



International Society for Neuronal Regulation 14th Annual Conference

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Scientific Presentations – Abstracts

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ORAL PRESENTATIONS, Thursday, September 7, 2006

INVITED PRESENTATION: Neurobehavioral Electrophysiology: Historical Perspective and a Survey of Applications

David S. Cantor, PhD

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Abstract: The field of electrophysiology has emerged as a potent tool in the exploration of brain function and an important adjunct measure for clinical intervention applications. With the advent of computerized quantitative methodologies, studies have been able to identify specific measures that have sensitivity to various distinct disorders and have been able to provide indicators of specific responses to therapeutic interventions. The advent of complementary neuroimaging techniques has provided convergent validity to functional interpretations of measures specific to electrophysiology. This presentation will provide a historical review of electrophysiological techniques used to assess human performance and behavior and some of the emergent clinical neuroscience intervention techniques that can be married to these techniques to improve impairments or to enhance performance. The increasing linkages of these functional measures to traits of human behavior have paved the way for the emergence of the Neurobehavioral Sciences as a multidisciplinary field which increasingly includes professionals from the fields of medicine, allied health, psychological sciences, and engineering. Illustrations of these assessment and conditioning techniques in fields of developmental psychology, neuropsychiatry, neurology, psychoneuroimmunology, and forensics will be provided. Discussion will also be provided regarding the ethical considerations when applying emergent clinical techniques which are based primarily on theoretical grounds without the standards of validity and reliability or strong actuarial outcome data to support their application at a time when evidence based medicine is becoming the standard.

Student Award: Qualitative and quantitative analysis of a single case study examining the effects of neurofeedback training in an autism diagnosed child

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Abstract: An autism diagnosed 8 year-old boy was evaluated for neurofeedback training at the Southwest College of Naturopathic Medicine in Tempe, AZ. The initial evaluation included extensive interview and a quantitative electroencephalography (qEEG). Based upon these findings a treatment plan was developed which incorporated neurofeedback training. The client completed in excess of 35 sessions of amplitude training protocols base upon correlating data from the symptoms presented and the qEEG findings. The amplitude training was based on the qEEG data involved decreasing slow activity and increasing mid range beta at site T6 and decreasing faster frequency beta at site FZ. Previous reports have indicated the relevance of site T6 in autism due to its location above the fusiform gyrus (Thompson & Thompson, 2003). This consideration along with the indications from the quantitative analysis and reference database analysis determined the protocols. qEEG data was obtained at each session along with subjective information regarding symptom severity from parents and teachers. Upon the completion of the treatment plan there was a second interview and EEG recording for comparison. Following neurofeedback protocols, the client was enrolled in a sensory learning program, which incorporates the use of vestibular stimulation, visual evoked stimulus, and auditory retraining. Finally a third EEG recording was completed. The quantitative and qualitative data from the initial evaluation, each session and following the final session of neurofeedback was compiled and a mixed design statistical procedure implemented to evaluate effects of the neurofeedback training on both symptom presentation and qEEG. The results indicate the neurofeedback had statistically significant effects on both the symptoms presented and the qEEG. Data from the sensory learning program is still being analyzed. Single case studies are an important first step in validating the utility of neurofeedback and provide an opportunity for clinicians to review and critique current protocols.

Thompson, M., & Thompson, L. (2003). The Neurofeedback Book: An Introduction to Basic Concepts in Applied Psychophysiology. Wheat Ridge, CO: The Association for Applied Psychophysiology and Biofeedback.

Mu-like Rhythms in Autistic Spectrum Disorder: EEG Analyses and Neurofeedback

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Category: Research & Clinical Application

Introduction. Autism occurs in approximately 60 per 10,000 (1 in 166) children (Medical Research Council, 2001). Research has linked social deficits in Autism to mirror neuron dysfunction (Mu rhythm activity; Dapretto et al., 2006; Oberman et al., 2005; Williams, Whiten, Suddendorf, & Perrett, 2001). However, the mechanisms underlying the Mu rhythm have yet to be studied.

Method. Twenty out of 50 patients with a diagnosis of ASD were identified as having significant Mu-like rhythm. Patients received a battery of neurobehavioral, neuropsychological testing, and QEEG assessment. There was a median split of Mu level activity for each patient so that portions of their EEG recordings were divided into high and low Mu level groupings. Each category was in turn analyzed in terms of absolute, relative power and connectivity. In ten patients, interhemispheric bipolar training was utilized. The remaining ten patients underwent coherence training designed to increase connectivity between

regions C3/C4 and the peripheral frontal cortex.

Results. Within and between group analyses indicated greater frontal hypoconnectivity ($p < .05$) in the high Mu group associated with social and executive deficits. The power analyses indicated greater alpha (Mu) activity for the C3 and C4 sensor sites for patients in the high Mu category. Both groups of patients improved significantly on neurobehavioral and neuropsychological measures ($p < .05$). However, only coherence training reduced Mu activity significantly. Coherence training was linked to reduced Mu activity which may be associated with improved social-emotional functioning.

Conclusion. The findings indicate that social deficits and Mu-like Rhythm activity in Autism may both be associated with frontal hypoconnectivity. Both assessment-guided neurofeedback and coherence training are associated with improved symptoms in ASD. Coherence training significantly reduced Mu activity ($p < .05$) and resulted in improved social-emotional functioning.

Autistic Spectrum Disorders including Asperger's Syndrome- EEG & QEEG Findings, Results, and QEEG Findings, Results & Neurophysiological Rationale

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Category: Research & Clinical Application

Introduction This paper reviews our EEG, QEEG and LORETA findings which correspond to known functional neuroanatomical sites associated with the symptoms of Asperger's. We show how we use that information to guide successful neurofeedback interventions. Theoretical formulations arise from work with more than 1,000 autistic spectrum clients and EEG neurofeedback analysis and results with more than 150 of these clients.

Method: Before neurofeedback we used medications, behavior therapies, psychotherapies, education and speech therapies (Thompson & Havelkova, 1982). When neurofeedback became available clients were trained to decrease slow wave activity and beta spindling and raise 13-15 Hz often at FCz. Pre and post testing (after 40 sessions) used the WISC, WRAT, TOVA, IVA, questionnaires and QEEG changes. A selection of these clients has had 19 channel EEG assessments and analysis using LORETA.

Results: 126 Asperger's clients reviewed showed significant improvement ($P < .001$) on all measures. Brain maps were done on a sample of the clients. These revealed low activation P4 T6 in Asperger's cases and decreased activation Cz and Pz in the Autistic group. LORETA showed anterior cingulate Brodmann area 24 dysfunction in Asperger's and dysfunction in the posterior cingulate Brodmann area 31 and in the cuneus and precuneus in the autistic cases.

Conclusion: Findings to date suggest an axis of disturbed functioning (anterior and posterior cingulate Brodmann areas 24, 31) often with high amplitude 3-10 Hz and spindling beta (> 20 Hz) and low amplitude 13-18 Hz usually at FCz (LORETA abnormalities seen in the cingulate, medial and orbital frontal and/or prefrontal cortex). Similar findings are seen with anxiety disorders. Asperger's is unique in also having right temporal-parietal cortex inactivity corresponding to sensory aprosodia. Beta spindling suggests that the cortex is irritable, unstable and / or easily kindled. Increasing sensorimotor rhythm (SMR) using neurofeedback has a stabilizing effect (Serman, 2000).

Student Award: Testing the Efficacy of a New Neurofeedback Protocol for Major Depressive Disorder.

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Introduction: Rumination and worry are dysfunctional cognitive processes involved in the maintenance of negative mood (Segerstrom et al., 2000) and frequently seen in Major Depressive Disorder (MDD). Little is known about the neural mechanisms underlying these dysfunctional cognitive processes. Here we conducted two studies. The goal of Study 1 (QEEG) was to identify the brain regions and frequency bands associated with rumination and worry in MDD subjects. Based on those results, the goal of Study 2 was to measure the efficacy of a novel neurofeedback (NF) protocol that aims at normalizing abnormal EEG activity in brain regions underlying rumination and worry. We hypothesized that NFT would decrease depressive symptoms.

Method: Thirty subjects (mean age: 44) with moderate to severe MDD (Mean BDI-II scores = 35) were recruited for Study 1. QEEG was recorded with 19 electrodes during three conditions (eyes opened): 1) Baseline resting state; 2) Self-induction of a ruminative state; and, 3) Self-induction of a worry state. In Study 2, 28 of the MDD subjects having participated to Study 1 underwent twenty sessions (two sessions per week) of NF training to normalize the EEG activity associated with rumination and worry.

Results

Study 1: Abnormal high-beta activity (21-30Hz) was measured in MDD subjects, relative to age-matched non depressed subjects, at frontopolar (FP1-FP2) and temporal regions (T3-T4).

Study 2: We are currently analyzing the results of Study 2.

Conclusion: The results and conclusions of both studies will be presented at the next ISNR meeting.

Effectiveness of Neurotherapy for ADHD as Assessed by Steady State Visually Evoked Potentials (SSVEP), TOVA and Behavioral Measures

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Category: Research & Clinical Application

Introduction: Silberstein and colleagues previously used steady state visually evoked potentials (SSVEP) to demonstrate changes in frontal and parietal lobe function in ADHD and changes in these functions due to methylphenidate. In this study we assessed the effectiveness of neurotherapy as a treatment for ADHD in 17 children with ADHD.

