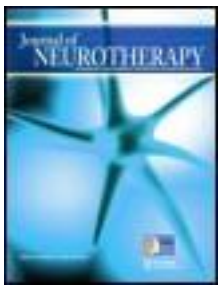

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Selected Abstracts of Conference Presentation at the 2007 International Society for Neurofeedback and Research (ISNR) 15th Annual Conference, San Diego, California

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Selected Abstracts of Conference Presentation at the 2007 International Society for Neurofeedback and Research (ISNR) 15th Annual Conference, San Diego, California

QEEG Studies of the Effects of the Entheogenic Plant Salvia Divinorum

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Introduction

The visionary plant Salvia divinorum, known as Diviner's Sage in the Entheogenic community, is native to the Mazatec region of Oaxaca, Mexico, where it is known as *La Pastora* (Shepherdess). For centuries and to this date, Salvia has been used in a sacred ritual manner by shamans (mostly women healers) for divination to guide a patient's healing and as a potent herbal medicine. Currently, Salvia is unscheduled and not legally regulated, which has enabled unhindered psychedelic experimentation and recreational use since the early 1990s. Pharmacological studies revealed that Salvia contains very potent active molecules, known as Salvinorin A, B, and C. These naturally occuring compounds are nonnitrogenous diterpenes bearing no structural similarities to other known common psychoactives and they act as Kappa Opioid (KOP) receptor system agonists. KOP mediated central nervous system pathways are involved in analgesic and antinociceptive functions. The rapid onset, short acting (10–20 min) nonhabituating and reversible nature of the Salvia "trip" make Salvia a psychoactive drug suitable for EEG studies.

Method

Healthy adult volunteers ($N = 8$; 6 men, 2 women; M age = 30.9 years) were prepared for quantitative electroencephalographic (QEEG) recordings (10–20 electrocap, referential linked-ears montage, 19 channel hookup, using Mitsar 201 equipment, St. Petersburg, Russia). QEEG data analysis was performed using WinEEG (Mitsar) and NeuroGuide (Applied Neuroscience, St. Petersburg, FL) software. A 10-min baseline control (resting eyes closed) was first obtained and then followed by EEG data collection for the onset and entire duration of the Salvia experience (about 15–20 min). A post-Salvia (recovery) EEG was also recorded in all cases. Delivery of the drug was by smoking inhalation of a $5\times$ or $10\times$ extract of commercially available Salvia divinorum. A suitable supportive environment was provided for these experiments. After inhalation of enough Salvia smoke to induce an altered state of consciousness (ASC), the participants drifted into a kind of dissociative state, remaining motionless while EEG recordings took place.

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Results

The Salvia-induced shifts in EEG compared to the baseline signature were striking. The most consistent effects observed were: In 6 of 8 participants, Alpha power (9–10 Hz) was significantly reduced ($M = 63\%$, $p < .04$, two-tailed correlated samples) and alpha spindling disorganized. In 4 participants, abundant large amplitude slow cortical potentials (SCPs) were recorded at many cortical sites. If SCPs were present during baseline, they increased in amplitude and frequency and were evident at more scalp sites during the Salvia experience. Intersubject Salvia effects varied considerably, consistent with individual baseline signatures. Some significant effects revealed: increased Delta power (2–4 Hz), increased Theta power (4–6 Hz), and increased Beta1 power (14–16 Hz). Also, significant shifts in amplitude asymmetry, coherence, and phase maps were evident. Consistently observed for all participants, the EEG signature returned toward baseline values upon recovery (10–15 min post). That is, Salvia-induced shifts in EEG were reversible and correlated with a participant's report of ending the ASC and returning to ordinary consciousness.

Conclusions

Salvia's short-acting and nontolerance buildup profile may find application in the broad interface between psychiatry, psychopharmacology, and herbal medicine. Salvia is currently being studied for its therapeutic antidepressive potential (Hanes, K.R. MAPS, Vol. 13, No. 1, 2003).

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Amplitude Asymmetries Across the Frequency Spectrum in a Normative Population

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Interest in the relationship between frontal asymmetry and emotions has focused on comparisions of activity in left and right dorsolateral frontal cortices. The alpha electroencephalography (EEG) frequency has been used as a measure of hypoactivity, and there has been general agreement among researchers that mood is enhanced when the right dorsolateral prefrontal cortex is more hypoactive (less active) than left dorsolateral prefrontal cortex. To date there have been no studies which compare the relationship of other frequencies to the alpha frequency in a normal, nondepressed population. In this study, data were reviewed from 35 nondepressed control participants.

Quantitative Electrophysiological Differences in Subgroups from a Group of Individuals Rated "At Risk" for a Psychotic Episode

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Introduction

Longitudinal, post hoc analysis of quantitative electroencephalography (qEEG) was conducted in a multiyear, multidisciplinary study investigating scientific bases for early identification of psychosis. In a review of the literature of neurophysiological studies, group differences in first episode and schizophrenic populations were evident, but few if any studies present prepsychosis data. This study is unique because it evaluates qEEG data recorded prior to psychosis. The objective was to evaluate qEEG data as a predictor for development of psychosis in individuals assessed by clinical psychiatric examination to be at risk for schizophrenia.

Method

Individuals at risk for schizophrenia were identified using criteria of Yung et al. (1998), based on the Basel screening instrument for

psychosis (Riechler-Rössler et al., 2006) and the Brief Psychiatric Rating Scale. This study looked at quantitative EEG data of 12 at-risk individuals, 6 who in the meantime developed frank psychosis. Fast Fourier Transformed qEEG data were evaluated. In the amplitude data set two main effects were evaluated: group and electrode site for each of 10 frequency bands. The two-way interaction Group × Site and the main effects were analyzed. In the coherence data set, three-way interactions, Group × Site A × Site B; two-way interactions, Group × Ssite A; and Group × Site B and Site A × Site B and the main effects were analyzed.

Results

Significant amplitude Group × Site Differences were found primarily in the Alpha 1 ($p < .001$) and Gamma 1 ($p = .02$) bands. Significant differences were found in the intrahemisphere coherence Group × Site A × Site B data with the most significant in the right hemisphere Alpha 2 band ($p = .03$).

