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Journal of  
**Neurotherapy**

## International Society for Neuronal Regulation

12<sup>th</sup> Annual Conference, 26-29 August 2004

Harbor Beach Marriott Hotel, Fort Lauderdale, Florida



## Scientific Presentations

Updated 22 July 2004 (This file prints over 30 pages.)

Focus of Presentation will be indicated by "R" for Researchers or "C" for Clinicians or "R/C" for Both

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

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#### Introduction

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

#### Method

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

#### Results

PAF neurofeedback (NF) seemed to improve mental processing speed and executive functions, but have no effect on memory, or even negative effect on visual memory. On the contrary, alpha amplitude NF seemed to improve verbal, visual, and working memory, but worsen story memory, speed of processing, and executive functions. Pseudo-NF had some effects similar to alpha amplitude but smaller in size.

#### Conclusion.

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

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## Effect of Neurofeedback Training on the Neural Substrate of Executive Deficits in ADHD Children (R/C)

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### ISNR Research Fund Supported Research Project

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### Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is characterized mainly by impairments in executive functions, which refer to cognitive regulatory capacities for the initiation and maintenance of efficient attainment of goals. These capacities have been largely associated with the prefrontal lobe. In line with this, a recent functional magnetic resonance imaging (fMRI) study (Vaidya et al., 1998) has demonstrated a hypoactivation of the fronto-striatal circuit in ADHD children while they were engaged in a Go/NoGo task. Another fMRI study (Bush et al., 1999) showed a dysfunction of the anterior cingulate cortex in adults with ADHD when they performed a Stroop task. In this context, the present fMRI study was undertaken to measure the effect of neurofeedback training (NFT) on the neural substrate of executive deficits in ADHD children.

### Method

Twenty ADHD children not taking any psychostimulant participated in the study. Fifteen children were randomly assigned to the experimental group (NFT), whereas the other five children were assigned to the control group (no NFT). NFT was based on a protocol previously proposed by Thompson and Thompson (1998), and conducted over a period of 13 and a half weeks (40 sessions, three training sessions per-week). Subjects from both groups were scanned with a 1.5 Tesla fMRI scanner one week before the beginning of the NFT (Time 1) and one week after the end of this training (Time 2), while they performed a "Counting Stroop" task and a Go/NoGo task.

Results and Conclusion – This information is forthcoming.

### References

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## Event-Related Potential (P300) Prolonged Latency is Differentially Negatively Correlated with Sex Hormones and Insulin Growth Factors as a Function of Gender: A Preliminary Study Of Hormones in Neurocognition (R/C)

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### Introduction

A review of the literature reveals that sex hormones have often been associated with changes in behavioral and mental abilities. In one NIH funded study, the blood level of unbound testosterone was found to be significantly lower in men who develop Alzheimer's disease (AD) and it has been suggested that lack of testosterone may be a causative factor in this disease. Previous published research from our laboratory provided strong evidence that P300( latency) event-related potential, a marker of neuronal processing speed, is an accurate predictor of early memory impairment in both males and females across a wide age range.

### Methods

These facts and findings prompted us to systematically evaluate the relationship between sex and other hormones and P300 latency. In this large (n=1,372; average age for females was 57.4 and 55.8 for males with a range of 30 to 93 years) clinically-based study, we

report for the first time, a number of very important findings.

## Results

Specifically: (a) in males, both IGF-1 and IGFBP-3 significantly associated negatively with prolonged P300 at different age periods; (b) in males the spearman correlation between P300 latency and free testosterone was significant. at different age periods; (c) in males aged 50-69 there was a significant negative correlation between P300 latency and DHEA levels; (d) in females only IGFBP-3 not IGF-1 significantly associated negatively with prolonged P300 latency; (e) in females there were no significant correlations between estrogen and progesterone and P300 latency ;(f) in females there were significant negative correlations between DHEA levels and P300 latency at different age periods. Moreover, there were no statistically significant correlations between any hormone and WMS-111. However, there was a significant negative correlation between estrogen levels and the number of ADD complaints.

## Discussion/Conclusion

This information coupled with early primary care diagnosis of cognitive decline by utilizing P300 latency as an electrophysiological marker of processing speed may initiate a powerful paradigm shift as it relates to potential prevention of neurocognitive decline and possibly even AD. If these results can be confirmed, it may have important value in the early diagnosis, prevention and treatment of cognitive function and potentially impact multifactorial causes of AD.

## The NeuroFeedback Value of Photic Driving (R/C)

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## Introduction

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

## Method

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

## Results

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

## Conclusion

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

## Targeting Higher than Beta Frequencies: Using 7 Hz Resonances as a Basis for Targeting (R/C)

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Traditional targeting approaches are based on decades-old band designations like "beta", "alpha" or "theta" among others. Even when these bandwidths are "tuned" in some fashion, the basic phenomenology remains. Although there has been limited interest in 40 Hz

or gamma-based training, most amplifier systems are incapable of operating effectively in that target range. This problem is exacerbated further when targeting is attempted above this range, particularly in countries in which the mains current is 50 Hz 220 V.