Method: TOVA, behavioral measures and SSVEP were obtained in ADHD subjects before and after 40+ sessions of neurotherapy. Subjects performed the CPT-AX cognitive task during SSVEP recording. SSVEP was calculated over a ten second epoch centered at the presentation of the X, and compared to ten seconds of a baseline task of sequential numbers 1,2...5, centered around presentation of the target "5."

Results: ADHD subjects showed reductions in SSVEP amplitude and latency that were consistent with right hemisphere normalization of frontal lobe activation and inhibitory functions and normalization of posterior right hemisphere arousal. TOVA and behavioral measures normalized. All subjects ceased medications and 16 no longer met the criteria for ADHD. They remained so at three year follow-up.

Conclusion: Neurotherapy is an effective treatment for ADHD and should be considered as its primary treatment.

A First Case of Anxiety Disorder Treated with Neurofeedback in Romania

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Category: Clinical Experience

Introduction: This is a single case study of a 26-year-old female presenting anxiety disorder and depression. She is one of the first patients from Romania who was evaluated and treated with neurofeedback. At the intake she reported severe anxiety, depression, panic attacks, and insomnia with nightmares, decreased energy and concentration. These symptoms appeared three years ago after physical and emotional trauma. She was treated with psychotherapy and medical treatment for the last six months prior to neurofeedback without any resolution. She also followed nutritional treatment for anemia and at the intake she reported taking only supplements / minerals and that the psychotherapy was discontinued. In the past three years she also reported suffering from repeated upper respiratory infections. After she had already completed 12 sessions of neurofeedback, a test for Mycoplasma Pneumoniae showed positive and antibiotics were prescribed.

Method: The assessment and re-assessment tests done included SCL-90R, CES-D for depression and other stress tests, plus IVA for cognitive testing, and the Bioexplorer software with ROSHI II + instrument were used for EEG evaluation and training. EEG evaluation over the frontal areas showed high amplitude of high beta (over 22Hz) and extreme expansion of alpha, in particular 9 and 10 Hz which may indicate depression and / or obsessive thought process. Two re-evaluations were performed after 14 and 21 sessions, respectively. In association to the neurofeedback training, Freeze Framer for heart rate variability was also used.

Results and Discussion: The neurofeedback training was done mostly over the frontal area enhancing the SMR. Training EEG coherence in parallel to heart coherence contributed to faster amelioration of her symptoms. It is important to mention that amelioration of her symptoms started under neurofeedback / biofeedback training even before the clinical chronic infection was addressed!

KEYNOTE PRESENTATION: Fear Learning in Humans

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Category of Presentation: Research

Abstract. Over the last few decades there has been an explosive growth in our understanding of the neural systems mediating fear learning in animals models. I will review how we have extended our understanding of fear acquisition and extinction to human function. Using paradigms that closely mimic those used in other species, we have been able to confirm that the mechanisms of fear learning are shared across species.

However, humans also have cognitive and social means of conveying the emotional properties of stimuli in the environment. I will review how the neural systems of fears in humans that are imagined and anticipated, but never experienced, rely on shared neural mechanisms. I will also discuss the neural mechanisms involved on different techniques for diminishing acquired fears.

ORAL PRESENTATIONS, Friday, September 8, 2006

Global qEEG Changes Associated with Non-frequency and Non-site Specific Neurofeedback Training

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Category: Clinical Experience

Introduction. The prevailing paradigm in neurofeedback training has been to target specific symptoms or disease entities with site-dependent and/or frequency-specific protocols. However, global, or non-specific effects of neurofeedback (NF) training have been reported despite the use of narrowly defined approaches. These findings suggest that more comprehensive targeting protocols may provide therapeutic outcomes for an array of symptoms resulting from central nervous system (CNS) dysfunction. We are reporting a case study showing the global renormalization of qEEG measures of CNS dysfunction from Lyme Disease, utilizing a non-specific, comprehensive NF targeting protocol (NeuroCareProAr; NCP).

Method. *Subject.* A 63-year-old female diagnosed with Lyme Disease (LD) in late 2003, with CNS changes supported by MRI and SPECT scans. *QEEG:* Standard clinical qEEGs were performed and analyzed by a board certified clinician in 2000, 2003, 2004 and 2005. *NF:* The subject underwent 16 NCP sessions weekly from June to November 2005. Sixteen targeting frequency ranges (8 targets per hemisphere encompassing 0-57 hz) were used to provide feedback. Interruptions were triggered by excessive emergent variability in the recorded EEG data stream, with settings adjusted to trigger approximately 10-20% throughout a 30-40 minute session.

Results. *QEEG:* A qEEG recorded as part of peak performance training in 2000 was essentially within normal limits. The qEEGs recorded in 2003 and 2004 after Lyme symptoms emerged were strikingly abnormal with many amplitude and

coherence values 2 standard deviations (SD) above the mean. The qEEG recorded in 2005 after completion of 5 months of NCP training demonstrated a return to baseline values for the majority of measures. *NCP*: Measures of emergent variability show a significant decrease across the training period indicating much greater CNS efficiency and similar improvement in a measure of complexity indicating more CNS resilience.

Conclusion. Non-specific NF training is sufficient to produce significant and robust global brain changes as indicated in both dynamic EEG and static qEEG measures. These data suggest the plausibility of a very different, yet highly effective, NF training paradigm.

First, Do No Harm: Predicting a "No Medication" Response

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Category: Research & Clinical Application

Introduction. This presentation reviews the ability to predict psychotropic medication response. Various uses of quantitative EEG are emerging as possible ways to predict positive and adverse psychotropic medication responses. The presentation will illustrate the harm of inappropriate medication use that is an inadvertent common occurrence and demonstrate the benefit achieved by using referenced-EEG (rEEG) to guide medication selection.

Method. Three brief case histories of patients having been on as many as 22 previous medications are presented along with their rEEG responses. In all cases the results suggested the patients did not need any medications.

Conclusion. For the past two years, rEEG has been used by the author in over 275 hard-to-treat cases with 67% of the patients tested resulting in medication changes or combinations that would not have been chosen without the aid of the rEEG. rEEG may offer a way to provide mental health with a set of clinically useful biomarkers to guide the pharmacotherapeutic choices. Their past medications did not lead to clinical improvement, were probably causing psychological symptoms or neurotoxicity and the rEEG report predicted the previous medications would have a low probability of being helpful. Implications for increased remission rates, as well as lower health care costs, also suggest reasons why rEEG should be seriously investigated.

NIRS: Functional Neuroimaging in Psychiatry

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Category: Research & Clinical Application

Introduction. It has recently been shown that Near Infrared Spectroscopy (NIRS) provides a noninvasive optical technique for neuroimaging function. Like positron emission tomography (PET), magneto encephalography (MEG), and functional magnetic resonance imaging (fMRI), this technology can identify deficits in cerebral oxygenation with a high resolution.

Method. Twenty-five patients participated in this study: depression or mood change, bipolar (N = 6, two males, four females), hyperactivity, behavioral problems (N = 3), ADD, ADHD, learning disorder (N = 10), weight problems, obesity, hypoglycemia (N = 4), and sleep disorders (N = 2). Eight healthy volunteers were tested. The aim of the present study was to assess the hemoglobin concentration changes in both prefrontal regions, to investigate the activation of the parietal cortex during a cognitive and visuo-spatial task, a modified version of Horatherapy, the Jomin's method. Measurements were performed with a technique combining 48 channel Near Infrared spectroscopy apparatus (Neurobek system) and qEEG.

Results. The results show that distinct patterns of blood oxygenation changes during different cognitive tasks. Correlations at $p < 0.007$, t test, $p = 0.01$, [Hb] (average values from -0.29 ± 0.37 to $-0.99 \pm 0.97 \pm M$, NS, t test) and [Hb sum] (average values from -0.2 ± 1.16 to $-2.2 \pm 0.35 \pm M$, $p = 0.06$, t test, $p = 0.04$), in the left frontal lobe were examined.

Conclusion. This method can offer therapeutic possibilities in certain cases an alternative, a relay and a complement to medicines. For this reason, it should also contribute to advances in psychiatry and neurology. Near Infrared spectroscopy can be used to detect changes in the concentration of oxygenated hemoglobin (oxy-Hb) and deoxygenated hemoglobin (deoxy-Hb) in tissue.

INVITED SPEAKER: A New QEEG, ERP Data Base and Its Application for Neurofeedback and Transcranial Direct Current Stimulation

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Category: Research & Clinical Application

Introduction. This paper presents a methodological approach developed in the Institute of the Human Brain for assessment electrophysiological indexes of sensory-motor and cognitive functions of neurological and psychiatric patients.