Conclusions

Data suggest that increased resting neurophysiological activity may precede the first episodes of psychosis. It appears that qEEG analysis may aid in the correct identification of individuals in very early stages of schizophrenia adding to the ability for earlier intervention in an extremely debilitating disorder.

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Self-Perception and Experiential Schemata Assessment

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Introduction

This study was conducted to gain insight into the neurophysiological changes that occur as a result of completing a newly designed measure of self-perception and experiential schemata in recovering addicts and controls.

Method

This study was conducted was conducted with 110 participants total. Fifty-six of the participants completed the assessment while undergoing electroencephalography (EEG). The responses were marked within the EEG record. Twenty-eight of the participants were recovering addicts, and 28 were university students (control group). One hundred ten participants completed the paper version of the assessment.

Results

Statistical comparisons reveal subtle differences in processing of self and experiential schemata between addicts and controls. The main differences are in alpha frequencies in the right amygdaloid complex and inferior frontal regions—specifically, in Brodmann areas 25, 34, 37, 47, 13, and 38, associated with uncus, amygdala, and hippocampus. The assessment results show no differences for sex, race, or age. The results of structural equation modeling indicate that adolescence is a mediator between these childhood and adulthood experiential schemata and perceptual processes.

Conclusion

Differences between recovering addicts and controls appear in relatively few

frequencies in both baseline and assessment procedures, offering evidence for frequency and spatial specificity regarding experiential schemata and perceptional processes. It is reasonable to assume these autobiographical schemata are formed in early development and continue to develop throughout adolescence and if left unattended become engrained in neurocircuits and neural pathways in adulthood. If the alpha frequency is a state of preparedness for cognitive functions as suggested, then perhaps these data show a state of preparedness attuned to negativity and a perpetual state of flight or fight that is somehow relieved by use of substances. Hence based on the broad base of literature we would conclude this condition to be an antecedent to drug or alcohol use.

Autistic Spectrum Disorder: Outcome of EEG Coherence Training Targeting Social Skills Deficits

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Introduction

One of the most significant problems for people on the autism spectrum is difficulty in social interaction. Previous treatment studies lack improvement in individual behavior, have limited generalization, or show little maintenance of targeted behaviors (Hwang & Hughes, 2000). Research utilizing functional neuroimaging has linked social cognition dysfunction and language deficits in autism to neural substrates (McAlonan et al., 2004), especially related to the amygdala, superior temporal sulcus, and fusiform gyrus. This study attempts to locate these substrates and individually train these brain dysfunctions associated with social skills in addition to other autistic symptoms.

Method

Twenty-four patients diagnosed with Autism or Autistic Spectrum Disorder underwent quantitative electroencephalography (QEEG)-guided EEG coherence training (experimental group). Each patient received approximately 20 sessions of training two times a week. Each patient received pre- and posttreatment parent ratings, social skills ratings, neuropsychological, and QEEG assessments. A wait-list control group of 20 autistic patients were available for comparison and received pre- and posttreatment parent rating scales, social skills rating scales, neuropsychological, and QEEG assessments. There were no significant differences between experimental and comparison groups on demographics and symptom severity.

Results

Results showed that the experimental group significantly improved in neuropsychological test findings related to attention and visual perception skills ($p < .05$). Similarly, parent rating scales showed significant decreases in autistic symptoms and social skills deficits. Pre- and posttreatment QEEG measures showed significant enhancements of coherence associated with these improvements.

Conclusion

These results suggest that QEEG-guided EEG coherence training is an effective form of intervention in cases of Autistic Spectrum Disorder. Changes in attention and visual perception skills as well as parent rating scales ratings corresponded to changes in measures of brain functions. Implications were discussed.

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Learning Disabilities: A Controlled Study of EEG Coherence Training

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Introduction

The Learning Disabilities Association of America (2006) has estimated that the prevalence rate for learning disabilities is 15% of the student population. Despite the enormity of the disability rate, interventions currently employed have largely been unsuccessful in obtaining significant and meaningful results (cf. Thornton, 2006).

Method

Twenty-two patients diagnosed with a learning disability underwent quantitative electroencephalography (QEEG)-guided EEG coherence training (experimental group). Each patient received approximately 20 sessions of training two times a week. Each patient received pre- and posttreatment neuropsychological, educational, and QEEG assessments. An alternate treatment control group of 20 learning disabled patients received a combination of resource room and educational tutoring with pre- and posttreatment educational assessments. There were no significant differences between experimental and comparison groups on demographics.

Results

Findings revealed that patients receiving QEEG-guided EEG coherence training changed significantly on measures of educational progress when compared to the control group ($p < .05$). The experimental group showed an average gain of 1 to 1.5 grade-level improvements compared to the control group, which showed little gain (less than 6 months). Pre- and post-QEEG assessment showed significant improvements in coherence anomalies for the EEG coherence trained group.

Conclusion

These results suggest that QEEG-guided EEG coherence training is an effective form of intervention in cases of learning disabilities. These findings and implications were discussed.

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Targeting Strategies for EEG Biofeedback Using Normative Databases

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Introduction

Electroencephalography (EEG) Biofeedback has been developed upon a traditional model of employing amplitude-based metrics and providing feedback using contingencies based on thresholds and related techniques. This approach is effective when the overall goal is to teach self-regulation of brain activation or relaxation, and can be guided using traditional operant conditioning models. When applied to brain connectivity, however, this approach has known deficiencies in that individual connectivities are optimal when they fall within certain ranges, rather than being simply large or small.

Method

An EEG biofeedback system was developed that uses a normative database as the core computational engine, using *z*-score-based targeting in place of thresholds.

Results and Conclusions

It is found that feedback contingencies can be controlled by adjusting the size of z-score targets, as well as conditions describing compliance of an EEG signal with these

targets. It is demonstrated that use of live *z* scores is a viable and effective means of developing EEG biofeedback protocols for practical clinical use.

