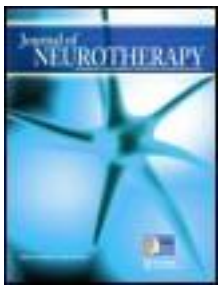

Journal of Neurotherapy: Investigations in Neuromodulation, Neurofeedback and Applied Neuroscience

General Conference Presentation Abstracts

Anat Barnea DSc , Donald Bars PhD , Donald R. Bars PhD , Eugenia Bodenhamer-Davis PhD , Tonya Callaway MS , Grant Bright PhD , Valdeane W. Brown PhD , V. Shannon Burkett MA , John M. Cummins PhD , Robert M. Dickson LPC , Malcolm H. Skolnick PhD and JD , Jeffrey A. Carmen PhD , Marco Congedo PhD , Joel Lubar PhD , David Joffe MS , B. Robert Crago PhD , Lonnie A. Nelson MA , Raymond M. Daly PhD , Bella Lev MSW , Roger deBeus PhD , J. D. Ball PhD , Mary E. deBeus PhD & Richard Herrington PhD

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General Conference Presentation Abstracts

The Effects of Neurofeedback on Hemispheric Specialization and on Cognition

Anat Barnea, DSc
Bio-Keshev Clinic, Kibutz Givat Chaim Ichud, Israel
<anatbr@ghi.org.il>

Introduction

We applied theta/SMR training at central sites of 20 Israeli children aged 10 to 12, half boys and half girls. Half of the subjects received C3 training and the other half received C4 training. Training consisted of 20 half-hour sessions. We assessed the effects of training on lateralized lexical decision in Hebrew, on dichotic listening to nonsense stop consonant-vowel syllables, as well as on some cognitive tasks.

Method

The lateralized lexical decision test reveals an independent contribution of each hemisphere to word recognition. The dichotic listening test, measuring phonetic perception, is exclusively specialized to the left hemisphere, as signaled by a right ear advantage (REA). The cognitive tests were computerized and included the IVA CPT, Spatial Orientation, Nonverbal IQ, Picture Memory and Word Memory.

Results

In the lateralized lexical decision task, training increased accuracy and sensitivity. It did not affect overall hemispheric specialization or interhemispheric transfer, but it did affect psycholinguistic processing in the two hemispheres, differentially at C3 and C4, and it increased hemispheric independence. Finally, C3 feedback selectively improved error monitoring in the left hemisphere.

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There were surprising sex differences in the effects of training. Both C3 and C4 feedback affected both hemispheres, though differently in boys and girls. For example, in boys C3 training improved right hemisphere accuracy and C4 training improved left hemisphere accuracy; whereas, in girls both C3 and C4 training improved left hemisphere accuracy. C3 training also selectively improved error monitoring in boys.

The dichotic listening test revealed an improvement in overall scores with neurofeedback (NF). Furthermore, NF increased the REA in girls but decreased the REA in boys, thus shifting the superiority of the REA from boys to girls. Here, NF on either side affected hemispheric specialization (in girls) as well as callosal transfer (in boys). Alternatively, these changes in the REA in both sexes could be due to strategic shifts in attention to one ear.

C4 feedback improved the IVA Auditory Speed in girls; whereas, C3 feedback improved it in boys. By contrast, Spatial Orientation improved with C4 feedback in boys, but with C3 feedback in girls. There was no change in either Picture Memory or Word Memory.

Conclusion

Laterality of NF can affect asymmetric control networks (as in lexical decision), while feedback on either side can affect the same lateralized processing modules or the same callosal channels (as in dichotic listening). We suggest that the NF protocol activates hemispheric control circuits that are organized differently in boys and girls and reorganize distant hemispheric networks.

The Mixed General Linear Model of Statistical Analysis and qEEG

Donald Bars, PhD
Kantonsspital Basel Unversitaetskliniken, Basel, Switzerland
<the.bars@balcab.ch>

Introduction

This paper described the application of a statistical model for the analysis of digital quantitative electroencephalographic information (qEEG). The model is similar to regression, which allows one to build a regression or "best-fit" line for the data structure, but also provides for correlations between observations. A linear mixed model states that data consists of two parts: fixed effects and random effects. Fixed effects are the expected values while random effects consist of the variance and covariance of the observations. It is the vari-

ance that makes a variable unique; thus, the more accurately we can isolate it the more we might understand what the data is trying to say.