Method. Nineteen-channel EEG was recorded in eyes-open, eyes-closed and different task conditions in 250 normal children (age 7-17) and 250 healthy adults (age 18-60). The tasks included (a) GO/NOGO task for assessment motor and executive functions, (b) math task for assessment abstract reasoning, (c) reading task for assessment reading and speech understanding, and (d) acoustic tasks (including auditory oddball) for assessment auditory information processing. Artifacts were corrected by spatial filtration based on artifact topographies extracted by means of independent component analysis (ICA). Absolute and relative power and amplitude spectra, spectral ratios, spectral asymmetries, coherence, phase are normalized for various age groups and were used for calculation z-scores for each of above mentioned parameters in each recording condition for a tested subject. ICA method is applied for separation independent event-related potentials (ERPs) components associated with separate psychological operations, such as early stages of visual and auditory processing, engagement operations, comparison and monitoring operations and some others. For mapping EEG parameters into Talairach space, LORETA and s-LORETA are used.

Results. The paper discusses the results of application of the data base for separating ADHD sub-types out of an ADHD group of 300 children. Application of EEG spectrograms, ERPs and event-related desynchronization ERDs for constructing individual protocols of neurotherapy (neurofeedback and transcranial direct current stimulation) will be presented.

Conclusion. This study is the first to present the normative QEEG data base that includes not only conventional spectral parameters of EEG but ERPs independent components as indexes of sensory-motor and cognitive functions.

Student Award: Pilot Study in the Development of Sham Protocol

for Neurofeedback Treatment in Children with ADHD

Moreau et al.

University of Quebec. Montreal

Introduction. Sham protocols have been used in neurofeedback research for the treatment of epilepsy (Finley, 1976; Kuhlman & Allison, 1977), of ADHD (Cho et al., 2002; deBeus, 2003; Heywood & Beale, 2003; Shouse & Lubar, 1979) and of learning disabilities (Fernandez et al., 2003). Even though the Declaration of Helsinki limits the use of placebo conditions in research with consulting patients, the general scientific community (Barkley, 1992; Arnold, 1995; Baydala & Wikman, 2001) as well as the neurofeedback community (Efficacy Task Force, 2002; Monastra et al. 2005) still await further double-blind studies of the efficacy of neurofeedback.-----Relevant elements from social psychology and from motivation theory that could, in principle, account partly for the observed effects will be reviewed. This aims at promoting their explicit application in complementing neurofeedback effects and at emphasizing required characteristics for scientifically convincing placebo or sham control conditions. Sham protocols should indeed be able to maintain the illusion of a real treatment, which is required by the double-blind criterion, and allow apparent progress of the trainee to account for motivational and other like effects.

Methodology. The implementation of a sham protocol using Thought Technology equipment and its Infinity software (TTL Inc.) will be described, as well as its use in a randomized design including a waiting list and two double-blind treatment conditions. This design is targeted at children who are already on medication and standard support programs and who would not ordinarily have neurofeedback as additional treatment option. A review of the Declaration of Helsinki and of the Efficacy Task Force Evaluation of the Clinical Efficacy of Psychophysiological Intervention Guidelines will be done to verify that such protocol meets their criteria.

Student Award: Double Blind Sham Study of Neurofeedback Treatment in Children with ADHD

Picard, BA

University of Quebec in Montreal

Introduction. Critics of neurofeedback suggest that the results could be explained solely as a placebo effect. It would be mediated by motivational and social variables as well as the technological ceremony of the treatment. If other variables than EEG modification play a role in neurofeedback, it is important to evaluate them, to quantify their contribution to the effect and to document that EEG control adds to eventual psychological effects.

Method and Results. A study was performed, consisting of two stages. The first stage evaluated the effect of neurofeedback compared to waiting list, served to select relevant variables and provide data for a sham condition, while the second stage added such a condition. All children were diagnosed by a physician after a neuropsychological evaluation and had to present a ratio θ/SMR greater than 2.5. In stage 1, 15 children were assigned randomly to one of the two groups. Children had 40 sessions of neurofeedback three times a week using a standard protocol (increased SMR, decreased theta). Results from the behavioural questionnaires filled by parents showed that only the children who were in the neurofeedback group improved. For stage 2, 31 children were assigned randomly to one of three groups: neurofeedback, placebo or waiting list. The same protocol was used in double blind training sessions. The results replicated the difference on the questionnaire between neurofeedback and waiting list conditions. The sham group was undistinguishable from the waiting list and differed from the neurofeedback group.

Conclusion. These results indicate that the benefits observed after neurofeedback are not the result of motivational and social variables embedded in the treatment. The burden of the proof should now switch sides: the claim that the effects regularly produced by neurofeedback could be obtained by psychological principle should be substantiated by positive demonstrations of this alternate hypothesis.

Efficacy of Attention Training For Children with ADHD: A Randomized Double-Blind Placebo-Controlled Study

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Category: Research & Clinical Application

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 the Connor's parent and teacher rating scales, and the Integrated Visual and Auditory continuous performance test (IVA). 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 playing video games while brainwave activity was monitored and then received 20 sessions of brainwave-modulated video games. Group 2 received treatment in the opposite order.

Results: Results are based on 53 seven- to eleven year-old children completing mid-point and 42 children completing post-assessments. All data were normalized. Statistical analyses was the ANOVA of crossover trials with baseline run-in observations. This function evaluated effectiveness of intervention vs placebo, treatment effects, and period effects. For the children on the IVA, Response Control Quotients showed Effectiveness of Intervention ($p < .0001$) and Treatment Effect ($p < .0001$). On the IVA Attention Quotient there was significant Effectiveness of Intervention ($p = .0004$) and Treatment Effect ($p = .0004$). On the Connor's parent DSM-IV Inattentive scale, there was a significant Effectiveness of Intervention ($p = .0002$), Treatment Effect ($p < .0001$), and Period Effect ($p < .0001$). Connor's teacher DSM-IV Inattentive scale results indicated significant Effectiveness of Intervention ($p = .05$) and Treatment Effect ($p = .046$). The DSM-IV Hyperactive-Impulsive scale showed Effectiveness of Intervention ($p < .0001$) and Treatment Effect ($p < .0001$).

Conclusions: In summary, the analyses indicated that the attention training via EEG biofeedback was effective not only as a treatment, but effective when compared to an active placebo. More specifically, children improved on responding and attention on a computerized attention task (IVA); parents indicated improved DSM-IV inattentive symptoms; and teachers reported improved DSM-IV inattentive and hyperactive-impulsive symptoms. Additional findings and implications of this research will be discussed.

KEYNOTE SPEAKER: The Event-Related Optical Signal

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Category. Research

Introduction. The Event-Related Optical Signal (EROS) is a recently developed imaging technique possessing a combination of high spatial and temporal resolution. It can be used to measure the time course of localized cortical activity. It is based on the observation that neural activity is associated with changes in scattering properties of the neural tissue. EROS is based on passing near-infrared light through superficial cortical areas.

Method. The sources and detectors are placed at the surface of the head, making the technique non-invasive. The changes in light scattering associated with neural activity cause both changes in the amount of light transmitted (intensity) and in the time taken by photons to move through active brain areas (delay). Delay measures are relatively more sensitive to deep structures, such as the brain, than the intensity measures.

Results. Since our first report (Gratton et al., 1995), we have published more than twenty studies using EROS. Recently, several other laboratories have also reported fast optical signals with similar properties (Franceschini & Boas, 2004; Tse et al., in press; Wolf et al., 2002). I will present several examples of EROS measures in perceptual, motor, and cognitive tasks.

Conclusion. These data demonstrate that EROS combines ms-level temporal resolution with sub-cm spatial resolution. The major limitations of the technique are limited penetration (a few cm from the scalp) and relatively low signal-to-noise ratio.

Student Award: A Normative Database Analysis of EEG Effects of Clinical Hypnosis

Sarah Wyckoff, Larry Stevens, and Leslie Sherlin

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Electroencephalograph (EEG) activity was recorded across 19 scalp locations during pre- and post- eyes closed baselines, Spiegel eye roll induction, arm levitation, passive progressive neuromuscular relaxation deepening, Hammond's "Serenity Place" self-esteem enhancing suggestions, and trance termination among 59 right-handed female Northern Arizona University student volunteers, previously screened with the Psychological Absorption Scale, Stanford Group Hypnotic Susceptibility Scale: Form C, Harvard Group Scale of Hypnotic Susceptibility. Quantitative electroencephalographic (QEEG) analysis was computed and compared to a normative database. FFT relative power z-score means across eyes closed pre-baseline and "serenity place" conditions for delta (1 - 3.5), theta (4 - 7.5), alpha (8 - 12), beta 1 (12 - 15), beta 2 (15 - 17.5), beta 3 (18 - 25), and high beta (25.5 - 30) activity were calculated for low, moderate, high, and very high hypnotizables groups. Due to our interest in examining the differences in the repeated measures of baseline and serenity task within each group, t-tests were computed for each group's mean z-scores rather than a MANOVA analysis. Results indicated (a) significant electrode sites by frequency bands during the eyes closed pre-baseline condition for low, moderate, and high hypnotizables; (b) significant electrode sites by frequency bands during the "serenity place" condition for low, moderate, high, and very high hypnotizables; (c) differences between the highs for theta and beta in comparison to the lows, moderates, and very highs during both conditions; (d) differences between the lows for alpha in comparison to the moderates, highs, and very highs during both conditions. These results indicate that theta and beta activity appear to increase with level of hypnotizability and phase of hypnotic induction for lows, moderates, and highs. Very high hypnotizables do not appear to share these linear characteristics.

