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CONTENTS

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EDITORIAL

Psychological EEG Analysis

Recently a colleague of mine used quantitative EEG to help him determine whether a man convicted of felony murder deserved the death penalty. The question was whether this young man had sufficient mental capability to control himself. My friend, a psychologist, used a number of psychological instruments, but the QEEG results were by far the clearest, revealing significant functional immaturity missed by conventional neuropsych testing. Anyone trained in psychological EEG analysis would come to the same conclusion as my colleague, that the convict's frontal lobes were significantly functionally undercon- nected. in nearly every index of EEG connectivity, that his brain activity resembled that of a teenager more than that of an adult in his early 30s. I was Hown in to testify, to support the application of EEG analysis for this purpose.

The practice of law is the practice of science, an ideal slowly actualized through iteration. In both realms progress is slowed by ambition and error, but such is to be expected of any human endeavor. It is also clear to me that law must incorporate scientific understanding of human behavior if it is to survive, and functional neuroimaging in particular poses a unique challenge to its existence. Law and science both rely on prccedcnts. though wc have an advantage over law in that we are able to repeat an experiment as many times as necessary to understand human behavior and they must judge a single instance. We can replicate an action and change participants, setting, lighting, anything of interest, but law is given a single outcome and force to play the cards it was dealt.

In my testimony I explained to the judge and trial lawyers how individuals trained in Psychology interpret neuroelectromagnetism differently from those trained in Neurology, that EF.G is a tool shared by both fields and one group may use it for X and another for Y and either may be valid in their use and interpretation. Of course I didn't use algebra to make my point but analogies, as a verbal reasoner. the judge, was the audience I hoped to convince. EEG is a tool, and like any tool it may be used in different ways by different people. A judge uses a hammer to maintain order and a carpenter uses it to build a house, but we wouldn't force all hammers to be round at both ends, or require a metal claw to protrude from a gavel, would we? Hammers come in all shapes and sizes, and like EEG they can be wielded in different ways. Same tool, different purposes.

The opposing view, expressed by the DA, was the neurologist's view of this tool, that EEG can be used only to identify structural problems in the brain, a stance so misguided and limited that it should evoke pity in the reader. The study of neuroelectromagnetism is closer to cosmology than medicine in the way we are doing it. We are investigating how human thought creates light, currents of electromagnetism. the generation of orderly energy, and how that regulated energy controls and manipulates matter, the body. Ln fact Hans Berger created the first EEG equipment in the 1920s to study thought processes (mostly in his son) and

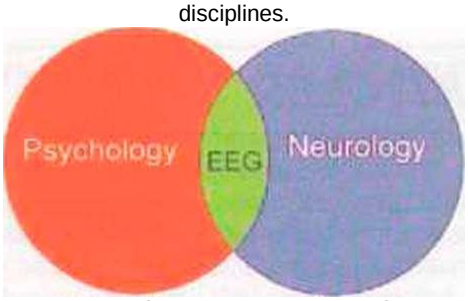
only later did he adapt his technology to study epilepsy and other brain disorders.

The defense team phoned me a few days after my testimony and asked me to help undermine the credibility of the opposing expert, a well-known neurologist and friend of a friend. 1 told them to ask the witness questions relevant to psychological investigations of EEG. For instance, what would we expect to see in an F.FG record of an individual during a lexical decision task, with or without lateralized presentations... that's easy enough. And what happens at posterior electrode sites when a gambler playing blackjack considers himself ahead or beating the house? Most of my undergraduates can answer these questions, and these are just two of the many psychological applications associated with EEC analysis. More than 42,000 quantitative EEG papers have been published since 1965. and a survey of last year's publications revealed three times more EEG research on issues under the umbrella of Psychology—attention, sleep, unconsciousness. animal behavior—than under the smaller parasol of Neurology. In other words, identifying and studying organic disorders with EEG has been a minority application of this technology for my entire lifetime.

The DA asked me whether I knew the neurology standard for sampling rates was 200 Hz. and I laughed when he told me the number, disbelief to the point of mockery. Why would any BEG science rely on a base-10 number? I asked aloud. The defense loved my response and I continued to explain to the unhappy DA how such a standard was archaic, 40 years out of date, a relic from the hey-day of Grass and Gibbs in the late 1930s, perhaps, or established by Molly Brazier and her crew in the 1950s. A base-10 sampling rate was like using horse-and-buggy rules to control highway traffic. The Fast Fourier transform (FFT) was invented in 1965. and no serious scientific group would rely on a base-10 value after its occurrence. as it would sacrifice accuracy, speed, and communication, the trifecta of scientific investigation. We have been the power ol 2 since 1965. with rates set to 128, 256. 512 samples per second for a reason. The FFT is a clever and highly efficient algorithm for quantifying frequency information within a time scries, light years ahead of any spectral estimation technique in vogue prior to 1965. The discrete Fourier transform (DFT), available since the 19th century, for instance, requires endless iterations of trigonometry and floating-point operations, a dicey and memory-intensive operation 40 years ago. whereas the FFT is an NlogN algorithm, which is geek speak for "Hello, gorgeous!" It was superior in every way, a major algorithmic breakthrough when it hit the world in the late 1960s, and all serious sciences that employed frequency analysis seismology, acoustics, physical oceanography responded to this change... except neurology, apparently.