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

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

### **Executive Function: A Possible Circuit of Attention, Cognition and Motivational Brain Processes (R/C)**

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#### **Introduction**

The anterior cingulate gyrus is suggested to have involvement in numerous executive processes. It has been the topic of extensive research and continues to be a focal point for understanding cognitive, affective and attentive brain processes. The anterior cingulate circuit is suggested to involve sub-cortical, limbic, and prefrontal areas. This study examined structures involved in the executive processes of cognition, reward acquisition, motivation, short-term and long-term memory. The region of interest for this study is the anterior cingulate gyrus cognitive division (ACcd), dorsolateral prefrontal cortex and laterality in the supramarginal gyrus, and parietal areas. The data were extracted from LORETA neurofeedback sessions in which participants were rewarded for increasing 14 to 18 Hz beta activity in the ACcd (Talairach coordinates -3, 31, 29).

#### **Method**

This study was conducted with eight non-clinical students, four male and four female, with a mean age of twenty-two, at the University of Tennessee, Knoxville. All recordings and feedback were provided through DEYMED Truscan Acquisition System employing 19 active channels, linked ear references, and ground.

#### **Discussion**

The preliminary data suggests that the anterior cingulate gyrus, dorsolateral prefrontal cortex, supramarginal gyrus and parietal areas increase with apparent uniformity. Regression models and statistical data support the correlation of activity in the specified frequencies for the region of interest.

#### **Conclusion**

The anterior cingulate gyrus is involved in a circuit involving executive function. The cognitive division of the anterior cingulate gyrus, dorsolateral prefrontal cortex, supramarginal gyrus and parietal areas appear to have relative involvement in the executive functions elicited by this study.

### **Frontal Alpha Asymmetry: A State or Trait Measure of Affective Response (R/C)**

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#### **Introduction**

Research has demonstrated differential patterns of anterior cerebral activation during the experience or expression of positive and negative emotions (Tomarken, Davidson, & Henriques, 1990). Prior studies have examined whether resting alpha asymmetry predicts individual affective response to film clips (Tomarken et al. 1990; Tomarken, Davidson, Wheeler, & Doss, 1992). The present study examined whether anterior encephalographic alpha asymmetry pattern would reliably shift in response to elicited affective state over

an extended period of time.

## Method

Frontal alpha asymmetry was recorded in 17 right-handed female students during a 116-minute video selected to elicit both happy and sad affects (Return to Me, 2000).

## Results

Alpha asymmetry score was stable across conditions with correlation across scores significant among all scenes at the .05 level ( $df = 3D 15$ ). There was no significant difference between A scores during conditions,  $t=3D .519$ ,  $p=3D .303$ . A score did not correlate with self report of mood during scenes. The first A score correlated with self reported sad mood prior to viewing the film,  $r=3D -.612$ ,  $p < .01$  level. According to self-report, conditions impacted mood. Sad score was compared to happy score during sad scenes,  $t=3D 13.12$ ,  $p < .001$  (Mean Sad score 6.25,  $SD=3D 2.5$ , mean happy score .81,  $SD=3D 1.41$ ).

## Conclusion

Alpha asymmetry ratio appears to be a stable physiological phenomenon within a sample of non-depressed, well-adjusted individuals.

## References

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## Infrared Imaging of the Frontal Cortex (R/C)

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## Introduction

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

## Method

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

## Results

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

## Conclusion

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

## References

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- Shevelev, I. A. (1998). *Functional imaging of the brain by infrared radiation (Thermoencephaloscropy)*. *Progress in Neurobiology*, 56, 269-305.

## **EEG in Real-Time: New Perspectives and a Platform for 3-D Visualization of Functional Brain Dynamics (R/C)**

### **ISNR Research Fund Supported Research Project**

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### Introduction

Recent advances in micro-processors and graphic cards as well as recursive algorithms for digital signal processing have allowed the exploitation of EEG system in real-time. Besides neurofeedback (NF), a considerable amount of research is focusing on the development of Brain-Computer Interfaces (BCI). On the other hand, Virtual Reality (VR) provides a powerful framework for the construction of virtual environments (VE) that may enhance NF and BCI systems by capturing the participants' attention, raising their motivation, and providing them with more informative feedback of the brain activity.

### Method

Recent literature in NF, BCI, and VR focusing on real-time EEG will be briefly reviewed. Then, the OpenViBE (Open-platform for Virtual Brain Environments) project will be presented. OpenViBE has been conceived so to be a general platform for real-time navigation and visualization of a 3-D virtual brain. It supports key features such as the distribution of processing on a PC net and stereovision, hence it is suitable for the development of high-performance and immersive virtual brain environments. As an example, we will show how to use functional electromagnetic data (e.g., Standardized Low-Resolution Electromagnetic Tomography) to dynamically represent brain activity in the form of 3-D objects superimposed on a volumetric rendering of brain anatomy. In this application the participants can truly navigate into their brain and observe the neocortical dynamics in realistic spatio-temporal relations.