Modulating Thalamocortical Dysrhythmia and Phantom Perceptions

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Introduction

Simple and complex phantom perceptions such as tinnitus, auditory hallucinations, and neuropathic pain might be the result of hypersynchronized dysrhythmic focal hyperactivity of thalamocortical loops in the auditory and somatosensory system. Normal thalamocortical firing at rest runs at alpha band frequencies. Animal studies have revealed that tinnitus and neuropathic pain are associated with a synchronized hyperactivity of auditory and somatosensory cortex, respectively. This has been verified in humans and a pathophysiological mechanism proposed (thalamocortical dysrhythmia): Decreased auditory or somatosensory stimulation results in decreased firing rate (theta band), decreasing lateral inhibition. Consequently the surrounding area becomes hyperactive, firing at gamma band rates, which is suggested to be a necessary requirement for auditory and somatosensory consciousness and thus tinnitus or pain. Synchronization of gamma band activity could possibly induce topographical reorganization due to Hebbian mechanisms, resulting in permanent phantom perceptions. Functional imaging techniques have demonstrated a correlation between (a) tinnitus strength and amount of reorganization of primary cortex and (b) pain severity and amount of somatosensory cortex reorganization.

Method

Our first electroencephalography (EEG) data suggest that the amount of hyperactivity in the gamma band as measured by current density ratio in auditory cortex correlates to intensity of unilateral tinnitus. Therefore it seems logical to try and modify this tinnitus-related auditory cortex reorganization/hyperactivity in an attempt to suppress the tinnitus, and attempt to treat pain in a similar way. This can be achieved using Functional magnetic resonance imaging (fMRI)-based neuronavigation-guided transcranial magnetic stimulation (TMS), a technique that is capable of modulating cortical activity focally. If TMS is capable of suppression of tinnitus or pain, the effect could be maintained by implantation of electrodes at the area of signal abnormality on auditory and somatosensory cortex respectively. The BOLD signal on fMRI has been shown to correlate with gamma band event-related synchronisation. Thus fMRI imaging of the phantom perception can most likely demonstrate the neural generator of the phantom perception, as the area of BOLD signal correlates with gamma band activity and gamma band activity correlates with the subjective perception of the phantom.

Results and Conclusions

The first results in both tinnitus and pain patients demonstrate a statistically significant tinnitus suppression for unilateral tinnitus, and similar significant pain suppression as well. We recently initiated neurobiofeedback approaches using this theoretical model. Recordings directly from electrodes implanted on the secondary auditory cortex on the area of abnormal signal on fMRI demonstrate increased gamma band activity. A trial is currently on the way to train alpha up/delta delta down in an attempt to decrease this pathological gamma band activity using neurobiofeedback on electrodes implanted on the auditory cortex. If successful, noninvasive neurobiofeedback could be proposed to treat phantom perceptions.

The Effectiveness of the Low Energy Neurofeedback System on Autism, ADHD, Depression, and Anoxia: Case Presentations

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The purpose of this presentation was to show effectiveness of the Low Energy Neurofeedback System (LENS) on children who have been diagnosed with autism, ADHD, depression, and anoxia. Electroencephalography (EEG) LENS data were presented showing amplitude reductions over the course of treatment. The LENS maps were discussed over the treatment period to include amount of sessions, protocols utilized, symptom reports, and EEG amplitude changes. Data suggest that LENS treatment causes significant reduction of slow frequency amplitudes over the course of treatment.

EEG Alpha and Theta Oscillations and Cognitive Performance

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Introduction

The study of cognitive performance with respect to intelligence is a central element of psychological research and yet, despite extensive studies, until now neither neural fundamentals nor corresponding electrophysiological processes have been completely clarified. The aim of this report is to highlight the basics of cognitive performance in relation with human electroencephalography (EEG), in particular with the alpha as well as the theta rhythms. Some of the data that have been collected using functional brain imaging techniques can be interpreted in a way that persons with better cognitive performance demonstrate a generally weaker cortical activation while performing cognitive tasks (Haier et al., 1992). These findings are known as the ''neural efficiency hypothesis'' and have also been confirmed in EEG experiments (Neubauer et al., 1995). Klimesch and collleagues (Klimesch, 1999; Klimesch et al., 2001) however, have proposed another model based on their results, suggesting that persons demonstrating good cognitive performance show a stronger activation.

Method

In the first part of the talk a broad overview about the relation of cognitive performance and different EEG parameters were given. In the second part the divergent results of event-related desynchronization/synchronization (ERD/ERS) studies were addressed. This is done by reporting two recent ERD/ERS studies focusing on the relationship of alpha and theta activity with respect to intelligence. In these two studies EEG was recorded during an intelligence task as well as during a verbal analogy task.

Results

The results of the reported ERD/ERS studies indicate that participants with better performance show stronger theta band activation (ERS) during the task, as well as a more pronounced activation in task-related brain areas in an upper alpha band. These results are well in line with the model proposed by Klimesch. Regarding cognitive task demands in which upper alpha is functionally relevant, participants with better task performance show a stronger activation. On the other hand, during tasks in which upper alpha activation is not relevant, an active inhibition occurs (inhibition hypothesis).

Conclusions

Several parameters of the EEG show significant correlations with task performance and intelligence. However with respect to power changes as assessed by ERD/ERS analyses two models predicted different results. Although according to Klimesch's model, participants with good performance should yield a stronger activation, the neural efficiency model predicts a weaker

activation. However, the presented data and the introduced ''alpha inhibition hypothesis'' is capable of explaining these contradictory results.

Use of a qEEG-Driven Brain–Computer Interface and Neurofeedback with Patients in Pervasive Vegetative State

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Introduction

Research interest has grown to develop various forms of Brain–Computer Interface (BCI), which allows the use of real-time changes in physiological signals into meaningful or intentional signals from patients in cognitive or physiological compromised states to allow them to communicate using the computer interface or enhance certain functions. A number of studies during the last decades have shown that it is possible to implement a BCI system and even some locked-in patients could use BCI systems to express their thoughts and wishes to the outside world (Birbaumer et al., 1999). Although most of such efforts have focused on the use of such methodology with people who suffer from severe physical disabilities while having intact cognitive functions (e.g., ALS), the usefulness of these methods with patients with compromised cognitive functions (e.g., persistent vegetative state [PVS] and minimally conscious states) needs further exploration.

