularity after 30 half-hour sessions of intentional enhancement of local blood oxygenation.

**KEYWORDS.** Brain blood flow,

**Effects of Hemoencephalographic (HEG) Training at Three Prefrontal Locations upon EEG Ratios at CZ**

*Robert Sherrill, Jr., PhD*

**Background.** Light in the wavelength region of 650 to 1000 nanometers is able to penetrate living human tissue, including bone. Medical research has exploited this optical window into the body to develop non-invasive monitoring of brain functioning. In 1994 Herschel Toomim discovered that he could measure and teach persons to control the amount of oxygenated blood flowing in the prefrontal regions with such an optical device. He has labeled the biofeedback of brain blood flow hemoencephalography (HEG).

**Methods.** A fifteen-year-old male with a history of mild articulation problems and poor spelling was administered twenty sessions of combined HEG/EEG biofeedback, with a referential recording at Cz. Feedback in each session was conducted in three trials with the HEG optodes placed over the left eye, at midline, and over the right eye for ten minutes each. The order of placement was counterbalanced across trials. Changes in HEG levels within each trial were computed and plotted across sessions, as was the theta/beta ratio for each trial.

**Results.** The subject clearly learned improved voluntary control over brain blood flow. The slope of increases of HEG within each trial improved across sessions at all three forehead locations. There were three indications from this case that HEG training to improve attention might be most efficacious at the midline location: (a) the theta/beta ratio at Cz decreased slightly over sessions only in response to HEG training at midline, (b) bursts of beta lasting ten seconds or more occurred more often, and (c) occasionally a marked increase in HEG within a trial was associated with a corresponding increase in power in beta. This occurred only with HEG at midline.

Hemoencephalography, HEG, brain exercise, ADD/ADHD, toxic encephalopathy

### Exploring Hemispheric Differences in Infrared Brain Emissions

*David Freides PhD, Lisa Aberbach, BA*

**Background.** Carmen (Toomim & Carmen, 1999) has shown that training to increase frontal lobe infrared emissions with neurofeedback techniques inhibits migraine pain, but nothing is known about the psychological correlates of the infrared signal. We assess if reading *out loud* would increase activation in the left hemisphere in comparison to the right. We also assessed test/retest reliability by repeating measures a week later.

**Methods.** Measurements of infrared activity, while reading or not, were taken three times from the left, center, and right forehead of 24 persons who had signed Institutional Review Board approved consent forms. The order of reading and non-reading was varied systematically.

**Results.** Significant differences in activation favoring the right rather than the left hemisphere were found, but only in those who read first. Both order-of-reading groups significantly declined in overall activity during the second session. Five of six Pearson correlations measuring test/retest reliabilities in the reading-first group and two of six in the reading-second group attained statistical reliabilities in the reading-first group and two of six in the reading-second group attained statistical significance. Only measurements taken at the left forehead site were reliable across all four conditions, which represent the combination of two orders and two types of stimulation.

**Conclusions.** Test/retest correlations provide some support for the inference that the infrared measures reflect enduring traits, especially in the left hemisphere. Hemispheric difference data suggest that infrared emissions were sensitive to processes such as orientation, habituation and attention. There was no evidence of sensitivity to left

**Conclusion.** HEG biofeedback is a promising treatment modality, especially for improving the functioning of executive control systems mediated by the prefrontal regions of the cerebral cortex.

**KEYWORDS.** Hemoencephalography, HEG, electroencephalography, EEG, rheoencephalography, REG, near-infrared spectroscopy, NIRS, blood flow biofeedback, biofeedback

### Hemoencephalography - A New Therapy for Attention Deficit Hyperactivity Disorder (ADHD): Case Report

*William Mize, MD*

**Background.** Hemoencephalography (HEG) is cortical circulatory biofeedback using refracted light tuned to oxygenated hemoglobin emitted into the skull and detected at the scalp using a photoelectric cell. Red light at 660nm is used as the probe, with changes in the returning refracted light representing changes in cortical circulation.

**Method.** A single-subject design case study was employed. TL, at age twelve, had a well-established diagnosis of ADHD given by pediatric neurologists, and required significant stimulant medication that was clinically effective. He was performing well in school on Concerta 36mg at 7 a.m. and Ritalin 5mg at 4pm. Off medication, he had significant abnormalities on IVA testing (Attention Quotient or AQ=78) and in the quantitative electroencephalogram (QEEG). Using HEG, the patient engaged the system to exercise increases in signals corresponding to cortical circulation in the prefrontal cortex. QEEG, Continuous Performance Testing (CPT) and clinical status measurements were made before and after 10 sessions of HEG therapy. HEG exercise was typically given in weekly to bi-weekly sessions for 10 minutes in each of three standard prefrontal EEG locations: FP1, FP2 and FPz.