Real-time EEG Neurofeedback using Normative Z Scores

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Category. Research & Clinical Application

Introduction. This report describes the implementation of a real-time neurofeedback system based upon the use of a normative database and Z score computations. The Z scores are used as targeting variables, which provides a method that does not rely on conventional thresholds to produce training targets.

Method. A normative database was constructed from a population of normal and abnormal subjects (Thatcher, 1998; Thatcher, Walker, Biver, North & Curtin, 2003). A software interface was created that allows the computation of Z scores in real time, for use in a real-time system (Thatcher, 2000). The interface and database were incorporated into a neurofeedback system, and configured for general use.

Results. The resulting system produces 76 different Z scores in real time, and provides them for use as feedback variables, and to control sound, graphic, and general-purpose feedback elements.

Conclusions. This implementation provides a significant new way of targeting and controlling neurofeedback. In addition to providing real-time variables for control and feedback, the system produces information comparable to that provided by a QEEG, in real time.

INVITED SPEAKER: Relationship of qEEG Comodulation Findings in TBI and Congenital Vascular Anomalies to Recent Concepts of Brain Injury Biomechanics

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Category: Research, Theoretical

Introduction. A body of data from adult patients with transient brain injury (TBI) as well as from a pilot study of adolescents with Congenital Heart Defect (CHD) has disclosed a common pattern of pathology with comodulation analysis.

Methods. Comodulation is measured as the cross-correlation between derived time series, where the time series are the amplitude spectra of the EEG in relevant frequency bands. The cross-correlations are computed between all possible site-pairs and evaluated statistically by comparison to a normative database, using a number of significant corrections to both spectral analysis and statistical methods.

Results. Both of these clinical populations show a high percentage of disrupted correlation between bilateral frontal cortical areas, particularly during engaged test conditions. This "left-right frontal dissociation pattern," as we have termed it, is seen also with surgical transaction of the anterior corpus callosum in epileptic patients.

Discussion. Studies of the biomechanics of brain injury have shown that stress and pressure distortions of the brain impose their greatest disturbance on frontal cortex and particularly on the anterior corpus callosum. Further, Diffusion Tensor Imaging studies have confirmed diffuse micro-tubular damage within the axonal fibers of the anterior corpus callosum. The role of comodulation analysis and neurofeedback in the evaluation, understanding, and treatment of these disorders will be discussed.

Brain Music Therapy: Home Neurofeedback for Insomnia, Depression, and Anxiety

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Category. Research & Clinical Application

Introduction. Brain Music Therapy is a neurofeedback method developed in Russia that involves establishing optimal rhythmic and tonal parameters based on the individual's EEG to regulate functional states. By using a Brain Sound Compiler, EEG patterns are converted into synthesizer-based music, tailored to the patient and recorded on a CD.

Method. There are 18 different transformation algorithms that provide a selection of one of 120 musical instruments for each channel. The Brain Sound Compiler is capable of creating changes in tempo, varying the volume of each channel, transposing the music of each channel to different octaves, changing musical parameters (e.g., legato to staccato), adding major and minor chords and analyzing the note patterns of each channel. Then EEG patterns are converted into personalized music files. After a brief evaluation, including a Subjective Sleep Questionnaire (modified Athens Scale) and Beck Depression Scale, the patient is invited to relax while a brief eyes closed EEG is recorded. After transforming the EEG into a musical map representing the EEG architecture the patient receives a CD with two musical tracks for relaxation and activation along with instructions for use.

Results. In several double blind studies, including 58 patients with insomnia at the Moscow Medical Academy, 40 patients at the Clinic of Dr. Lemoine in France, and 10 insomniacs at the University of Toronto, significant results were found in increased total sleep time, reduced sleep latency, and decreased awakenings. A study by Levin (1998) showed increased relative power alpha along with decreased relative power delta, theta, beta1 + beta2, and delta + theta/beta1 + beta2. Studies and clinical experience show 82 to 85 % efficacy.

Conclusion. Brain Music Therapy can be an effective complement to other therapies or an addition to a neurotherapy practice.

Effective Stress Management Using Neurofeedback and Biofeedback

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Category. Research

Introduction. Stress induced anxiety and emotional intensity may correlate with ruminating and can correspond to bursts of high frequency beta activity or beta spindling (23-35 Hz) with corresponding low amplitude SMR and / or low high frequency alpha activity at FCz. LORETA often showed the origin of this activity to be anterior cingulate Brodmann area 24. These EEG changes corresponded to psychophysiological findings including poor RSA, HRV, shallow, frequent, irregular respiration, increased heart rate, drop in skin temperature, rise in EDR and an increase in muscle tension. This review quantified EEG changes that could stand as a clinical marker.

Method. Clients are asked to experiment with feedback to find how their mental states correlate with specific EEG frequency band amplitudes and to find how these correlate with psychophysiological variable changes. Clients are trained to self-regulate those variables that correspond to feelings of anxiety, tension and stress (Thompson & Thompson, 2003). They are taught how to generalize control of those variables that correlate with stress to their every day living. A chart review was carried out on 165 consecutive clients who presented to one room of the Biofeedback Institute to ascertain which EEG variables correlated with stress and anxiety.

Results. All of the clients who complained of tension and anxiety with even minor stress demonstrated high frequency beta 23-35 Hz / SMR 13-15 Hz and/ or 19-22 Hz / 11-12 Hz ratios that were higher than controls. All reported much improved control with training.

Conclusion. Symptoms and signs, combined with the EEG and stress assessment findings, and knowledge of neuroanatomy and neurophysiology, can lead to an appropriate and specific NFB & BFB intervention.

Effect of Lifewave Energy Patches on Heart Rate Variability

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Category. Research

Introduction. A new energy medicine product by Lifewave has been shown to increase strength in athletes. A pilot study indicated that it might also enhance heart rate variability.

Method. Heart rate variability (HRV) was measured before and 15 minutes after wearing of Lifewave energy (N=20) or placebo (N=20) patches.

Results. Mean post-pre differences in HRV parameters were not significant because of large variations in the data. However, all medians changed in the hypothesized direction.

Conclusion. Median trends suggest that the energy patches did enhance heart rate variability, although a larger N study may be required to achieve statistical significance.

ORAL PRESENTATIONS, Saturday, September 9, 2006

Student Award: Changes in Quantitative EEG and Low-Resolution Electromagnetic Tomography Following Cranial Electrotherapy Stimulation

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Category: research

Introduction: The cortical and subcortical effects of cranial electrotherapy stimulation (CES) were evaluated by Quantitative Electroencephalography (qEEG) and Low Resolution Brain Electromagnetic Tomography (LORETA). CES is an FDA approved treatment for depression, anxiety, sleep disorders and pain; it has also been shown in previous studies to be

efficacious in treating alcoholism (Padjen, Dongier & Malec, 1995) and drug withdrawal (Gold et. al, 1982).

Method: Seventy-two (72) research subjects were provided with a single session of CES; 38 subjects were provided with .5 Hz CES, whereas 34 were provided with 100 Hz CES. Group analysis was conducted with paired t-tests. The effects of CES on EEG made it impossible to both collect valid EEG data and use a double blind design. Previous studies, which did not involve EEG, have used double blind designs and found significant effects from CES (Gold et. al, 1982; Padjen, Dongier & Malec, 1995; Weiss, 1973). A within subjects design was used in which each subject functioned as their own control; this design provided the maximum isolation of the independent variable possible for the study.

Results: Both frequencies of CES produced a significant (.05) increase in alpha relative power with a concomitant decreases in delta and beta relative power. Statistically significant changes were also found for coherence, amplitude asymmetry, phase lag and power ratios. Statistically significant changes in current density were found in all 2, 394 gray matter voxels represented by LORETA. Cortical and subcortical increases were found in theta and alpha frequency current density with concomitant decreases in delta and beta current density. The effects of CES on current density varied by frequency but not by proximity to the CES contacts or structures within the brain.

Conclusion: CES increases EEG alpha and decreases delta and beta. The LORETA results indicate that response to a single session of CES involves whole brain activation in alpha frequency current density. The qEEG and LORETA data of the current study indicates that CES does have a significant effect on the cortical and subcortical activity of the human brain. The nature of the changes found in brain activity after CES is consistent with the physiological, affective and cognitive effects of CES reported in the literature.

Student Award: A Comparison of QEEG Patterns of Children with a History of Abuse and/or Neglect and Adults with a History of Sexual Abuse.

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& Eugenia Bodenhamer-Davis, Ph.D. (R)*

University of North Texas Neurotherapy Lab

Introduction: Previous research conducted at the University of North Texas Neurotherapy Lab investigated QEEG patterns in children who have histories physical or sexual abuse or neglect. The results indicated that these individuals show a pattern of less delta and more theta in the frontal region, though these findings did not reach statistical significance using the NeuroGuide database. The purpose of this research is to compare the pattern seen in abused children to a group of high functioning sexually abused adults.