### Results

Through several examples with real EEG data streams, OpenViBE is shown to be a flexible platform that can be used in very diverse EEG real-time applications, which include, but are not limited to, NF and BCI.

### Conclusion

The aim of this presentation is to delineate a "crossroad" to which NF, BCI, and VR may converge in future research involving functional brain data in real-time. By developing OpenViBE as open-source software, we hope to promote the development, exchange of information, and cross-publication in these fields of research.

## **On the Neuropsychological and Electro cortical Impacts of Mixed Mold Exposure (R/C)**

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### Introduction

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

### Method

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

## Results

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

## Conclusion

Most patients are suffering from problems of acute stress, adjustment disorder, or post traumatic stress. Differential diagnosis confirmed an etiology of a combination of external stressors along with organic metabolically-based dysregulation of emotions and decreased cognitive functioning due to toxic or metabolic encephalopathy. Neuropsychological testing reveals impairment similar to mild traumatic brain injuries. The QEEG findings indicate a hypo activation of the frontal cortex, possibly due to brainstem involvement and insufficient excitatory input from the reticular activating system. Findings of a dose response relationship between measures of exposure and the outcome of neuropsychological tests and QEEG measures suggest that toxic mold can cause central nervous system dysfunction. Study limitations include lack of comparison group, possible patient selection bias, and incomplete data sets to allow some comparisons among variables.

## Reference

Crago, R., Gray, M., Nelson, L., Davis, M., Arnold, L., & Thrasher, J. (2003). *Psychological, neuropsychological, and electrocortical effects of mixed mold exposure*. *Archives of Environmental Health*, (in press). Permission to reprint from: Heldref Publications, 1319 Eighteenth St., N.W., Washington, D.C. 20036-1802, [www.heldref.org](http://www.heldref.org)

## The Efficacy of Attention Training For Children with ADHD: A Double-Blind Placebo-Controlled Study (R/C)

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## Introduction

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

## Methods

The design of the study consisted of a diagnostic workup, 40 sessions (with a crossover after 20 sessions), and pre-, mid-, and post-assessments. Testing measurements were parent, teacher, and self-report rating scales, and a continuous performance test. During the sessions each child played Sony PlayStation games with an active sensor placed at FZ. The children were randomized into two groups. Group 1 received 20 sessions of brainwave-modulated videogames and then received 20 sessions with the videogames while brainwave activity was monitored. Group 2 received treatment in the opposite order.

## Results

Results are based on 53 seven- to 11-year-old children. The primary analysis used in this study was Hierarchical Multivariate Linear Modeling (HMLM). The outcome measures used to determine the efficacy of this intervention (experimental vs. placebo-control) were divided into five domains: (a) ADHD Symptoms (b) Aggression & Conduct Problems, (c) Internalizing Symptoms, (d) Adaptive Skills, and (e) Academic Performance. There were ten significant findings ( $p < .000$ ) across all the domains for the experimental group compared to the control group.

## Conclusions

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

be discussed.

## **Preliminary Data from Comparison of Electrophysiology and Cognitive Profile of 50 ADHD Subjects to the International Brain Database: Implications for Treatment Predictive Validity and Individualized Treatment (R/C)**

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### Introduction

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

### Method

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

### Results

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

### Discussion

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

## **The FPO2 Baby: The Observed Effects of the Mother's Neurofeedback Training at FPO2 on Pre- and Post-Natal Development of Her Infant (R/C)**

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### Introduction

"The FPO2 Baby" is a case study of the effects of FPO2 training on the mother and her infant pre- and post-natally. We observed "in session" effects on fetal movement and we continue to observe exceptional levels of regulation, as manifest in sleep, temperament, and achievement of developmental milestones through the first 15 months. The mother is a multi-parous, 33-year-old woman with a history of severe post-traumatic stress disorder, anxious attachment and post-partum depression. She has had multiple hospitalizations. Her two older children receive special services in school. Her history up to and including the first five months of this pregnancy would not have predicted this outcome.

### Method

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

### Results

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

## Conclusion

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

## References

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## Roshi Assisted Neurofeedback Suppresses Theta (R/C)

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## Introduction

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

## Method

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

## Results

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

## Conclusion

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

## References

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 Hammond, D. C., (2000) *Neurofeedback treatment of depression with the Roshi*. *Journal of Neurotherapy*, 4(2), 45-56.