Method

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

The Model:

$$\boldsymbol{Y} = \boldsymbol{X}_{\beta} + \boldsymbol{Z}_{\Upsilon} + {}_{\varepsilon}$$

Conclusion

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

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

Donald R. Bars, PhD
Kantonsspital Basel Universitaetskliniken, Basel, Switzerland
<the.bars@balcab.ch>

Introduction

There are at least two major subtypes of explosive, aggressive behavior based upon identifiable biological substrates. One originates in the basic primitive "fight-or-flight" mechanism of the limbic system and the other results from disinhibition of the frontal lobes. Visual evoked potential (VEP) amplitudes were statistically analyzed to assess their association with these two

types of explosive behavior in children and adolescents and were found to be an objective viable adjunct to present methods of classification.

Method

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

Results

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

Conclusion

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

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Extended Follow-Up of Peniston Protocol Results with Chemical Dependency

Eugenia Bodenhamer-Davis, PhD, and Tonya Callaway, MS
University of North Texas, Denton, Texas
<genie@unt.edu>

Introduction

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

Method

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

Results

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

Conclusion

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

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The World Is Flat! The World Is Round?

Grant Bright, PhD
Private Practice, Alpharetta, Georgia
<gbright@bellsouth.net>

Introduction

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

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

Method

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

Results

Researchers report significant findings using advanced mathematical analysis. These findings are not apparent without these techniques. JTFA is used to isolate the transient, non-periodic, "chirp-like" qualities present in EEG (Durka, 2003).

Conclusion

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

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

Valdeane W. Brown, PhD
Zengar Institute and Neurofeed.com
<val@zengar.com>

Introduction

Various measures for change in neurofeedback have been proposed including QEEG z-scores and ratios using amplitude-based measures within training sessions, such as theta/beta ratio and traditional spectral densities (Fell, Elfadil, & Klaver, 2002). Recent work has confirmed the possible value of several other measures including the Correlation Dimension [C(r)] and the First Derivative (FD; Lamberts et al., 2000) as well as the Auto Correlation (AC) and/or Cross Correlation (CC) of Joint Time Frequency Analysis (JTFA), specifically the Wigner-Ville distribution (Lai, Osoria, Harrison, & Frie, 2002). In this study, these measures were applied to neurofeedback training data to determine their usefulness for differentiating successful from less successful outcomes.

Method

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

Results

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

Conclusion

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

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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 H. Skolnick, PhD, JD
Southwest Health Technology Foundation,
supervised by the Committee for the Protection
of Human Subjects at the Health Science Center,
University of Texas, Houston, Texas
<vsburkett@hotmail.com>

Introduction

EEG biofeedback has been demonstrated as effective in the treatment of alcoholism, as evidenced by Peniston and Kulkosky's research efforts (1989, 1990). Most research with alpha-theta EEG biofeedback has addressed alco-

hol addiction. Given that cocaine is the most common drug problem of patients entering treatment for drug abuse (NIDA's Drug Abuse Treatment Outcome Study, 1999), research in the treatment of this "untreatable" population is warranted. The current study is a four-year research project developed by the Southwest Health Technology Foundation (SWHTF). It is currently underway at the Open Door Mission in Houston, Texas, and utilizes EEG biofeedback with mostly homeless "crack" cocaine addicts in a nine-month residential, faith-based treatment program.

Method

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

Results

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

Conclusion

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

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

Jeffrey A. Carmen, PhD
Private Practice, Manlius, New York
<carmen5272@aol.com>

Introduction

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

Method

Three thousand six hundred (3,600) infrared images have been collected over the last three years using infrared video technology to view brain activity. Some basic aspects of this technology were developed in a laboratory setting by Shevelev (1992, 1998). These current images have been digitally processed to emphasize the capture of excess thermal output exiting the brain from the prefrontal cortex originating in underlying metabolic activity and blood flow. The images have been captured before and after pIR HEG sessions, reflecting pre/post session changes as well as changes at intervals of weeks and months (Carmen, 2001).

Results

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

Discussion

Infrared imaging through the human skull appears to be a valid measure of relative brain activity within the prefrontal cortex (Shevelev, 1998). This process has some similarities to fMRI, PET, and SPECT in terms of monitoring brain activity. Although it probably does not monitor brain activity as precisely, it has an advantage of flexibility and ease of use that allows monitoring of cognitive and motor processes during varying task demands.