Method: QEEGs were obtained by Richard Davis, MA, as a part of a pre-treatment assessment of 21 children who had been removed from their home by Child Protective Services due to abuse and / or neglect. The children were between the ages of 5 and 15 years old. The QEEGs of the high functioning sexually abused adults were collected by Lisa Black, Ph.D. during the course of her doctoral dissertation research. The adults ranged in age from 20 to 53 years old. The QEEG results for both groups were then compared to the NeuroGuide database of normal controls. The resulting patterns of relative power z-scores were examined to determine if the two groups share similar characteristics.

Results: Results showed that both groups have decreased delta at Fp1, Fp2, F3, F7, F8 and T3 and increased theta at Fp1 as evidenced by averaged z-scores greater than .50. The problems of making further inferences or conclusion about the common features between the two groups will be discussed.

Heart Beat Artifact Effects on QEEG Results

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Category: Research

Introduction: EKG can sometimes be an unavoidable artifact when recording EEG. However, little has been published showing its actual effects on the QEEG. Cantor (In Evans and Abarbanel, 1999) states that EKG artifact loads in the theta range. Due to changes in Neuro-Electric Eigen Images (NEI), Hudspeth (personal communication, 2006) believes it is alpha that is affected by EKG artifact. And, Thatcher (personal communication, 2006) states that "heartbeat contains a slow component and a higher frequency component depending on the shape of the wave." He clarifies that absolute power maps are useful for "isolating the artifact to the specific channel(s) the heart beat is in and the frequencies it may produce." The purpose of the current study is to examine EKG artifact effects on different QEEG measures.

Method: Archival clinical EEG eyes closed files containing obvious and subtle EKG artifact were edited with Neuroguide software. Each file was edited twice, once including EKG artifact, and once excluding EKG artifact. Statistical comparisons were computed between each individual's two edited files.

Results: Preliminary results indicate that EKG artifact may or may not exhibit significant differences on QEEG data depending on which electrodes are contaminated, how subtle or obvious it is, and morphology and rate of the heart beat.

Conclusion: When EKG artifact is embedded in the EEG so that it is difficult to see, the effects of its inclusion can be insignificant. However, when EKG is easily seen, its effect is dependent upon location of contaminated electrodes, morphology, and heart beat rate. The results have important implications for referential versus sequential neurofeedback applications.

Dense-Array Event-Related Potential Study of Perceptual and Motor Components of Psychomotor Slowing in Euthymic Patients with Bipolar Disorder

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Category: Research

Abstract: The aim of the study was to evaluate the role of perceptual and motor demands of the reaction time task performance in patients with bipolar disorder (BD). Eleven euthymic patients with BD and 11 healthy subjects participated in this study. Euthymia was defined as the absence of major depression, hypomania, or mania. We recorded EEG from 128 locations on the scalp. During the experiment visual stimuli were presented for 200 ms. Stimuli probability for targets was 20%, while for standards was 80%. Half of target and standard stimuli were masked by 35% filling of background. Subjects performed two tasks in blocks of 400 trials. In the first task subjects were instructed to press key whenever the target appears. In the second task subjects were instructed to respond to the targets by silent count. The mean amplitudes and latencies of centro-parietal N200 and P300 components of event-related potentials (ERP) were cast into ANOVA with the factors: Masking (unmasked,

masked), Response (motor, silent count), and Stimulus (target, standard). Between subject factor was Group (patients, controls). BD patients showed slower reaction times (RT) than controls both to masked and unmasked targets. Though masking had main effect on RT, Masking x Group effect was not significant. RT in the BD group was globally longer than in controls. ERP effects were observed in P300 latency in a form of significant Stimulus x Masking x Group interaction. P300 latency was longer in BD patients and showed interaction with stimulus type and perceptual loading. The latency of N200 showed only Mask x Group effect, being relatively more delayed to masked stimuli in bipolar patients compared to controls. There were no group differences in amplitude of ERP measures. In summary, the group of bipolar patients compared to controls showed longer RT and delayed P300 in oddball task with motor demands. ERP indices of stimulus property evaluation and classification speed were different between groups regardless of the type of response demands. These ERP findings suggest that slow speed of response-related processes, along with the slow perceptual stimulus-evaluation processes, might be important components of the pattern of psychomotor impairments in patients with BD.

Continuous Performance Test results following EEG training with transverse and longitudinal -bipolar derivations

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Category: Research & Clinical Application

Introduction: This paper is a follow-up to a study published last fall in the Journal of Neurotherapy (Putman, 2005) and a presentation given at the 2005 ISNR conference by Siegfried Othmer PhD on response time regression. Particular emphasis will be given to those scale results that moved against the direction of improved functioning, or at least displayed some ambiguity with respect to our operating hypothesis -i.e. that higher scale values are indicative of improved functioning. Specifically, response time standard scores will sometimes decrease following EEG training. Examination of correlated impulse control scores provides some illumination.

Method: One hundred and thirty-four (134) subjects were evaluated using the TOVA (visual) prior to EEG training and re-evaluated following the 20th session. EEG training involved the use of both longitudinal and transverse bipolar derivations with the longitudinal configurations being confined to the most recent 25 subjects.

Results: Post training TOVA results indicate a trend towards normalization on both the commission and omission scales ($p < .001$) for all $N=134$. Data on the most recent subjects ($N=25$) yielded similar results ($p < .01$, $p < .001$). Upon examining those subjects whose response time scores worsened, it was found that nearly all showed improved functioning in impulse control.

Conclusion: Bipolar neurofeedback protocols are establishing themselves as an efficacious approach in the clinical treatment of ADD (Othmer, 2005). The mechanics of this improvement likely involves the engaging of those regulatory centers that govern phase relationships between cortical generators -both local and distal. Interaction between generators at-a-distance and across midline likely involve mechanisms that are quite different than those in the more local, unilateral placements.

**Combined Neurofeedback - Brain-Computer Interface Technology
 for Self-Managing EEG Rhythms Based on the Control of Moving Objects**

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Category: Research

Introduction. There are high correlations between specific cortical EEG patterns and optimum levels of human performance. Neurofeedback (NF) is used for voluntary change of an individual's EEG and for training individuals to optimize one's performance. However, only small number of people can easily learn to control the EEG rhythms in NF. Although NF training is successful for the small number of people, the achieved characteristics of EEG tend to change in a short period to an unpredictable way. It is a key issue of the NF to control rhythms of EEG.

Method. Our technology includes parameters of EEG connected to movements of real or virtual objects in 3D space on the base of brain-computer interface (BCI). The NF training does not increase or decrease the power of EEG rhythms; instead it helps the trainee learn how to control EEG rhythms while they are trying to move the objects.

Results. We developed two technologies for training ability of object movement using the brain waves. The first one was aimed at control of an external object which was similar to the radio-controlled toy. After a short period of the learning, subjects could move the object freely using only brain waves and eye movements. In the other experiment, subjects trained themselves 3-dimensional control without conscious efforts. Three EEG parameters were connected to RGB drivers of color display without informing that connections to the subjects. Subjects performed tasks not related with conscious attention to colors of the display. Thirteen (13) subjects out of 15 could manage the colors of the monitor (Kaplan et. al., 2005).

Conclusion. Combined NF-BCI approach allowed people to learn how to manage their brain waves by themselves.

KEYNOTE SPEAKER:
Measuring and Controlling Brain Activation
Using Real Time fMRI (rtfMRI) With Resultant Changes in Behavior

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Category: Research

Introduction. It is now possible to visualize brain activation in real time using fMRI, potentially making it possible for a subject to observe both their own subjective experience and measures of its underlying neural mechanisms nearly simultaneously. We have investigated whether real time visualization of brain processes can be used to train subjects to control anatomically localized brain activation. All people exercise implicit, unknowing control over the brain processes that mediate their actions in performing normal behavior. Beyond this implicit control, it is not known whether subjects can learn to explicitly control the activation in a target region within the brain using rtfMRI, potentially impacting behavior, cognition, or associated disease. We have investigated this phenomenon in several behavioral models including pain regulation and emotion regulation, in both healthy subjects and patients. Pain regulation, an important test case, is mediated through a powerful and highly developed endogenous brain modulatory system spanning multiple brain regions. This system could, if it were brought under greater conscious control, lead to greater control over pain.

Methods. Subjects were provided with real time fMRI (rtfMRI) information regarding their brain activation. fMRI scanning was conducted using a 3 Tesla GE Signa scanner at the Lucas Center at Stanford University or at the Omneuron 3T MRI Research Center (64x64voxels, 3.43mm² in-plane resolution, 7mm thick), using a T2*-sensitive spiral-out pulse sequence (1s TR, 30ms TE, 70° flip angle) and a volume head coil. ROIs were individually selected during an initial physiological localizer scan. Healthy subjects received noxious thermal stimuli and were instructed to attend towards and attend away from alternate stimuli. Chronic pain patients produced the painful stimulus by contracting distal musculature in the painful area (for the localizer scan only). It was explained to subjects that the goal of training was for them to learn to enhance their control over activation in a localized brain region associated with pain and pain regulation (for groups receiving rtfMRI) or to learn to enhance their control over pain through repeated practice (for non-rtfMRI control groups), and detailed instructions were provided.