Method

BCI methods including auditory and kinesthetic feedback for direct human electroencephalography (EEG) BCI and training was used in three participants in PVS or minimally conscious states. In addition, pharmacological approach, medial nerve stimulation, and neurofeedback methodologies were used to help enhance cognitive functions.

Results

Preliminary results suggests some improvements in brain functions as measured by quantitative EEG, improvement in cognition as measured by level of awareness and responsiveness to commands, and return of some speech in at least one participant. The training and use of BCI for communication in these patients is still an ongoing effort and results are inconsistent. Preliminary results were discussed.

Conclusions

The utility of BCI systems is generally limited by several factors that include high error rates, long training and preparation times, high subject variability, and so on. The use of BCI in patients in PVS and minimally conscious states introduces another layer of complexity and new challenges because that the level of cognitive functioning is compromised in these patients as compared to patients with ALS whose cognition may be intact. Creating a paradigm to introduce meaningful signal detection and task comprehension is a great challenge in training these patients. Further challenges, developments, and need for future research is discussed.

Early Electroencephalography Correlates of Visual Perception and Memory

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Introduction

In the presented experiments we emphasized both the functional meaning of cortical oscillations on cognitive functions and to what extent these oscillations are related to event-related potential (ERP) components. Establishing a visual representation is associated with enhanced induced gamma activity

(30–70 Hz). In a first task induced gamma activity was investigated in regard to source and in relation to an ERP component peaking at 230 msec. P1 component was often associated with spatial attention. In a second task we wanted to outline the influence of nonspatial processing on P1 amplitude and evoked alpha oscillations. We also investigated evoked oscillations in a priming paradigm in the time-window of the P2 component. P2 was often associated with working memory so we expected to find effects in the theta frequency (4–7 Hz), usually related to working memory processes.

Method

In a first experiment, participants were shown picture stimuli that they had to judge as real or scrambled objects. The same stimulus material was used for a second experiment, but now participants had to indicate whether objects represent living or nonliving things. For the first experiment ERP and frequency analyses were performed; in addition, LORETA and BESA source analyses methods were used to unravel possible generators of a component peaking at around 230 msec. In the third experiment the impact of semantic priming on ERP components and frequency characteristics were investigated.

Results

We found that in the visual discrimination task a pronounced ERP component at around 230 msec is apparent. In this time window, increased induced gamma oscillations are observable. Localization of the C230 component showed enhanced activity in the anterior cingulate gyrus. Visual discrimination was also associated with a pronounced P1 component that was further investigated in a second experiment. In the time window of the P1, enhanced evoked alpha oscillations were found. In the priming experiment it was found that a priming-related P2 component could be associated with theta phase-locking stronger for new as opposed to primed items.

Conclusions

In the series of experiments we show the significance of EEG oscillations on cognitive functioning. Enhanced induced gamma was found to be strongest in a frontal region, which can be interpreted as a mechanism involving the establishing of visual object representations. P1 amplitude analyses showed that within the time window of the P1 an early categorization of object stimuli might take place. Evoked theta as shown in a priming task is probably related to encoding of new stimuli which is also characterized in enhanced P2 amplitudes.

Discrete Biochemical Reactions Dynamics of the Neural Networks and Brain Creativity Mathematical Modeling

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Human brain thinking abilities and brain creativity in particular are specific properties of the living matter, which is still not fully scientifically understood as it happens with components of nonliving matter where the main theories and dynamical laws of nature have been formulated and supported by corresponding mathematical models. Here we are proposing novel theoretical approach for mathematical modeling of living and thinking systems based on biochemical reactions discrete chaotic dynamics (CRDCD). CRDCD is the theory based on expanded first physico-chemical principles by including into consideration specific for living and thinking systems properties such as an information processing and exchange, reproduction, memorizing. Basic equations derived from CRDCD have a form of systems of nonlinear difference equations and describing multicomponent systems evolution in discrete time and space.

According to this theory, interaction between living and thinking system's constituents formally include into basic equations "information exchange." Physical meaning

of information exchange between neurons, discrete time, and space found its explanation within the proposed theory. CRDCD and its basic equations being applied to a neural networks dynamics simulation starts with an initial hypothesis about mechanisms of biochemical reactions that are taking place within individual neurons and a scheme of ''information exchange'' between neurons. We speculate that specific time–space chemical distributions (patterns) within the brain's neurons networks initiate and are intrinsically responsible for its creativity. For example, before artist starting to paint, the image should appear in a specific part of the brain in a form of the neuron's distributed chemicals. If our theory is correct it should have an ability to generate a variety of creative patterns correlated with natural human brains activity such as artistic patterns in a form of ornaments, music, poems, and all other types of natural brain creative activity. Our basic equations are easily expandable to 3D and to nD neural networks and to any complex schemes of biochemical reactions within the neural networks, which will enable us to simulate extremely complex patterning. This approach for neural networks mathematical modeling should lead to the creation of computerized artificial brain systems with the abilities to simulate basic brain functions with tremendous facilities.

Based on our results, we can expect that the CRDCD theory and resulting mathematical models could be effectively used for simulation of neural networks dynamics and brain creativity in a form of emerged artistic patterns in particular. This proposed approach could contribute to better understanding of brain functioning and explain basic features of living and thinking systems' dynamics, which is quite different from nonliving matter dynamics. Possible applications of CRDCD: new generation of artificial neural networks and ''artificial brain'' systems, biofeedback systems with the visual stimuli in a form of mandalas, electroencephalography simulation and analysis, mathematical imaging, and signals generators.

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Editor's note: This abstract was edited for length and clarity.