*Shepherd, G. M. (1994). Neurobiology (3rd ed.). New York: Oxford University Press.*

## **A Randomized, Double-Blind Clinical Trial of EEG Neurofeedback Treatment for Attention Deficit / Hyperactivity Disorder (R/C)**

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### Introduction

This presentation is a preliminary report on the outcome of an Institutional Review Board (IRB) approved, blinded, placebo controlled study design investigating the efficacy of standard practice neurofeedback for a subgroup of children with Attention Deficit/Hyperactivity Disorder (ADHD).

### Method

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

### Results

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

## **The History and Current Applications of the Alpha/Theta Protocol (R/C)**

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

## **Referenced EEG - A Database of Medication Response (R/C)**

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### Introduction

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

### Methods

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

## Results

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

## Conclusions

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

## Coherence Training ( C )

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## Introduction

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

## Method

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

## Results

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

## Conclusion

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

## References

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Marosi, E., Harmony, T., Becker, J., Reyes, A., Sanchez, L., & Bernal, J. (1995). *Electroencephalographic coherences discriminate between children with different pedagogical evaluation. International Journal of Psychophysiology, 19(1), 23-32.*

## Cognitive Performance in the use of LORETA Neurofeedback: Psychometric Correlates (R/C)

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## Introduction

Neurobiofeedback, shown to yield behavioral and attentional improvement, has had less objective evidence than anecdotal support. This investigation included standardized assessment of attention, memory, and processing speed, from selected subtests of the Wechsler Adult Intelligence Scale, Third Edition (WAIS-III, Wechsler, 1997). Of primary interest were Index scores in Working Memory (WM) and Processing Speed (PS); these subtest clusters have been shown to be valid.

## Method

Designed as a pre-test and post-test paradigm, the WAIS-III's Indexes, WM and PS were paired with the neuropsychological tasks of Rapid Automatized Naming (RAN) and Rapid Alternating Stimuli (RAS) for concurrent measure of executive function. After piloting the study, marked improvements were shown; however, the gains were questioned with respect to total intellectual ability. Assessment was expanded to include the entire WAIS-III, administered in pre-test. All measures were re-administered in post-testing, after eight weeks of neurobiofeedback training (N = 12).

## Results

Pre- and post-comparisons yielded consistent improvement over pilot testing (Np = 4) and in subsequent study (Ns = 8). Pilot data included significance in response times with naming objects ( $p = .009$ ) and graphemic stimuli ( $p < .04$ ); covariate analyses with total WAIS-III scores are pending. Data show significant improvement in the QEEG, but also in the principle behavior correlates of attention and speed of processing found in psychological assessment. Skills in memory, impulse control, and focused task execution were improved.

## Conclusion

Neurofeedback, as a paradigm of therapeutic intervention, has shown remarkable results. However, in the LORETA analyses of QEEG, until principle behavior correlates can show significant and reliable gains, this procedure has questionable generalizability. Direct implications for self-regulation and control of impulsivity, as well as in viable training (treatment) models for ADHD symptomology is clear. Further research is needed: developmental, lifespan response levels; for both normal and clinical matched pairs, examining performance with-and-without traditional psychopharmacological treatment, etc. Traditional psychometrics may prove valuable as one means toward accountability.

## Reference

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## Integrative Clinical Neuroscience (R/C)

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## Introduction

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

## Methods

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

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

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

## Conclusion

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

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## Rogue Site Analysis (RSA): A Comodulatory Metric of Trauma and Consciousness (R)

David A. Kaiser, PhD  
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## Introduction

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

## Method

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

## Results

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

## Discussion

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

## Aha! On the Neural Basis of the Eureka Experience (R/C)

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## Introduction

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

## Method

Subjects solved verbal problems and after each correct solution indicated whether they solved the problem with or without insight.

One group solved these problems while being scanned by fMRI; 128-channel EEG was recorded from another group. Neural activity was analyzed separately for problems solved with or without insight (Jung-Beeman et al., 2004).

## Results

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

## Discussion

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

## Reference

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## QEEGs of Dissociative Identity Disorder (DID) Subjects ( R )

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## Introduction

For decades dissociative identity disorder (DID) has been a controversial diagnosis. This study did brain mappings of three subjects with DID and three matched subjects without any dissociative disorders (DD). An analysis of the FFT (Fast Fourier Transform) power spectrum was done *within* DID and non-DD subjects and *between* the DID group and non-DD group.

## Method

Four QEEG recordings were made of each subject using the Lexicor NeuroSearch-24 with eyes-closed in a linked-ears montage. The FFT power spectrum analysis consisted of FFT absolute power, FFT amplitude asymmetry, FFT coherence, and FFT phase lag for five frequency bands (delta, theta, alpha, beta, and gamma) using NeuroGuide software. For each subject a comparison was done between the host/alter ego states of DID subjects and similar cognitive states of non-DD subjects using the NeuroStat program. Finally, all 12 QEEG recordings of the DID subjects were compared to the 12 QEEG recordings of the non-DD subjects using the NeuroBatch program.