**Results.** During the 10 therapy sessions TL's HEG data showed positive gain indicating

hemisphere specialization for verbal processing.

**KEYWORDS.** Infrared, neurofeedback, orientation, habituation, test/retest reliability

### **Passive Infrared Hemoencephalography: Four Years and 100 Migraines**

*Jeffrey A. Carmen, PhD*

**Background.** One hundred migraine sufferers were treated using passive Infrared Hemoencephalography (pIR HEG) over a period of four years. All subjects met the criteria for at least one of the categories set forth in the International Headache Society (IHS, 1988) classification criteria for headache disorders for primary migraine.

**Methods.** Subjects were treated using the pIR HEG system in 30-minute sessions. A central forehead placement (approximately Fpz) was used for the sensor assembly for all subjects. Changes in headache patterns were examined. After two years, an infrared video imaging system was added to the data collection process and was available for 61 of the 100 subjects. Infrared forehead images were captured at the start and end of each session to examine changes in prefrontal cortical brain activity.

**Results.** Most of the subjects improved control over their migraine headaches. Over 90% of those subjects who completed at least six sessions reported *significant improvements in migraine activity*.

**Conclusions.** pIR HEG appears to have a strong impact on migraine headaches, even for people who have not had a positive response to medication. Headache response by the end of six sessions appears to be a good predictor of probability of improvement.

**KEYWORDS.** pIR HEG, HEG, hemoencephalography, migraine, headache, biofeedback, neurofeedback, frontal, inhibition

success at raising the biofeedback signal. Following the 10 sessions, TL showed a normal QEEG with improved Z scores for relative power and normal IVA testing off medication (mean AQ  $99.75 \pm 7.85$  on three dates), which persisted in the 18-month follow-up. His medication was lowered to Focalin 2.5mg twice daily.

**Conclusion.** This work documents a patient who showed clinically significant improvement after only 10 sessions using a new form of neurobiofeedback, hemoencephalography. If confirmed in controlled studies, this represents a breakthrough in treatment options for ADHD. Future studies should explore synergies between HEG and EEG neurofeedback therapies.

**KEYWORDS.** Hemoencephalography, neurotherapy, neurofeedback, ADHD, prefrontal cortex, cortical circulatory biofeedback, biofeedback, alternative medicine

## NUMBER 4

## EDITORIAL

**Time for a Change***David L. Trudeau, MD*

## SCIENTIFIC ARTICLES

**Limbic Beta Activation and LORETA: Can Hippocampal and Related Limbic Activity be Recorded and Changes Visualized Using LORETA in an Affective Memory Condition?***Rex Cannon, BA, Joel Lubar, PhD, Keri Thornton, BA, Stuart Wilson, BA, Marco Congedo, PhD*

**Background.** The purpose of this study was to determine the validity of Low Resolution Electromagnetic Tomography (LORETA) in visualizing limbic structures and possibly identifying electroencephalographic (EEG) frequencies in the limbic region during an anger memory recall process.

**Method.** This study was conducted with twelve subjects, non-clinical students at the University of Tennessee, Knoxville. A pre-study screening was conducted. Eyes-open baselines were obtained employing 300 epochs, or five minutes, using a 19-channel quantitative electroencephalographic (qEEG) acquisition system with linked ear reference. The experimental condition recording directly followed an eyes-open baseline. The experimental condition was to allocate a memory that created intense anger and retain the state as long as possible. All files were no less than 100 total epochs upon editing. The data were analyzed in both individual and group conditions with LORETA imaging software. Statistical differences between conditions were evaluated for significance, then computed and transformed into LORETA images.

**Results.** The data revealed significant differences between the anger condition and

With mixed model methodology now available (e.g., the mixed procedure [Mixed PROC] of the SAS<sup>®</sup> system), the covariance structure can be incorporated into the statistical model. Disregarding potential random effects not specific to single individuals and absorbing potential within-subject random effects into the covariance matrix allows one to work with a simplified model.

The use of a mixed procedure and its method of modeling the data structure appear to provide an accurate and objective method of analysis resulting in quantifiable equations for testing predictions. Essentially, this method allows the physiological pattern of each individual in the study, not related to any other variable, to be represented and accounted for in the model. Several comparative examples will be used to highlight the information that can be hidden in data structures depending on the type of statistical analysis used.