Integrating Neuromarkers for the Era of Brain-Related ''Personalized Medicine''

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The talk outlines key drivers (including the Food and Drug Administration [FDA] and the *Diagnostic and Statistical Manual of Mental Disorders* [5th ed.]) for a ''Personalized Medicine.'' Personalized Medicine has been driven by the FDA as finding the best markers of treatment prediction (of which individuals will respond to what drugs). The proof of concept successes in Personalized Medicine and exemplars of neuromarkers were presented in attention deficit hyperactivity disorder, depression, MCI/Alzheimer's dementia, schizophrenia and posttraumatic stress disorder. This context will serve as a frame of reference as to how a Personalized Medicine approach may be effectively implemented in neurofeedback training. Success of this endeavor is contingent on a deeper understanding of mechanisms underpinning electroencephalography and how this insight translates into more valid and personalized protocol selection in neurofeedback training.

EEG-Related Colored Symmetrical Images as Visual Stimuli for Neurofeedback

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Introduction

In this work we propose a new methodology for neurofeedback based on a visual

stimuli generated by biochemical reactions discrete chaotic dynamics (BRDCD; Gontar, 1997). BRDCD is an innovative theoretical approach applied to the simulation of the brain's neural networks dynamics.

Method

Mathematical modeling of neural networks based on BRDCD resulted in a variety of internal neuronal constituents concentrations oscillatory regimes. Individual neuron's internal oscillations occurring within concrete neural networks show similar patterns to experimentally observed electroencephalography (EEG). In the same time, BRDCD mathematical models allow us to present instant network's distributed neuron states (firing) reflecting amplitudes of the neuron's oscillatory regime at "discrete time" t_q in a form of 2D colored patterns. It was shown that simulation of neural networks dynamical activity could result in the variety of oscillatory regimes including chaotic ones and in the variety that corresponded to these oscillatory regimes 2D patterns including "creative" symmetrical ones (mandalas; Gontar, 2000). In this work we intend to correlate oscillatory neural networks regimes with experimental EEG while corresponding 2D symmetrical patterns (colored mandalas) were used as visual stimuli for biofeedback system.

Results

Different oscillatory regimes and corresponding mandala images generated by the BRDCD mathematical models were demonstrated. Mathematically modeled signals and mandalas were compared with experimentally observed EEG signals and mandala images created by Jung's patients. The prototype of the neurofeedback system exploiting proposed method were presented and discussed.

Conclusions

The idea to use mandalas as visual stimuli is inspired by Jung's observation that this kind of images, being created spontaneously by an individual, has a therapeutic effect on their authors (Jung, 1973). We propose to use a patient's EEG data as input for a BRDCD mathematical model to transform EEG signals in real time into mandala images that should reflect personal ongoing brain activity. Therefore we can expect that biofeedback systems based on the proposed methodology will enhance therapeutic impact on the patient.

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Bioaccoustical Utilization Device-Assisted Neurotherapy in the Management of Attention Deficit Hyperactivity Disorder

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Introduction

The use of neurotherapy or electroencephalography output to help a person learn how to affect brain frequencies has been documented for management of attention deficit hyperactivity disorder (ADHD). The primary limitation for this and other self-regulation approaches, however, is a function of the length of time it takes for a person to learn these subtle controls. For these and other logistical issues, the BioAccoustical Utilization Device (BAUD) was developed for treatment of ADHD based on the principles of brain entrainment using acoustical tones. The engineering technology of the BAUD utilizes a stereophonic sound wave of a square pattern for each ear in which interference

between the two forms a third tone considered to be the frequency that drives brain patterns. The application of the BAUD to neurotherapy is based on increasing control and logistics to the client. The client is told to increase or decrease the acoustical feedback in accordance to a desired frequency, offering feedback to his or her manipulation of the machine. The purpose of this study was to investigate efficacy of the BAUD in management of ADHD symptoms.

Method

Participants included 26 children and adults drawn from a private practice office in Dallas, Texas. All were initially diagnosed with ADHD from a licensed psychiatrist and were in counseling or psychotherapy. There were 15 males and 11 females, ranging in age from 14 to 65 years. Seven participants were used as a wait-list control group. All participants received two sessions of BAUD-assisted neurotherapy. Pre- and postassessment included measures of individual brain wave patterns, emotional functioning, arithmetic, short-term auditory memory, and spatial organization.

Results

Result indicated that the BAUD intervention produced ascensions of LoBeta and Beta (Cz placement, $p < .001$; Fz placement, $p < .001$). Significant improvements occurred in ratings of distraction ($p < .001$), anger ($p = .01$), and stress ($p < .001$). Number of arithmetic problems attempted increased ($p < .001$) as did number correct ($p < .001$). Spatial organization improved with less disconnections ($p = .003$), less errors ($p < .001$), and improvement in scale ($p < .001$). Analysis of the wait control group ruled out practice effects and confirmed these findings.

Conclusions

These findings support utilization of the BAUD as an adjunct to neurotherapy for treatment intervention for ADHD.

QEEG Mapping: An Aid to Subtype Diagnosis and Etiology of Autism

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The incidence of autism continues to increase to a current estimate of 1 in 150 children. However, etiology and causes of autism remain unclear as do the most successful treatment approaches. This talk described quantitative electroencephalography (QEEG) subtypes of autism. Possible etiologies of autism based on QEEG subtypes were presented together with recommended neurofeedback and other treatments.

Evaluating Oscillatory Dynamics in Autism Spectrum Disorder

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Evidence from neurophysiological studies suggest that synchronized oscillatory neuronal activity plays a crucial role in integrating higher brain processes. Behavioral dysfunction in developmental psychopathologies appears to be associated with large-scale brain abnormalities. This suggests that altered connectivity among brain networks, rather than changes in function in any one cortical region, may form the anatomical basis of cognitive impairments. Levels of synchronization between neural populations distributed across different parts of the brain can be estimated from electroencephalography (EEG) recordings domain via coherence measurements. Emerging data suggest that autism spectrum disorder is associated with both increases and decreases in EEG coherence at different spatial and temporal scales.