## Results

Significant difference ( $p < 0.001$ ) were found between the alter ego states of the DID subjects compared to the differences found between the cognitive states of the non-DD subjects. The most notable differences were found in the variation (range of signals) in all aspects of the FFT power spectrum. The DID subject were found to have variations approximately seven times the range of non-DD subjects for absolute power, amplitude asymmetry, and coherence. However, non-DD subjects had variations in phase lag four to five times that of DID subjects.

## Discussion

The results of this study indicated differences in neuroactivity *within* and *between* DID and non-DD subjects. These findings indicate distinct and enduring differences in the mental processing of DID subjects and thus contribute to the evidence that dissociative identity disorder is a real psychiatric condition and is not the result of play acting.

For decades dissociative identity disorder (DID) has been a controversial diagnosis. This study did brain mappings of three subjects

with DID and 3 matched subjects without any dissociative disorders (DD). An analysis of the FFT power spectrum was done *within* DID and non-DD subjects and *between* the DID group and non-DD group.

## **Preliminary Findings in the Treatment of Traumatic Brain Injury with Occipital Nerve Stimulation: QEEG and Cognitive Assessment (R/C)**

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### Introduction

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

### Method

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

### Results

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

### Conclusion

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

### References

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- Schoenberger, N., Shiflett, S., Esty, M. L., Ochs, L., & Matheis, R. (2001). *Flexyx neurotherapy system in the treatment of traumatic brain injury. Journal of Head Trauma Rehabilitation, 16(3), 260-274.*

## **Event Related Potentials (ERP) and Event Related Desynchronization (ERD) Normative Data Base for Children and its Application for Neurofeedback (R/C)**

Juri D. Kropotov, PhD (1), Andreas Muller, PhD (2), and Valery A. Ponomarev, PhD (1)  
(1)Institute of the Human Brain of Russian Academy of Sciences, St. Petersburg, Russia  
(2) Praxis für Kind, Organisation und Entwicklung, Chur, Switzerland  
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### Introduction

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

### Method

Two hundred fifty (250) children from ordinary schools in Chur, Switzerland (age from 7 to 16 years, 132 males, 118 females, all whites) participated in the study. Artifacts were corrected by means of independent component analysis (ICA) method. Absolute and relative spectra, spectral ratios, spectral asymmetries, coherence, phase, as well as ERPs and ERDs in four different tasks were used

as parameters for the normative data base. The tasks included (a) GO/NOGO task for assessment executive functions, (b) mathematical task for assessment abstract reasoning, (c) reading task for assessment reading and speech understanding, and (d) acoustic task for assessment auditory information processing. Power spectra and ERPs can be mapped into Talairach space by using LORETA developed by Roberto Pascual-Marqui (free software from the KEY Institute, Zurich, Switzerland, <<http://www.keyinst.unizh.ch>>).

## Results

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

## Conclusion

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

## **Heart-Brain Dynamics: Using Positive Emotions to Improve Health and Performance (C)**

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[stephenlarsen@earthlink.net](mailto:stephenlarsen@earthlink.net)

## Introduction

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

## Method

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

## Results

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

## Conclusion

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

## **LENS Neurofeedback with Animals (R/C)**

Stephen Larsen, PhD (1) and Robin Larsen, PhD (2)

(1) Psychology Professor Emeritus, SUNY; Director Stone Mountain Center, New Paltz, NY (2) Director, Center for Symbolic Studies, New Paltz, NY  
stephenlarsen@earthlink.net

## Introduction

LENS is a passive, non-volitional neurofeedback procedure in which the patient's own brainwaves drive the neurofeedback. For several years now LENS has been used clinically with children as young as six months and more recently, with animals. In such a procedure the dogged (pardon please) "placebo-effect" accusation against biofeedback is ruled out, and the animals show the same robust, uncomplicated response as young humans.

## Method

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

## Results

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

## Discussion

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

## **Case Studies of QEEG Mapping & Neurofeedback with Autism (R/C)**

Michael Linden, PhD  
Director, ADD Treatment Centers, San Juan Capistrano , CA  
drmike49@aol.com

## Introduction

This talk will describe case studies of neurofeedback with children & adolescents with Autism. Pre- and post-QEEG & CPT scores will be presented.

## Method

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

## Conclusion

QEEG Mapping is helpful in determining subtypes of Autism & guiding neurofeedback training.

## **T3 Beta for Normal & Dyslexic Adults While Reading at Three Levels (R/C)**

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charles.norman@ualberta.ca

## Introduction

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

#### Method

Each participant read at three individually determined levels: easy, medium, and difficult. Reading was done silently and comprehension questions followed. While participants were reading, EEG activity was recorded using the 10-20 system. Artifacts were done manually. The John data base was run, and the clean data were reported in absolute power.