Results. Subjects successfully learned explicit control over blood oxygen level dependent (BOLD) activation in the rostral anterior cingulate cortex (rACC), a region involved in pain perception and regulation. This learned activation pattern grew through the course of training, was spatially specific, and did not take place in four independent control groups receiving similar training but in the absence of rACC rtfMRI information. When subjects deliberately induced increased versus decreased rACC activation, there were corresponding changes in the perceived pain intensity caused by an applied noxious thermal stimulus. Patients with chronic pain were trained to control activation in the rACC using rtfMRI information following a similar protocol. After training conducted using this procedure, chronic pain patients reported substantial decreases in their ongoing pain level.

Conclusions. It is possible for subjects to learn explicit control over brain activation using rtfMRI-based training, and there is a concomitant impact on cognitive processes. This procedure is being actively investigated in ongoing clinical trials in chronic pain and other disorders involving central nervous system function.

QEEG Findings with Adults Reporting a History of Sex Addiction

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Category: Research

Introduction: Research examining the EEG characteristics of those engaging in abnormal sexual behavior has been mixed (Kirenskaya-Berus & Tkachenko, 2003), with some studies pointing to deficits in the left fronto-temporal regions (Flor-Henry, Koles, and Frenzel, 1991) and others identifying deficits in the left posterior region (Corley, Corley, Walker & Walker, 1994). The purpose of the current study is to further examine EEG characteristics of adults reporting a history of deviant sexual behavior.

Method: Thirty-two (32) adult males reporting a history of engaging in abnormal sexual behavior were administered a QEEG as part of standard pre-treatment assessment. The EEG data was edited to reduce artifact and run through NeuroGuide as well as NTE Map Insight and standardized Low-Resolution Electromagnetic Tomography (sLORETA).

Results: Our hypotheses predicted QEEG power abnormalities in the left posterior and right frontal regions in the delta, theta, and alpha frequencies. Coherence abnormalities were predicted in the delta and beta ranges in the frontal and temporal regions. Preliminary data analyses indicate power abnormalities in the frontal region in slower frequencies (delta and theta). Preliminary analysis of coherence shows hypocoherence abnormalities in anterior and temporal regions, primarily in the delta and beta bandwidths. Further results regarding sLORETA analyses will be forthcoming.

Conclusion: Identifying the QEEG features of individuals who display addictive sexual behavior enables better development of neurotherapy treatment protocols. Since all subjects in this study received at least twenty sessions of QEEG guided neurofeedback, their protocols and treatment outcomes will be discussed.

The Effects of Neurofeedback Training on Impulsivity

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Category: Research & Clinical Application

Introduction. Impulsivity is generally considered to be a multidimensional construct. This study addresses whether impulsivity can be reduced by neurofeedback training. Although impulsivity is often treated by neurofeedback as a symptom of ADHD, the studies that specifically address impulsivity are limited.

Method. Thirty students (N=30) were selected for this study on the basis of high scores on the Barratt Impulsivity Scale, the BISBAS Questionnaire and the Cloninger Scale for Sensation Seeking. The group was randomly divided into three subgroups. The experimental group was offered 8 neurofeedback sessions of SMR neurofeedback at C4. The sham group received 8 (randomly rewarded frequencies) sessions at C4. The control group received no intervention. All three groups were tested pre and post treatment: Continuous Performance task, Anti Saccade task and Stroop. Pre- and post-test EEG-data included a 19 channel QEEG and Evoked Potentials (under a Go-NoGo task). Process related data was also collected.

Results. No differences were found on the Continuous Performance Task and the Anti Saccade Task. However, the experimental group showed significant improvement on the interference condition of the Stroop. ERP-analysis also showed a significant improvement in the NoGo-ERP, specifically at Fz.

Conclusion. After 8 sessions some clear effects of neurofeedback training were found. Some methodological issues that may have played a role in this study will be discussed during presentation.

Hemoencephalography for Autistic Spectrum Disorder

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Category: Research & Clinical Application

Introduction. The epidemiology of Autism is approximately 60 per 10,000 (1 in 166) children (Medical Research Council, 2001). Assessment-guided neurofeedback has been shown to significantly reduce the core symptoms of Autism (Coben, 2005). Hemoencephalography is a form of neurofeedback that has also been successfully utilized to improve function in patients with a wide range of diagnoses including Autism (Toomim, 2004).

Method. Thirty-five patients with Autism received 20 sessions of Near Infrared or Passive Infrared Hemoencephalography

(nir / pir HEG). The wait list control group (n=12) was matched for gender, age, race, handedness, IQ and other treatments. All patients had completed 20 sessions of EEG Biofeedback. The next phase of training was assessment-guided HEG. All patients had identified frontal system dysfunction based on neurobehavioral, neuropsychological testing, infrared imaging, and QEEG data.

Results. Findings indicated a success rate of 90%. A 42% reduction in symptoms was reported. Social interaction deficits decreased by 55%. Communication and social communication deficits decreased by 55% and 52%, respectively. There were statistically significant ($p < .05$) improvements in neurobehavioral and neuropsychological functioning. These improvements were associated with enhancement of thermal regulation and reduction in abnormal QEEG findings.

Conclusion. These findings suggest that Autism can be successfully treated with assessment-guided pir and nir HEG.

Low Energy Neurofeedback System: Breaking New Ground in Patient Outcomes

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Category: Research

Introduction. Building on the success of the former study with 100 subjects (phase 1; Larsen, Harrington & Hicks, in press), Stone Mountain Center conducted phase 2, increasing the number of subjects to 150, to be able to compare children and teenagers to the adult population, and we increased the number of sites monitored from two (in phase 1 of the study) to five, including the two highest amplitude, two lowest amplitudes and Cz. The study tracked changes in the amplitude (in μV) at each of the five sites, and measured the correlations of each with symptom reduction. All subjects were extracted from clinical treatment files of Stone Mountain Center and its satellite offices, treatment rendered over the last five years, and privacy practices were observed in the handling of data. Age of subjects was 5-80 and male to female ratio was 40 / 60.

Method. Patients had all completed a central nervous system (CNS) questionnaire at the beginning of treatment and also rated their five most severe symptoms (0-10) at each session. Fifteen symptom categories, each derived from patient reports, were tracked over the course of at least ten sessions of treatment. For this study, a follow-up was also added to see how the results held over time. No attempt was made to control for the effects of medications changes or other treatments.

Hypotheses:

1. The Low Energy Neurofeedback System (LENS) reduces the severity of CNS dysregulation. Certain symptom areas respond more quickly, others more slowly (these differences more precisely tracked in this study than the previous one.)
2. Amplitudes at the initial two highest sites and at Cz were reduced, while the amplitudes of the lowest sites increase.
3. There is a correlation between symptom reduction and these EEG changes.
4. People of all ages respond to treatment, but children respond more quickly than adults.
5. The results tend to hold after treatment is discontinued, but these are also subject to fluctuations from other life variables over time.

Results. The hypotheses were confirmed at high confidence levels (statistical significance). T-test statistics and multiple regressions were used to analyze data for significance and correlated variables. Longitudinal examination shows that treatment effects persist but are inversely correlated with the amount of time elapsed since the last neurofeedback treatment.

Conclusion. The LENS treatment is effective in ameliorating a wide range of symptoms. These positive effects vary with

different symptom areas and ages of subjects. Depending upon life-changes following the discontinuation of treatment, some benefits persist, while others diminish somewhat over time.

Electrophysiological Correlates of Auditory Memory Efficiency: An sLORETA Analysis

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Category: Research

Introduction: The current study contrasts electrocortical activation patterns during memory encoding and retrieval in a group of traumatic brain injury (TBI) survivors with objective verbal memory impairment and in a group of healthy non-amnesic controls without history of brain injury.

Method: Regional distribution patterns of electrocortical activity during memory encoding and retrieval were contrasted for a group of TBI survivors (N=10; mean age 27.6 years), with documented verbal memory impairment (scores > 1 SD below the mean on standardized memory measures), and a group of healthy controls with unimpaired memory (N=10; mean age 31.5 years). Three-dimensional current source density distributions were calculated for the normal versus traumatic brain injury cohorts utilizing standardized low-resolution brain electromagnetic tomography (sLORETA) during eyes-closed resting baseline and during an auditory paragraph encoding and retrieval task. A second analysis correlated subject's scores on standardized auditory memory tests with their corresponding sLORETA distribution patterns.

Results: Significant between group differences were evident only in the theta frequency band during both encoding and retrieval stages. **Encoding:** In comparison to the memory-impaired TBI group, normal memory subjects demonstrated significantly greater activation in medial frontal regions including anterior cingulate cortex (Brodmann areas 24 and 32) and medial frontal gyrus (Brodmann area 9). A review of past studies suggests an association between activation in these regions and subsequent successful recall. **Retrieval:** In comparison to the memory-impaired TBI group, normal memory subjects demonstrated significantly greater activation in the inferior frontal gyrus (Brodmann area 47), the anterior cingulate cortex (Brodmann areas 24 and 32) and medial frontal gyrus (Brodmann area 9), regions that have been associated in past studies with retrieval success. By contrast, the memory impaired TBI cohort demonstrated relatively greater reliance on a posterior activation pattern during retrieval, with significantly greater activation in the posterior cingulate gyrus (Brodmann area 31), a region that has been associated in past studies with both retrieval effort and success.