Effects of Cognitive-Behavioral Therapy on Regional Neurometabolism in Obsessive–Compulsive Disorder

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Introduction

Obsessive–compulsive disorder (OCD) is a chronic, frequently disabling psychiatric condition that some clinicians have sought to treat with neurofeedback. Such efforts may be aided by neuroimaging studies of the effects of OCD and of its treatment on brain physiology. Here we discuss recent exploratory studies of cognitive-behavioral therapy (CBT) for OCD using magnetic resonance spectroscopic imaging (MRSI) to assay brain metabolism.

Method

Severely impaired adult OCD patients participated. OCD symptoms were quantified with the Yale–Brown Obsessive–Compulsive Scale (Y-BOCS). Patients underwent 4 weeks of intensive daily CBT using the Gorbis method. Dose and type of any psychoactive drugs were kept constant from 12 weeks before enrollment until release from the study. MRSI was acquired at 1.5 T and short echo-time from multiple brain regions before and after CBT. Healthy control participants were scanned at baseline only. Regional metabolite levels were compared between pre-CBT patients and controls and post- versus pre-CBT within patients using nonparametric statistics.

Results

Mean decrease in Y-BOCS was -16.8 ± 5.1, reflecting major post-CBT relief of OCD symptoms. Among other pre-CBT findings, in left thalamus N-acetyl-aspartate + N-acetyl-aspartyl-glutamate (tNAA), creatine + phosphocreatine (Cr), and choline compounds (Cho) were 9–18%lower in OCD patients than in controls; Cr was also lower in right thalamus. Post-CBT, Cr and Cho increased 9 to 12%in left and right thalami; in right anterior middle cingulate cortex (aMCC) Cho increased 13%. Pre-CBT Cho in right aMCC correlated positively ($r = .80$) with pre-CBT Y-BOCS score.

Conclusions

Our separate 18FDG-PET study of OCD also found effects of CBT in bilateral thalamus (decrease in glucose metabolic rate) and right aMCC (increase in glucose metabolic rate). Severe impairment despite protracted (>12 weeks) prior drug administration suggests PET and MRSI results were because of CBT and not to concurrent psychopharmacologic treatment. Therefore, the thalami and right aMCC may be sites of OCD response to nonpharmacologic therapy and may be of interest to prospective neurofeedback treatments for OCD. Post-CBT increases in the osmolytes tNAA, Cr, and Cho may reflect CBT-induced relief of hypotonic conditions in the thalamus (reversal of apparent pathological metabolite effect, recovery to quasi-normal state); pre-CBT elevation of Cho in right aMCC (increasing with OCD severity) may reflect compensatory local membrane processes that are enhanced by CBT. These findings add to evidence that nondrug psychotherapy can induce concrete physiologic changes in the brain.

Inter-Hemispheric and Lateralized Frequency-Optimized Bipolar Training

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A comprehensive neurofeedback training strategy has emerged based on bipolar montage with a small set of either lateralized placements or inter-hemispheric placement at homotopic sites. All lateralized placements utilize T3 or T4 as a common site. Inter-hemispheric placement is predominantly at T3–T4. Optimization of response to training by adapting reward frequency to each individual has led to considerable enhancement in

clinical efficiency and rate of progress in training. The result has been a considerable expansion of clinical reach of neurofeedback to encompass disorders of attachment, autistic spectrum, obsessive-compulsive behavior, Tourette Syndrome, movement disorders, and chronic pain. The latter include migraine headaches, Complex Regional Pain Syndrome, and trigeminal neuralgia. The interhemispheric training is employed principally for stabilization of brain function in seizure disorder, migraine, panic, vertigo, hot flashes, and other transient conditions. The unstable brain is particularly sensitive to choice of reward frequency, which rendered an optimization strategy mandatory. Over the past year, training has been extended to center frequencies as low as 0.05 Hz in pursuit of an optimization strategy. Surprisingly, of the 127 clients who received optimized training over the last 6 months of 2006, 70% respond optimally at less than 1 Hz center frequency and as many as 30% respond optimally at the lowest reward frequency of 0.05 Hz. Optimal responding was determined based on client report with respect to alertness, vigilance, perceived calmness, and euthymia, plus appraisal of pain or other symptom severity. Principal diagnostic categories of the 127 clients were anxiety and depression, attention deficit hyperactivity disorder, migraine, insomnia, the autism spectrum, obsessive–compulsive disorder, and pediatric bipolar disorder.

Neurofeedback Treatment for Pain Associated With Complex Regional Pain Syndrome Type 1

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Introduction

Complex Regional Pain Syndrome Type I (CRPS-I) is a devastating pain condition that is refractory to standard care. Preliminary evidence suggests the possibility that neurofeedback training might benefit patients with chronic pain, including patients with CRPS-I. The current study sought to address the need for more information about the effects of neurofeedback on pain in persons with chronic pain by (a) determining average decrease in pain in patients with CRPS-I following neurofeedback training, (b) identifying percentages of patients reporting pain decreases that are clinically meaningful, and (c) documenting other benefits of neurofeedback training.

Method

Eighteen individuals with CRPS-I participating in a multidisciplinary treatment program were administered 0 to 10 numerical rating scale measures of pain intensity at their primary pain site, as well as pain at other sites and other symptoms, before and after a 30-min neurofeedback training session. A series of *t* tests were performed to determine significance of any changes in symptoms observed. We also computed effect sizes and percentage change associated with observed changes to help interpret the magnitude of observed improvements in symptoms.

Results

There was a substantial and statistically significant pre- to postsession decrease in pain intensity at the primary pain site on average, with half of the study participants reporting changes in pain intensity that were clinically meaningful. Five of seven secondary outcome measures also showed statistically significant improvements following neurofeedback treatment.

Conclusions

Findings suggest that many patients who receive neurofeedback training report significant and substantial short-term reductions in their experience of pain as well as

improvements in a number of other pain-and non-pain-specific symptoms. The findings support the need for additional research to further examine the long-term effects and mechanisms of neurofeedback training for patients with chronic pain.