#### Results

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

#### Conclusion

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

### **Movie Maps of Long EEG Treatment (R/C)**

Len Ochs, PhD  
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#### Introduction

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

#### Method

While beginning and end topographic maps give the end points of this movie, intermediary session data provides the actual guidance for the intermediary representation of changes, making the cinematic interpolations more data-based than they would otherwise be. This 80-session treatment of a fibromyalgia patient took place over a year-and-a-half using the LENS hardware and software.

#### Results

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

#### Conclusion

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

### **Three Generations of Brain Maps (R/C)**

Len Ochs, PhD  
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#### Introduction

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

#### Method

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

#### Results

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

#### Conclusion

Topographic EEG maps clearly show the influence of genetics.

### **Use of Neurofeedback to Abort Established Migraine (R/C)**

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#### Introduction

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

#### Methods

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

#### Results

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

#### Conclusion

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

### **Advances in Functional Imaging of Electric Neuronal Activity ( R)**

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#### Introduction

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

## Method

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

## Results

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

## Conclusion

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

## References

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## Foundations for a Clinical Approach to Neurotherapy (R/C)

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

Neurofeedback is being used as a therapeutic tool, and it has shown its benefits to improve the symptoms of different disorders. There is ever growing evidence that neurofeedback works, although we still don't know the physiological mechanisms involved and there is a lack of standardization in relation to the way neurotherapy is approached.

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

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

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

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### **Introduction**

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

### **Method**

Personality, stress indices, attention testing (TOVA or IVA continuous performance tests) and one of three types of neurofeedback training were administered to 142 patients. The neurofeedback protocols used were from one of three approaches: (a) symptom-based (no QEEG); (b) QEEG-based, using traditionally accepted training protocols; and, (c) custom protocols based on the data from task-activated, analog/QEEG data. Three months after discharge, follow-up testing was collected and statistically analyzed on approximately 25 percent of the group.

### **Results**

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

### **Conclusion**

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

### **Reference**

Smith, P. N., Sams, M. W., & Sherlin, L., (2003, September). *The neurological basis of eating disorders. I: EEG findings and the clinical outcome of adding symptom-based, QEEG-based, and analog/QEEG-based remedial neurofeedback training to traditional treatment plans. Paper presented at International Society for Neuronal Regulation Annual Conference, Houston, Texas.*

## **Low Resolution Electromagnetic Tomography (LORETA) in Monozygotic Twins Discordant for Chronic Fatigue Syndrome (R/C)**

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### **Introduction**

Chronic Fatigue Syndrome (CFS) is an illness characterized by profound fatigue lasting at least six months accompanied by disturbances of sleep, mood, musculoskeletal pain, and other symptoms. A study using EEG has demonstrated brain activity differences between CFS and healthy control subjects. Low Resolution Electromagnetic Tomography (LORETA) has been used to show differences between normal subjects and those diagnosed with depression and schizophrenia. This study addresses the potential utility of LORETA as a clinical tool for CFS. Because many EEG features appear to be heritable, the co-twin methodology provides a powerful control for non-genetic characteristics.

### **Method**

A comprehensive research project by Budzynski et al. provided the raw data for this study. Eighteen pairs of monozygotic twins discordant for CFS were selected for comparative analysis. Brain electrical activity had been digitally recorded in various awake states. For this study, the eyes-closed data was visually edited for artifacts, and the cross-spectral analysis for each subject was computed in nine bands. Each group's cross spectra was computed and the two groups compared using a within subject T-sum multiple comparison procedure based on a combination of test statistics.

## Results

When compared to their matched twins, individuals diagnosed with CFS have significant differences in current source density. The twin group diagnosed with CFS has higher delta in the left uncus and parahippocampal gyrus and higher theta in the cingulate gyrus and right superior frontal gyrus.

## Discussion

These results demonstrate that underlying neurophysiological activity in certain areas of the brain differentiates normal individuals from those with CFS. Because the EEG is trainable and LORETA is a derivative of the EEG, we might hypothesize that neurofeedback treatment could be beneficial. Further study should address the specificity of these findings when comparing CFS to a more heterogeneous population sample.

## Evoked Brain Rhythmic Activity, Cortical Coupling and Cognition

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## Introduction

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

## Methods

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

## Results

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

## Conclusion

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

## Neurofeedback with Youth Offenders: A Pilot Study in the Use of Analog/QEEG Based Remedial Neurofeedback Training (R/C)

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## Introduction

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

#### Method

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

#### Results

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

#### Conclusion

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

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### **The ABC of Dyslexia: Alpha, Balance, and Color ( C )**

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#### Introduction

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

#### Method

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

#### Results

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

#### Conclusions

(1) Attenuation of abnormal alpha frequency is associated with "cognitive preparedness" and the ability to suppress it over the task relevant hemisphere. Some speculations suggest that this may be due to lack of myelination and/or coherence in the occipital-temporal-parietal areas. For example demyelinating diseases lead to blurred vision, involuntary eye movements, co-ordination problems, short-term memory deficits - all consistent with dyslexia.