Conclusion: Klimesch and his associates have demonstrated that good episodic memory performance is characterized by low resting (baseline) power in the theta band, with an increase in theta power during the memory task. Thus it is not surprising that activation patterns in the theta frequency band best discriminated the normal memory group from their memory impaired peers. In comparison to the brain injured group, normal memory subjects tended to demonstrate greater task-related lateral and midline frontal lobe activation in regions that have been associated in past studies with successful recall. In response to the decreased efficiency of frontal lobe contributions to encoding and retrieval processes in the TBI cohort, there appears to be a compensatory reliance on posterior midline regions during memory retrieval.

Cranial Electrotherapy Stimulation Stops the Sudden Assault Syndrome

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Category: Research & Clinical Application

Introduction. Cranial Electrotherapy Stimulation (CES) is a treatment that involves the transcranial application of extremely low dose electrical current to the brain. This therapy has been in use for aggressive patients at North Texas State Hospital at Vernon for the past four years (Childs, 2005). The case reported is of a highly aggressive, psychotic, retarded woman whose violent assaults diminished 80% in the first month of CES treatment.

Method. A pre-treatment QEEG was performed and was repeated after three months of one hour twice daily CES .05 Hz. Single band magnitude and single band % power topographies were extracted from the EEG data. No medication changes occurred in the three months before or the three months of active treatment.

Results. In the month before treatment the patient had eleven episodes of aggression, but only two in the first month of therapy. The QEEG done before treatment was highly abnormal with dominant slow waves (delta and theta) whereas the post-treatment brain map showed a shift to dominant alpha wave frequency. Coinciding with these brain wave changes the patients grooming, relatedness and aggression all improved.

Conclusion. CES dramatically reduced aggression in this medication refractory patient and caused changes in QEEGs resulting in a normal dominate alpha rhythm.

KEYNOTE SPEAKER: New Directions in the Results of Analyses of the EEG

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Category: Research and Theoretical

Abstract. Surprisingly, brain activity changes 100 to 200 times per second. Even more surprisingly, brain activity comes back to repeat more or less the same patterns under the same conditions for seconds, minutes and even months. An explanation of this phenomenon is found in non-linear dynamics also known as chaos theory.

We therefore performed an experiment in which we recorded the algorithmic complexity (a measure used in non-linear theory) of the EEG recordings and found good results. The interpretation of algorithmic complexity allows inferences to be made as to which brain and behavioral processes are involved.

We then tested to see what the energy and information distribution was in these processes and whether these distributions throw any more light on them. We used 128 electrodes in our experiments but even 19 are enough to obtain some of these results. My aim is to show that there is more to be gained from EEG analysis than from the relationships among the standard

frequencies -- although these relationships are still useful. I'll show some new ways of looking at these relationships (in some attention deficit individuals) during my seminar and relate these to the topics of my presentation.

ORAL PRESENTATIONS, Sunday, September 10, 2006

Student Award: Quantitative & Qualitative Analysis of Mental Addition, Division, Multiplication & Subtraction Using Electroencephalography (EEG)

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Introduction. Event-related brain potentials (ERPs) recorded from the human scalp can provide important information about brain normal processes. This processing may be impaired in psychiatric or neurological disorders such as dementia. We used the P300 component of ERP to investigate qualitative and quantitative differences during mental arithmetic processing (MAP) operations (addition, division, multiplication and subtraction). This was conducted in normal subjects with the aim of establishing a normal control database for assessing cortical dementia.

Method. Ten right-handed neurologically normal male subjects (mean age 23.4 years) were presented 600 addition, division, multiplication and subtraction questions on a computer screen in a standard format (i.e., $a + b$, $a \div b$, $a \times b$, $a - b$), in blocks of fifteen minutes each with ten minutes breaks between blocks. Subjects choose one out of three possible answers using a keypad with the right index finger. Simultaneously, ERPs were recorded using a high resolution 129 channel net.

Results. Behavioral data indicated that subtraction had the shortest mean reaction time with highest percentage correct. Multiplication had the longest mean reaction time with the lowest percentage correct. Probability topographical-maps showed significant differences between rest period and MAP in frontal and parietal areas. Differences in frontal activity patterns were observed between addition-multiplication, addition-division, division-subtraction, and multiplication-subtraction. Similarity in activity patterns were observed in addition-subtraction and division-multiplication pairs.

Conclusion. Group differences may be accentuated in dementia as observed in behavioral and ERP data. This observation shows that MAP ERPs may be a plausible diagnostic tool for cortical dementia. ERP provides more insight into brain regions involved in MAP using the four operations. The temporo-spatial distributed significant changes between rest and cognitive activity (MAP) may be helpful in the investigation of several forms of dementia through the four arithmetic operations.

A Phase Synchrony Model of Consciousness

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Category: Theoretical

Introduction. One missing element in consciousness research has been the understanding of consciousness itself, a primal state, a ground state of consciousness that may form the basis of the integrative structure of active states of consciousness. According to the most comprehensive and successful theory of consciousness (see John, 2005) the ground state of consciousness is a state of no information, a state of maximum order (maximum global negative entropy). In meditation terms this is a state of self-referral awareness, or consciousness being aware of itself only, a state of pure abstraction. Transcendental meditation (TM) is used in the present study to achieve and evaluate the state that is pure self-referral consciousness in order to understand the basis of neural coordination in active states of consciousness.

Methods and Procedures. The study examines the EEG phase activity of fifteen long-term TM practitioners who were studied for EEG alpha phase synchrony during eyes-closed and TM practice. Twelve controls were evaluated for EEG changes over the same conditions and time frame.

Results. The study finds evidence for a ground state of consciousness consisting of a whole-brain phase integration pattern in the alpha frequency. Significant changes were found globally and most prominently in long-range EEG connections during TM practice as compared to eyes-closed resting. No changes were found in controls. The changes were attributable to an enhancement of zero-lag oscillations across the whole cortex during TM. This pattern has not been reported in previous literature.

Conclusions. The evidence for stationary alpha phase synchrony environments along with the findings by others of cross-frequency phase synchrony gives rise to a theory of phase synchrony that may explain the unity of experience.

ISNR CONFERENCE RESEARCH GRANT PRESENTATION: LORETA Neurofeedback: A Cortical - Subcortical Comparison

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Category: Research & Clinical Application

Introduction: This study examines the efficacy of spatial-specific LORETA neurofeedback training (LNFB), and compares LORETA maps of source localization and topographical amplitude and coherence differences resulting from this training protocol in three regions of interest (ROI); a seven-voxel cluster of neurons in the cognitive division of the anterior cingulate gyrus (ACC), a three-voxel cluster of neurons in the left dorsolateral prefrontal cortex (LPFC) and a four-voxel cluster of neurons in the right dorsolateral prefrontal cortex (RPFC).

Methods: This study was conducted with fourteen non-clinical students with a mean age of 22. We utilized electrophysiological measurements and subtests of the WAIS-III for pre and post measures to assess the influence of this training protocol. We trained participants to increase 14-18 Hz activity in each of the ROIs over twenty sessions.

Results: We compare sessions 1, 5, 10, 15, and 20. The data indicate significant differences in activation patterns within these regions and throughout the cortex. More specifically the data indicate that the ACC shares a significant relationship with the RPFC, and the LPFC shows significantly different activation patterns from both the RPFC and ACC.

Discussion: The AC and RPFC appear to influence a specific frontal circuit in the trained frequency as compared to the LPFC. The AC initiates regions that do not appear to be influenced by either of the other ROIs. There are differences that occur relative to ROI within areas of the medial, ventral and orbital-frontal cortices during this training. The data offer further support to the moderation of the central executive by the dorsolateral prefrontal cortex, particularly the right hemisphere and AC.

Similarly, the differences in topographical EEG between pre and post baselines are significant over sessions as are the amplitude and coherence differences initiated by training in each ROI. The improvements in both working memory (WMI) and processing speed index (PSI) scores suggest that LNFB has an overall positive influence in cortical regions relative to cognitive, working memory and attentional processes.

Communication, Coherence and Connectivity Part1: How Do We Measure Them And What Do They Mean for Neurofeedback?

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Category: Theoretical

Abstract: Recently the terms coherence and connectivity have become prominent in discussions regarding neurofeedback; however, most in the field don't really understand these ideas nor their relationship to communication theory and the larger field of information processing. Using the work of Dennis Gabor as a basis, it becomes possible to understand the emergent interest in connectivity and coherence as arising primarily through the more widespread use of phase-preserving transforms in both real-time neurofeedback as well as in various approaches to off-line analysis of both ambient EEG and actual records of neurofeedback training sessions. This presentation will discuss the mathematical basis of coherence, the neuroanatomical and neurophysiological implications of connectivity and their shared foundation in communications, specifically as seen through the lens of Gabor information measures and techniques.