An Investigation on the Efficacy of Neurofeedback Training in Autism Spectrum Disorders

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Introduction

Mirror neurons have been implicated in behaviors that appear deficient in autism spectrum disorders (ASD). One aspect of this dysfunction is nonresponsivity in the mu rhythm of the electroencephalography (EEG) to observed actions. Our study investigated whether operant conditioning using neurofeedback on the mu rhythm would produce changes in resting and functional EEG and on behavior.

Method

Twenty high-functioning ASD children were randomly assigned to control or experimental groups before neurofeedback training. Children's diagnoses were verified using ADI/ADOS and WASI. They were then assessed pre- and posttraining with a battery of tests, including QEEG, TOVA, ATEC, Imitation, and Mu Suppression.

Results

Following training, experimental subjects showed decreased mu power and coherence, increased sustained attention ability, improved scores on various subscales of the ATEC, and mu suppression to observed action compared to controls. Both groups showed improvements in imitation ability.

Conclusions

These results are consistent with the idea that mu rhythm training using neurofeedback can be effective in producing changes in EEG and behavior in high-functioning ASD children.

The Polyvagal Perspective: How Brain–Face–Heart Connections Mediate the Interface Between Social Engagement Behaviors and Heart Rate Variability

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The talk focused on the Polyvagal Theory, which links evolution of the neural regulation of the autonomic nervous system to cognitive function, affective experience, emotional expression, facial gestures, vocal communication, and contingent social behavior. The theory provides a plausible explanation of several features that are compromised during stress and observed in several psychiatric disorders. The Polyvagal Theory introduces a new perspective relating autonomic function to brain structures. This perspective emphasizes that, depending on the match between context and physiological state, the neural regulation of the autonomic nervous system promotes adaptive or maladaptive behavior and psychological processes.

Combining QEEG and EEG Complexity Analysis in the Assessment of Attention Problems Due to Multiple Causes

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Introduction

It has been proposed that attention deficit hyperactivity disorder is due to many factors, including genetics, metabolic imbalances, neurotoxicities, traumatic brain injuries, epilepsy, and many psychiatric disorders.

Method

One hundred sixteen patients seeking help for attentional problems underwent standard 19-channel quantitative electroencephalography (QEEG) acquisition, TOVA, a medical screening, and urinary laboratory testing for metabolic imbalances (amino acids) and heavy metal accumulation. Raw EEG data were also analyzed for complexity based upon the Minimum Spanning Tree method. This method determines if there is ''renewal aging'' of the statistical properties of the EEG time series. Previous research has found evidence for this property to be present in healthy EEGs but not in EEGs of various neurological disorders (Bianco et al., 2007).

Results and Conclusions

The results of analysis indicated that attentional mechanisms were disturbed more in patients with heavy metal toxicity and EEG slowing than in those with metabolic imbalances alone. Attentional problems were also related to epileptoid EEG features. Two patterns of EEG complexity were noted with pathology, namely, where complexity was either too high (random) or too low (epileptoid). Physical symptoms were related to the coefficient of variation, corroborating previous research on QEEG and the immune system (Rider, 1997). Physical symptoms were also correlated with beta power, corroborating recent research by Montgomery (2007).

Building a Clinical Database

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Introduction

Neurofeedback is a specialty niche that is gaining recognition and consideration outside of extreme alternative circles. Many health care practitioners who operate in mainstream clinics and practices of psychology, medicine, counseling, and social work utilize neurofeedback as an effective intervention or complimentary intervention. Yet the desire for increased exposure and recognition as an effective modality from the public and the professional colleagues still remains. The opponents to neurofeedback as an intervention always point to the same fact that there hasn't been enough peer-reviewed published literature using control group or double-blinded methods for research. The intention of this talk is not to address the near sightedness of these claims but rather to address them with a strategy for overcoming them. In the neurofeedback community there are hundreds of independent and group practitioners who operate in clinics, hospitals, and private practice. This diverse group of professionals collects data daily with their clients in a variety of ways. Neurofeedback professionals may utilize quantitative measures such as single or multiple site electroencephalography (EEG), intelligence testing, and attention and response time testing; subjective measures such as rating scales and clinical interviews or a combination of both. Many professionals collect or record minute data points of objective and subjective changes after and during each session of intervention. The thorough nature of these professionals leaves the field with an abundance of the clinical data that are currently sitting idle on the shelves of the busy practitioner.

Method

This is a proposed method for the easy assimilation and collation of the clinician data for the use in research projects for the aim of further investigation and validation of using neurofeedback as an effective intervention for the treatment of various disorders. The data should be hosted on a server that allows easy upload of data points and would accept output from popular software testing such as the IVA or TOVA and would allow the upload of various formats of collected EEG or neurofeedback sessions. This data along with subjective measures collected such as symptoms, client demographics, and clinical responses would be

available for the compilation and distribution to approved research projects.

Results

Researchers may ask for access to some portion of data for ongoing research that supports the aims of the database collection. Students may request access for student presentations at the annual conference, independent research at their university, or even as thesis and dissertation projects. Professional organizations, private donors, or even individuals may solicit/fund top researchers to use these data to investigate and publish scholarly articles.

Conclusions

Given the amount of data being collected by clinical professionals, it is disturbing to allow it to sit idle when it may be used for advancing the public and professional exposure and validity of neurofeedback as a viable modality for the treatment of various disorders. A model and method for collecting this data were proposed with the intention of developing the idea for implementation.

Dense-Array QEEG/ERP Study of Frontal Deficits in Patients with Substance Use Disorder and Posttraumatic Stress Disorder

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Introduction

The goal of this exploratory study, based on dense-array electroencephalography (EEG), event-related potential (ERP), and dipole source localization techniques (BESA), was to determine deficits in response conflict detection and motor response error monitoring functions during a speeded forced-choice task (Eriksen's flanker test) in patients diagnosed with posttraumatic stress syndrome (PTSD), in patients with cocaine abuse/dependence, and in patients with dual diagnosis (substance use disorder [SUD] comorbid with PTSD). We investigated quantitative EEG and ERP in patients diagnosed with PTSD, SUD, and SUD co-occurring with PTSD to determine whether executive abnormalities in a speeded reaction time (RT) task are mediated by a dysfunctional interaction of prefrontal cortical networks with medial frontal (e.g., anterior cingulate cortex [ACC]) structures.