**KEYWORDS.** General linear model (GLM), covariance, Fourier, quantitative electroencephalography

## 2003 ISNR CONFERENCE

**Abstracts of General Conference Presentations Presented at the 2003 International Society for Neuronal Regulation (ISNR) 11th Annual Conference, Houston, TX**

Editorial Note: Introduction to the 2003 ISNR Conference Abstracts

**General Conference Presentation Abstracts**

- Advanced Buddhist Meditation: Multiple States and Their Neurophysiological Correlates  
*John W. DeLuca, PhD and Ray*

baseline recordings in limbic structures and frontal regions. The data suggests that limbic lobe and hippocampal activity can be recorded and visualized using LORETA during affective memory recall. There are several notable differences between the baseline and condition images. One of the more interesting of these differences is possible activation of the amygdala, uncinate gyrus and surrounding structures in the beta (12–32 Hz) frequencies. The hemispheric asymmetries during anger memory recall offer further support for the lateralization of hemispheric activity relating to affective states.

**Conclusion.** LORETA may be an effective method used to differentiate and visualize limbic lobe, hippocampal formation and other related structures during affective anger memory recall.

**KEYWORDS.** LORETA, amygdaloid complex, limbic lobe, hippocampus, anger, emotional lateralization, mnemonic processes, qEEG, affective cortical processes, mid-brain beta activation

### **EEG Coherence Effects of Audio-Visual Stimulation (AVS) at Dominant and Twice Dominant Alpha Frequency**

*Jon A. Frederick, PhD, DeAnna L. Timmermann, PhD, Harold L. Russell, PhD, Joel F. Lubar, PhD*

The effects of a single session of audio-visual stimulation (AVS) at the dominant alpha rhythm and twice-dominant alpha frequency on EEG coherence were studied in 23 subjects. An eyes-closed baseline EEG determined each subject's dominant alpha frequency. Subjects were stimulated at their dominant alpha frequency or at their twice dominant alpha frequency for 20 minutes, while EEG was recorded in five-minute intervals. A post-session baseline was recorded 30 minutes after each session. AVS decreased coherence in the intrahemispheric projections from the occipital region and the parietal midline, and generally increased coherence, with few exceptions, among all

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other longitudinal pairs. Interhemispheric coherence increased posteriorly and at high frequencies, and tended to decrease frontally and at low frequencies. Alpha AVS was more effective than twice-alpha AVS at increasing interhemispheric coherence, and tended to produce more effects overall. Although the main effects of frequency and time were observed when individual coherence pairs changed, they almost always changed in only one direction. Overall coherence was greater during the first 10 minutes than the last 10 minutes, and greatest in the beta 1 and delta 2 bands, and lowest in the alpha and delta 1 bands. Few, if any, significant effects persisted into the post-stimulation baseline. A new method of assessing the effects of multiple comparisons on experiment-wise error, based on randomization theory, is proposed and implemented.

**CURRENT CONCEPTS IN NEUROTHERAPY**

**EEG Activity in Subtypes of Attention-Deficit/Hyperactivity Disorder**

*Adam R. Clarke PhD, Robert J. Barry DSc*

This article is a review of electroencephalography (EEG) studies of different types and subtypes of Attention-Deficit/Hyperactivity Disorder (AD/HD). The review outlines the definitional history of AD/HD and changes that have been made to the conceptualization of the disorder as these different definitions have impacted on the EEG literature. EEG studies are examined using various models of AD/HD based on either behaviour or underlying central nervous system (CNS) abnormalities. From these studies, it appears that AD/HD children generally have increased absolute and relative power in the theta band, either at the frontal electrode sites or over the entire scalp. Reductions in absolute and relative power in the alpha and beta bands have also been found in several studies, although relative power measures appear to be more reliable than absolute power. Increased delta activity in both absolute and relative power has also been noted in several studies. These results are discussed in terms of existing CNS-based models of AD/HD, which attribute the

(AVS) on the Hemoencephalographic (HEG) Response

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- Electroencephalographic (EEG) Discriminant Analyses of Children

disorder to hypoarousal or a maturational lag in CNS development. Implications of these data for clinical use and future research and development in AD/HD are considered.

**KEYWORDS.** Attention-deficit/hyperactivity disorder, electrophysiology, electroencephalography, EEG, review

### **TECHNICAL NOTES**

#### **Mixed General Linear Model Analysis of Quantitative Electroencephalographic (qEEG) Data**

*Donald R. Bars, PhD, Christian Schindler, PhD*

This paper describes a mixed general linear analysis of the quantitative electroencephalogram (qEEG). The modeling is similar to regression, which builds a regression or 'best-fit' model for the data structure but, in addition, provides for correlations between observations. A mixed linear model states that data consists of two parts: fixed effects and random effects. Fixed effects determine the expected values of the observations, while random effects account for the stochastic deviations from these expected values both between and within individuals. Since errors are independent between subjects, the deviations from the expected values may also be modeled using a repeated measures approach. The term 'repeated measures' in this model refers to data with multiple observations from one specific source. It is reasonable to assume that these observations from the same source are correlated, even if only slightly, in some measurable way. Consequently, statistical analysis of repeated measures data gives a more accurate prediction capability when the issue of covariation between these measures is addressed.

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