(2) Colored lenses that are prescribed according to an individual's position in color space allow a preparedness helping reading, balance and processing speed.

(3) Some implications for neurofeedback are up training of beta at O2, T1 and P3 for visual dyslexics while F3 and F7 stimulation is most likely to benefit phonological dyslexics.

#### References

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Shaywitz, S., & Shaywitz, B. (2003). *Dyslexia: Lost for words*. *Nature*, 425, 340-342.

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### **Neurofeedback in ADHD: Results of a Preliminary, Randomized, Controlled Study (R/C)**

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#### Introduction

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

#### Method

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

#### Results

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

#### Discussion

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

#### References

Fuchs, T., Birbaumer, N., Lutzenberger, W., Gruzelier, J. H., & Kaiser, J. (2003). *Neurofeedback treatment for Attention-Deficit/Hyperactivity Disorder in children: A comparison with Methylphenidate*. *Applied Psychophysiology and Biofeedback*, 28, 1-12.

Monastra, V. J., Monastra, D. M. & George, S. (2002). *The effects of stimulant therapy, EEG Biofeedback, and parenting style on the primary symptoms of Attention-Deficit/Hyperactivity Disorder*. *Applied Psychophysiology and Biofeedback*, 27, 231-249.

### **SMR Neurofeedback Efficacy in the Treatment of Tourette Syndrome (C/R)**

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#### Introduction

Although practiced widely, there is almost no documentation in the literature for the efficacy of neurofeedback (NF) in the treatment of

Tourette Syndrome (TS). The only publication is a case report of two patients by Tansey (1986). The Tourette Syndrome Association funded our pilot study for twenty children (age 7 to 12) to provide such documentation. The purpose was to provide evidence for efficacy of NF using a double-blind design. We will report the results from the first six subjects.

#### Method

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

#### Results

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

#### Conclusion

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

*Reference*  
Tansey, M. A. (1986). *A simple and a complex tic (Gilles de la Tourette's syndrome): Their response to EEG sensorimotor rhythm biofeedback training. International Journal of Psychophysiology, 4(2), 91-97.*

### **EEG Gamma Coherence and Other Correlates of Subjective Reports During Ayahuasca Experiences ( R )**

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#### Background

The most common findings in the psychedelic EEG studies from 1951 to 1972 were small increases in posterior modal alpha frequencies, global power decreases, and relative increases in beta. Recent studies with the Amazonian beverage ayahuasca did not correlate EEG with subjective reports and did not use single Hz power or coherence analysis.

#### Method

QEEG power and coherence of ayahuasca experiences were examined with two experienced participants in a Brazilian jungle setting. An exploratory case series design was adopted for naturalistic field research. Medium to intense visual imagery was compared to eyes-closed baselines.

#### Results

Overall power decreases in all bands support the Riba et al. (2002) findings, but the 36-44 Hz band results did not support the Don et al. (1998) findings of increased power. Single Hz analysis revealed a 10 and 11 Hz power increase in one participant that was hidden within the standard 7-13 Hz band analysis. Global EEG coherence increases were found in the 36-44 Hz and 50-64 Hz frequency bands for both subjects and within one subject in a repeated session.

#### Conclusions

The 3.5-7.5 Hz power decrease reflects an increase in arousal, but the 13-16 Hz and 16-20 Hz power decreases suggest the opposite. Widely distributed cortical hyper-coherence is expected given the intense synesthesia during ayahuasca experiences. Binding theory will be discussed in this context.

*References*  
Don, N. S., McDonough, B. E., Moura, G., Warren, C. A., Kawanishi, K., Tomita, H., et al. (1998). *Effects of ayahuasca on the human EEG. Phytomedicine, 5(2), 87-96.*

Riba, J., Anderer, P., Morte, A., Urbano, G., Jané, F., Saletu, B., et al. (2002). *Topographic pharmaco-EEG mapping of the effects of the South American psychoactive beverage ayahuasca in healthy volunteers. British Journal of Clinical Pharmacology, 53(6), 13-628.*

### **EEG Predictions of Intelligence: Frontal Lobes, Power, Coherence and Phase Delays (R/C)**

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#### **Introduction**

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

#### **Methods**

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

#### **Results**

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

#### **Conclusions**

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

### **Adult ADHD. Neurofeedback Combined with Biofeedback and Metacognition: A Different Emphasis than Neurofeedback for Childhood ADHD (R/C)**

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#### **Introduction**

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

#### **Findings**

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

#### **Method**

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

system (ANS), and electromyogram (EMG) levels during the sessions.

## Results

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

## Discussion

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

## Hemoencephalography Adverse Reactions (R/C)

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## Introduction

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

- 1) A person with a case of tic doloroux experienced a one-week hospitalization after several hours of exposure to HEG.
- 2) A high-functioning autistic child experienced 24 hours of angry depression after his second 30-minute HEG session.
- 3) Mild transient one- or two-hour headaches, common to the initial HEG session, have been reported to last as long as a week.