Method

This study was aimed at investigating the functional chronometry of ERPs associated with response conflict detection and response error monitoring in patients with PTSD ($N = 12$), patients with SUD ($N = 10$), patients with dual diagnosis ($N = 10$), and matched control participants ($N = 12$). Specific aim of the study was to determine the differences in the induced EEG responses (e.g., gamma oscillations) and ERP indices of visual signal processing and action monitoring in this reaction task in patients with PTSD, SUD, and matched healthy controls. In this speeded RT task with interferences we used the fronto-central N200 and N450 components of stimulus-locked ERPs, and the response-locked error-related negativity (ERN) and correct response-related negativity (CRN) measures of motor response conflict and action monitoring. The dipole sources of these ERP measures (N200, N450, ERN) and single trial-based evoked EEG responses using BESA-based technology are known to be localized in the different portions of the ACC. All participants had EEG measured by an Electrical Geodesics system from 128 scalp loci during performance on the RT task with flanker distracters. This speeded RT test requires motor responses to congruent and incongruent stimuli is known to evoke response conflict and can be used to assess response error monitoring function in psychopathologies under study. Decrement

in performance in flanker task is thought to result from activation of the conflicting response by the incongruent flankers. The experiment was designed to test the hypotheses that (a) in patients with PTSD and comorbid SUD–PTSD, compared to controls, the medial frontal conflict monitoring system is overresponsive to response interferences and that (b) in cocaine-addicted participants compared to controls action monitoring is underresponsive to errors but response conflict function is spared.

Results and Conclusions

Patients with PTSD and SUD–PTSD comorbidity as compared to controls showed slower RT, higher error rate, and prolonged anterior N200 and N450 ERP components in an incongruent flanker condition indicating an overreactivity to potential response conflict. Both PTSD and PTSD–SUD groups compared to control participants showed smaller ERN on error trials and smaller CRN on correct trials, thus indicating lowered capacity of response monitoring function. Another important aim of our study was an investigation of feasibility using above EEG and ERP measures for functional assessment of frontal action monitoring neural networks in PTSD and SUD patients enrolled in biobehavioral interventions based on cognitive-behavioral therapy, motivational enhancement therapy, and neurofeedback.

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Concussions in Sport: Investigation of Assessment Measures and Functional Deficits

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Introduction

Mild traumatic brain injury (MTBI), otherwise known as concussion, continues to be one of the least understood but most common injuries in both sports and the general population. It is estimated that, in the United States, the incidence of brain injury is more than 2 million annually. According to a recent National Institutes of Health Consensus Statement, MTBI is an evolving dynamic process that involves multiple interrelated components exerting primary and secondary effects at the level of individual nerve cells (neuron), the level of connected networks of such neurons (neural networks), and the level of human thoughts or cognition. Because of the multiple systems negatively affected by concussion it is necessary to use multiple testing modalities to assess concussions.

Method

Through the presentation of new research, participants will gain knowledge in the area of brain injury and will learn how electroencephalography (EEG), LORETA, and postural assessments can be combined to improve concussion assessment sensitivity.

Results

Discussions of current and previous research and clinical findings elucidated shortcomings of uni-modal testing modalities and demonstrated the need for multiple testing modalities.

Conclusions

Because of the high incidence of MTBI, the vast array of affected systems and the possible detrimental affects of second impact syndrome, MTBI assessment methods should be expanded to assess all areas that are potentially negatively affected by concussion. The research presented here demonstrates the need for multimodal testing paradigms that include quantitative EEG measurements.

Achieving Excellence With Your Staff: A Consultant Staff Training Program in Neurofeedback

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Introduction

This article reviews the method used at the ADD Centre to train our 28 consulting staff members. These "staff" may be at a master's level and are going on later to complete their PhD. This means that there is a continual staff turnover. Ongoing staff training is therefore important.

Method

A detailed "log-book" lists areas of learning and readings, and it asks the staff to list the following in tabular format: training with the director, training with other trainers, self-training, and metacognitive strategy training times. A 68-question multiple-choice examination is completed orally with the first author both as a test of knowledge and a learning experience. This exam contains questions about every aspect of training and includes electroencephalography and neuroanatomy questions with diagrams. Meetings with the first author from time to time review how the each staff member is progressing with the log-book. Those who complete the log-book, examination, 30 directly supervised hr, 10 self-training hr, and 300 hr of neurofeedback (NFB) + biofeedback (BFB) experience with clients and those who participate in a major meeting or our BCIA 5-day workshop and/or publish in the field are eligible to receive The Biofeedback Institute of Toronto Certificate of Competence.

Results

The centre director can knowledgeably assure clients that she is confident that the staff who are working with them are competent. A number now have certification from the Biofeedback Certification Institute of America, and others are working toward it.

Conclusions

The only way that students can experience this field and thereby be able to make an informed decision as to whether to pursue neurofeedback in postgraduate studies is by having an in-depth hands-on learning experience using NFB and BFB. In addition the principle of parsimony—that the least invasive least disruptive and least expensive intervention be used first—dictates that we organize our serves such that low-income clients can benefit from a learning centre organization. For working with children and adolescents this age level of staff provides superb role models, and this is a desired "placebo" effect. Of interest, we have found that the older clients, executives, and professionals also often prefer to work with this age group of trainers. These factors all make it important that we provide an organized high-level training for these young staff members.

Similarities and Differences Between NxLink, Neuroguide, and SKIL QEEG Evaluations on a Group of Clients

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Although not required for successful treatment, the quantitative electroencephalography (QEEG) often uncovers otherwise hidden insights into brain dysfunction that can be extremely helpful in formulating custom protocols for an individual client. However, the picture is complicated by the existence of multiple QEEG databases that often provide different assessment findings. This presentation briefly compared Neuroguide, NxLink, and SKIL evaluations and database comparisons on several actual clients, focusing on commonalities and discrepancies between the findings of these three databases regarding power, coherence, and comodulation.