Communication, Coherence and Connectivity Part2: Advances in Neurofeedback Applications Within and Between Individuals

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Introduction: Realizing the value of Gabor Transforms as a particularly adaptive form of phase-preserving filtering that can be used in neurofeedback means that the relative role of communication theory and coherence measures can become clearer. From this basis we can come to understand how robust EEG measures for neurofeedback training can not only be derived from two or more active channels per individual, but that these same kinds of processing can be distributed across individuals within a group training environment. S.T.A.R. Training is just such a group-based neurofeedback training environment that relies upon the use of Gabor Transform-based filtering and two real-time EEG channels. It is a unique approach oriented to facilitating spiritual transformation and renormalization (S.T.A.R.) in which neurofeedback training equipment is shared across participants such that each person's feedback is both influenced by and influences the feedback of two other group members. This raises interesting questions concerning what communication, coherence and connectivity mean for neurofeedback - both within and between individuals.

Method: Review of the training records of 94 participants, drawn from eight different training groups, using this unique cross-person training approach is discussed and compared with data from individual training records.

Results: Real-time, cross-person neurofeedback training is both safe and predictable in its effect in facilitating personal transformation and group cohesion when appropriate targeting methods are used..

Conclusion: The S.T.A.R. process offers a unique approach to neurofeedback training that facilitates personal transformation in participants and the development of a safe group environment, using true inter-personal neurofeedback, that is based upon a core training approach that can also be used individually.

Comodulation is Not Connectivity

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Category: Research

Introduction: The current paper shows that magnitude spectra (FFTs) for dissimilar waveforms can have identical FFTs under controlled conditions. This finding clearly demonstrates the erroneous logic that underlies the comodulation method for investigating cerebral connectivities. The primary data are generated by a software demonstration and the routine will be made available to all attendees.

Method: Thirty-two synthetic chirp waveforms were generated to provide 128 sample/sec signals that contained 1 - 32 Hz components, based on 1 Hz increments to attain the terminal frequency (e.g., 1 - 2 Hz, 1 - 3 Hz,, 1 - 32 Hz). Each of the original (O) 32 waveforms was duplicated by reverse (R) transcription in the time domain. All 64 waveforms were reduced to a 32 point FFT (fast Fourier transformation) to provide an estimate for the comodulation between the O and R waveform pairs.

Results: Even though the O and R waveform pairs were mirror-images in the time domain, they had little or no correlation with each other, which is the required to meet operational definition for communication between 2 points in a closed network (Bendat and Piersol, 1980). Insofar as O and R waveform pairs contained identical real and imaginary components (i.e., sines and cosines), their computed FFT profiles were identical and highly correlated.

Conclusion: The findings show that, without exception, completely uncorrelated waveforms can yield perfectly correlated comodulation estimates, a condition that does not exist in neuronal communication networks. As well, the Surrogate program from the R - Analysis software can be used to generate random Fourier coefficients that produce identical FFT distributions. It would be impossible for NF clinicians to protect comodulation procedures from erroneous findings and conclusions due to the presence of signal sources that may be given distorted meanings with regard to cerebral connectivities. The only way to assure an accurate index for connectivity still remains the evaluation of waveforms.

Student Award: Optimizing Dimensions for EEG Alpha State Discrimination

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Introduction. While it is often stated that neurofeedback training increases perceptual acuity for subtle internal signals about EEG states, very few studies have directly measured the human ability to discriminate between these states. The purpose of this study is to determine the stimulus dimensions that optimize this ability.

Method. EEG alpha amplitude (at Pz or F3) was calculated for each epoch, and ranked among a percentile distribution of amplitudes of the most recent 150 seconds initially derived from a baseline recording. Each session, a random order of high and low trials was generated, and a tone is sounded whenever the amplitude exceeded a critical difference from the median of the baseline. Subjects responded "high" or "low," and receive feedback about whether the response is correct (high tone) or incorrect (low tone) after each trial.

Results. At the time of this writing, three out of four subjects have achieved a significant level of performance within eleven sessions. Preliminary evidence suggests that subjects perform better with four-second discriminative stimulus intervals than one- or two-second intervals. Our observations also suggest that absolute power in the peak alpha band plus or minus one Hz is more closely associated with the discriminative stimulus than relative power or peak alpha plus or minus two Hz.

Discussion. Although these results must be interpreted with caution because of the low subject number at this time, they suggest that measuring discrimination success could a useful method of selecting EEG variables that are more accessible to perception and volition. Ongoing research will determine the effects of electrode location, pre-session baseline power, eye movement, and critical difference from the baseline median, on subjects' performance.

Can an Automated Neuropsych Battery Help with Neurofeedback?

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Category: Research & Clinical Application

Abstract: When two clinicians say they've made great progress with a client suffering from anxiety, how do you compare their outcomes without an objective measure? In addition, how can we as a field capture more standard measurements that can assist our credibility?

A new automated neuropsych battery that has 12 different tests will be reviewed. It can be helpful to provide some functional measures of cognitive change. It can also play a role in initial assessment. Validity and reliability studies will be reviewed. This particular battery has 3000 norms, from age 6 to 80. A study has shown a high correlation of five specific test indicators measures for ADD. Some cases by clinicians utilizing the tests will be reviewed.

The Relationship of Nutritional Factors to Performance on Tests of Attention

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Category: Theoretical

Introduction: Initial ADHD testing of residents of a residential eating disorders treatment center seemed to produce higher incidence of ADHD than the population norms would suggest. An investigation of this was initiated to determine the effects of nutrition on ADHD test scores in adolescent and adult female eating disordered residents. In addition, it was attempted to determine if these were nutritional effects and if normal nutrition would return the neural functioning to normal.

Method: Follow up IVAs were completed at three and six weeks, following a period of normal nutrition.

Results: Anorexic and bulimic female adolescents and adults showed a significantly higher incidence of ADHD than the normal population. Normal nutrition returned this population to incidence consistent with national norms.

Conclusion: Bulimics and anorexic females who are still hiding their disorder will have a tendency to be identified as ADHD, probably medicated, and the effect of medication on this population can produce significant negative reactions.

Functional Connectivity of ADHD and Asperger Syndrome Children

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Category: Research & Clinical Application

Introduction. Functional connectivity was evaluated for Asperger and attentional deficit and hyperactivity disorders (ADHD) by means of EEG coherence and comodulation analyses.

Method. Coherence and comodulation of spectral activity from 19 electrode sites were computed during eyes closed rest and mathematical processing for 7 children with ADHD, 11 with Asperger's syndrome, and 10 normal children. Data from 20 normal adults were also analyzed. Besides pair wise comparisons, global connectivity was evaluated by averaging 342 pair wise comparisons (19x18) across frequencies and for the entire spectrum of interest (3-18 Hz).

Results. Using a one-way between-subjects ANOVA, global full-spectrum (GFS) coherence and comodulation were found to be higher for adults than for all children populations, $p < .05$. GFS comodulation was higher for normal children during baseline and task conditions but GFS coherence was only higher during baseline recordings, $p < .05$. ADHD children exhibited the lowest functional connectivity and showed evidence of an immature or impaired thalamocortical network in terms of coherence. Whereas coherence peaks for normal and Asperger children in the alpha range, ADHD children exhibit this peak in the theta range. They were also hypo-coherent / modulated for alpha activity at anterior sites. Asperger's syndrome children showed a mixed pattern of thalamocortical maturation with frontal disunity (hypo-coherence/modulation) but adult-level beta coherence between occipital and medial frontal cortex, $p < .01$ for both eyes closed rest baselines.

Discussion. A model for interpreting coherence and comodulation of thalamocortical activity is presented. It is proposed that coherence generally gauges activity of driver cells, which may be responsible for momentary consciousness (i.e., feedforward activation of cortical networks) whereas comodulation gauges activity of modulators systems, those associated with feedback activation of the brain and which may be responsible for sustained consciousness (i.e., self-narration). Instances where comodulation differs from coherence may be particularly helpful in classifying individual impairment in cortical organization and maturation.

In Search of the Perfect Protocol?

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Category: Clinical Experience

Introduction. How many different protocols are used for depression? For anxiety? For ADD? There are some very strong claims, or preferences, among clinicians, and they are often at odds. It's clear multiple protocols can accomplish the same things. Is there a good neurophysiological reason behind these various options? This is a short discussion about how protocol biases can affect all clinicians and organizations who train? How many well validated protocols really exist? How many protocols have been compare with other protocols, head to head?

Method. We will survey a sample set of protocols for depression, and then OCD that are widely used. From C3 to F3 to F3-F4 to FP1 to T3-T4, to C3 to FZ, etc. We will discuss the similarities and differences.

Results. Many protocols are based on imaging studies and neuropsychological data, but precise pathways and frequencies are more elusive and have not been well-defined.


Conclusion. There doesn't seem to be a basis for one protocol being "the protocol." Clinical bias is likely to provide a lot of noise as to what works and when.

INVITED SPEAKER: Transcending the DSM using Phenotypes

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Abstract: The clinical use of EEG / qEEG is rapidly expanding since the acceptance of the clinical application of qEEG in 1994. Many different approaches to the application of qEEG exist, from the more mathematical approaches, like neurometric and discriminant analysis, to the heuristic reading of brain maps visually without the use of databases. These divergent approaches represent the polar extremes, with the balanced use of the qEEG to help guide clinical judgment lying somewhere in the middle. This talk will provide a survey of various approaches, as well as having a depth discussion of the phenotype approach to looking at EEG / qEEG data.

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