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

## Method

Each client took the sensitivity examination in *The Highly Sensitive Person* (Aron, 1996). Results were divided into three emotional stability groups and graded by their sensitivity to a tool, taped to the inner surface of the forearm, warmed by an electric current. The value of the current deemed uncomfortable by each client determined a position in each group:

- a) Highly Stable: > 200 milliamperes (ma.)
- b) Intermediately stable: 100 to 200 ma.
- c) Highly sensitive < 100 ma.

## Results:

Group:

- a) 12%
- b) 21%
- c) 67%

## Conclusion

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

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## **Anxiety, Anger, Depression, Traumatic Brain Injury and Hemoencephalography (R/C)**

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### Introduction

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

### Method

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

### Results

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

### Conclusion

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

### References

- Eisenberger, N., Liebermann, M. D., Williams, K. D. (2003). *Does rejection hurt? An fMRI study*. *Science*, 302(288) 290 292.

## **LORETA Neurofeedback and Automaticity**

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### Introduction

Expert students, skilled at acquiring knowledge, may have automatized basic neural processes which allow fast, efficient, low effort access to component processes supporting cognitive activity (Schneider & Chein, 2003). Consistent practice with stimuli may reduce the cognitive task load and result in decreased processing speed, attention demands, and energy usage. Alpha frequency has been associated with highly skilled cognitive functioning. High IQ individuals may produce greater levels of alpha during cognitive tasks (Jausovec, 1996). Automaticity, a form of cognitive efficiency, may be accessible to LORETA neurofeedback.

## Method

Eight college students, four males and females (Mean age = 22), performed more than 30 LORETA neurofeedback sessions. EEG was recorded for pre- and post-study baselines, session baselines and neurofeedback tasks. Alpha frequency changes were examined between EEG pre- and post-baselines and selected neurofeedback tasks. WAIS-III was administered before and selected subtests were administered post 30 sessions to provide a measure of pre-study Full Scale IQ (FSIQ), and post-cognitive measures of working memory (WMI) and processing speed (PSI).

## Results

Average FSIQ (Mean IQ = 125, Range = 119 to 139) was in Superior range (Wechsler, 1997). Preliminary paired t-test analysis of psychometric data suggested an increase in the averaged standard scores for the PSI ( $p = .0028$ ) and WMI ( $p = .0033$ ). Alpha band (8-12 Hz) activity will be reported.

## Discussion

These students are skilled learners. After neurofeedback, increases in the PSI and WMI, which tap cognitive processing transmission speed, mental strategies, and memory processes, suggest refinement of already strong abilities. The relationship of alpha to changes in psychometrics discussed.

## References:

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## QEEG Findings and EEG Biofeedback with Adults Reporting a History of Childhood Sexual Abuse (R/C)

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## Introduction

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

## Method

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

## Results

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

## Conclusion

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

### References

Black, L., Townsend, A., Hudspeth, W., & Bodenhamer-Davis, G. (2004, April). *Adults with a history of childhood sexual abuse: Effects in a high functioning sample*. Oral presentation at the Association for Applied Psychophysiology and Biofeedback annual meeting: Colorado Springs, CO.

## **Cerebral Blood Volume and Oxygenation Assessment of the Child with Cerebral Palsy (R/C)**

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### Introduction

Many non-invasive measurement methods are used for brain research. We can cite electroencephalography (EEG), magnetoencephalography (MEG), functional magnetic resonance imaging (fMRI), and near infrared spectroscopic imaging (NIRS). EEG and MEG measure the electrical cerebral activity; fMRI and NIRS measure the blood oxygen level-dependent, the hemodynamic response.

### Objective

We developed a device to record EEG and event-related potentials (ERPs) from the human scalp. In this study we investigated the potential causes of seven children (7 to 10 years old) with spastic cerebral palsy. Our objectives were: (a) to observe regional functional activation; (b) to assess levels of hemoglobin oxygenation, cerebral hemodynamics in the prefrontal cortex, temporal lobes and parietal lobes with Neurobek (NBCW-IR10; a functional near-infrared spectroscopy) and QEEG; and (c) to determine cocontraction's relation to strength and motor function, the extent of ankle muscle weakness in children with cerebral palsy.

### Material and Methods

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

### Results

Correlates of alpha rhythm in QEEG and functional near infrared spectroscopy, (fNIRS) with changes in local cerebral blood oxygenation. The fNIRS-EEG measurements demonstrated a positive cross-correlation in occipital cortex between alpha activity and concentration changes of deoxygenated hemoglobin.

### Conclusions

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

## **QEEG-Guided Power & Coherence Training Remediate Tic Disorder (R/C)**

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### Introduction

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

### Methods

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

## Results

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

## Conclusion

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

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updated 29 December 2006