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

Marco Congedo, PhD, Joel Lubar, PhD, and David Joffe, MS
The University of Tennessee, Knoxville, Tennessee
<loretabiofeedback@yahoo.com>

Introduction

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

Method

Three individuals were trained to improve brain activation, suppressing low alpha (8-10 Hz) and enhancing low beta (16-20 Hz) current density in the

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

Results

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

Conclusion

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

QEEG and Neuropsychological Consequences of Exposure to Toxic Molds

B. Robert Crago, PhD (1) and Lonnie A. Nelson, MA (1,2)
(1) Neurobehavioral Health Services, Tucson, Arizona,
(2) University of Arizona, Tucson, Arizona
<bcbrain1@msn.com> <lan@u.arizona.edu>

Introduction

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

Method

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

Results

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

Conclusion

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

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

Raymond M. Daly, PhD and Bella Lev, MSW
University of Windsor and Neuro-Biofeedback Wellness Centre, Windsor, Ontario, Canada
<nbwc@mnsi.net>

Introduction

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

Method

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

Results

The QEEG and LORETA data clearly indicated that the positive QEEG & LORETA changes (i.e., normalization with respect to age related QEEG database samples) have been sustained. There also have been age appropriate developmental changes in his EEG, especially in posterior alpha and anterior beta frequencies. The distribution of current densities (LORETA) with reference to selected Brodmann areas were particularly informative and was compared to findings from other neuroimaging techniques (Wolf et al., 1996).

Conclusion

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

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

Roger deBeus, PhD (1, 2), J. D. Ball, PhD (2) , Mary E. deBeus, PhD (2), Richard Herrington, PhD (3)
(1) Advanced Psychological Services, Riverside Health System, Newport News, Virginia, (2) Eastern Virginia Medical School, Norfolk, Virginia,
(3) University of North Texas, Denton, Texas
<roger.debeus@att.net>

Introduction

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

Methods

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

During the sessions each child played Sony PlayStation games with an active sensor placed at FZ. In order to ensure that each child received treatment, a crossover occurred after 20 sessions. The children were randomized into two groups. Group 1 received 20 sessions of brainwave-modulated Sony PlayStation videogames and then received 20 sessions with the videogames while brainwave activity was monitored. Group 2 received treatment in the opposite order.

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

ers completed rating scales while the children were re-administered the intake procedure.

Results

Twenty-six children (eight girls and 18 boys) seven to 11-years-old (average age 9.0, SD = 1.25) in grades two through five (average grade 3.5, SD = 1.1) have completed the study to date. Eleven of the children were medicated on a psychostimulants only and 15 were not medicated. Each child had a primary diagnosis of ADHD (17 primarily Inattentive and nine Combined). Average Full-Scale IQ was 101 (SD = 12.43) and WISC-III Freedom from Distractibility Index was 97 (SD = 15.75).

Twelve children were in Group 1 (experimental/control) and 14 children were in Group 2 (control/experimental). Session data was collected and examined for trends. Two-way repeated-measures ANOVA indicated a group $\times$ condition interaction and had a significant impact on training Theta, Alpha, SMR, and Beta brain wave activity. In particular, effect sizes for Theta, Alpha, and SMR were very large (.77).

Conclusion

The results indicated different learning curves between the two groups and conditions showing that EEG biofeedback does change electrophysiology. The ANOVA results indicated that the Control-first group had difficulty decreasing Theta or Alpha activity in the following treatment condition. The Treatment-first group had a significant increase in Theta and Alpha activity after a withdrawal of treatment. It is possible that sham conditions interfered with the learning process. Furthermore, it is not clear to what extent the level of interactivity of the PlayStation interface played a role in the learning process. These results are preliminary and this study is still in progress until 52 children have completed the study. Future plans include a Phase II in which children will complete 20 more active feedback sessions.

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Editor's note: The remainder of the 2003 ISNR general conference presentation will be printed in the *Journal of Neurotherapy 8*(4).

ERRATUM

Tamara D. Lorensen, BSc Grad Dip
Paul Dickson, BSocSc Bpsych

For purposes of accuracy, this is a correction of inadvertent errors in the publication, "Quantitative EEG Normative Databases: A Comparative Investigation," *Journal of Neurotherapy*, 7 (3/4): 53-68, 2003. The reference to Thatcher et al., 2000 on pages 57 and 61 was to a website and the correct citations are: Thatcher, R. W., McAlaster, R., Lester, M. L., Horst, R. L. and Cantor, D. S. (1983). Hemispheric EEG Asymmetries Related to Cognitive Functioning in Children. In A. Perecuman (Ed.), *Cognitive Processing in the Right Hemisphere.* New York: Academic Press; Thatcher, R. W., Walker, R. A. and Guidice, S. (1987). Human Cerebral Hemispheres Develop at Different Rates and Ages. *Science* 23: 1110-1113; and Thatcher, R. W., Walker, R. A., Biver, C., North, D., and Curtin, R. (2003). Quantitative EEG Normative Databases: Validation and Clinical Correlation, *Journal of Neurotherapy, 7* (3/4): 87-122.

As explained in the corrected citations, the Thatcher et al., University of Maryland normative database acquired data from 19 channels and not 16 channels as was incorrectly stated on page 61 and in Table 2, page 61.