During most of my examination and cross-examination the computer screen behind me showed a Vend diagram of Psychology and Neurology, the study of mental functions and behavior and the study of disorders of the nervous system, respectively, with their intersection being "EEG" (see Figure 1). The assistant DA asked me time and again about the use of the EEG in diagnosing organic disorders, and time and again I responded that we were using EEG to study mental operations and abilities. My testimony was being evaluated under the Daubcrt decision (1994). which produced guidelines for evaluating scientific evidence and testimony in court trials. A technique or theory must be accepted by the relevant scientific community and governed by explicit rules to be viewed as credible evidence in a court of law. Aware of this decision, I explained how science, like law, is not homogeneous or uniform but an assemblage of independent disparate groups, each its own school of thought, largely inert to the successes and failure of adjacent fields. Each science makes its own rules, and only rarely do mies of one field extend or cascade into another. Unlike law. science has remarkably few rules shared across disciplines, but they are the following: a measurement must be repeatable. a theory falsifiable, an inference logical, all tools are considered imperfect, and communication between practitioners or to the public must be honest and transparent. Those are our

FIGURE 1. Use of EEG technology shared by disciplines.



Mental correspondence with behavior

Organic correspondence with disease

standards, by the way. Unfortunately the other day I noticed one of our "practitioners" breaking Rule 4. using the phrase "zero error* on his Web site to describe his analysis. We should remind ourselves that making a claim of zero error is not science but propaganda.

My take-home message from this experience was that the International Society for Neurofeedback and Research (1SNR) needs its own standards, which it is working on, and the recognition that neurofeedback instruments arc likely misclassified by the Food and Drug Administration as neurological therapeutic devices ($ 882.5050). The Food and Drug Administration does not regulate psychological tools such as the Minnesota Multiphasic Personality Inventory, Beck Depression Inventory, or l est of Variables of Attention, nor does it classify video games as food or drug, so how does computer-interface technology that encourages mental exercise and psychological change fall under the aegis of a government agency dedicated to drug safety? And if it does, why aren't World of Warcraft and other addictive video games similarly regulated? 1 think ISNR needs to establish its own system of evaluating the claims, safety, and efficacy of neurofeedback equipment.

In this issue of the journal David Vernon and colleagues weigh in on the general principles of neurotherapy. and Mark Jensen and his colleagues discuss opportunities for neurotherapy in pain management. Also included in this issue are the proceedings from our recent conference in Indiana, which was like a Roman marketplace of new ideas and new technologies in the service of mental health. Along with ISNR's proceedings, abstracts from the Society for the Advancement of Brain Analysis (SABA), a daughter group of ISNR. are also included. Finally the Perspectives section reappears, a section for clinical narratives. Storytelling is an important part of scientific investigation as stories arc often the best teachers. There are many who prefer examples to abstract principles, and in fact behavioral neurolop[r] owes its existence to case studies, that is. singular examples of brain dysfunction, beginning with Phineas Gage in 1848 and Paul Broca's observations of Tan in 1861 to the "split-brain" callosotomy patients first described at Caltech in 1962 to the uniquely brain-injured patients known only by initials, such as the late H.M. We hope the inclusion of clinical narratives in this journal provides further insights into the use of neurotherapy.

David A. Kaiser, PhD
Senior Editor

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SCIENTIFIC ARTICLES

Neuromodulatory Approaches for Chronic Pain Management: Research Findings and Clinical Implications

Mark P. Jensen, PhD Leslie H. Sherlin, PhD Shahin Hakimian. MD Felipe Fregni, MD, PhD

ABSTRACT. Two lines of evidence provide preliminary support for the role thai brain state, measured via electroencephalogram (EEG). may play in chronic pain. First, research has identified a link between brain EEG activity and the experience of pain. Second, there arc a number of published studies documenting the beneficial effects of interventions that impact the cortical activity associated with chronic pain. These interventions include neuro- bchavioral treatments such as neurofeedback and hypnosis as well as invasive and non-invasive brain stimulation. Preliminary data showing the efficacy of neuromodulator^- strategies for treating pain provides compelling reason to examine how conical activity (as measured by BEG) may underlie the experience of pain. Existing data already suggest specific approaches that neurofeedback clinicians might consider when treating patients with chronic pain. Reciprocally, observations by neurofeedback practitioners could provide important ease data that could foster the design of more definitive randomized clinical trials using such strategies lor the treatment of chronic pain.

Murk. P Jensen is affiliated with the Department of Rehabilitation Medicine, University of Washington School of Medicine. I .eslic 11. Sherlin is affiliated with '.lie Department of Psychology, University of Phoenix; Southwest College of Naturopathic Mcdicine & Health Sciences; Northern Arizona University; and Nova Tech EEG. Inc.

Shahin Hakimian is affiliated with the Department of Neurology, University ofWashington School of Medicine. Felipe Fregni is affiliated with the Center for Noninvasive Brain Stimulation. Harvard Medical School. Some of the material in this article was presented in a previous article and we acknowledge its original publication (Jensen. Hakimian. Sherlin. & Fregni, 2008).

Address correspondence :o: Mark P. Jensen. PhD. Department ol Rehabilitation Medicine. Box 356490. University ofWashington School of Medicine. Seattle. WA 98195-6490 (E-mail: mjcnsen.gu.washington cdu).

KEYWORDS. Chronic pain, hypnosis, neurofeedback, neuromodulation. tDCS, transcranial direct current stimulation

INTRODUCTION AND OVERVIEW

Chronic pain is now known to produce plastic changes in an extensive neural network that involves

areas associated with somatosensory and emotional-affective processing. An understanding of the specific neurophy- siological changes that are associated with chronic pain could contribute to the development of novel treatments aimed at central nervous system (CNS) modulation. Research from a number of sources suggests a link between electroencephalographic (EEG) activity and the experience of pain. As described in more detail in the section that follows, this research suggests that (a) in most otherwise healthy individuals, the subjective experience of pain is associated with relatively lower amplitudes of alpha activity and relatively higher amplitudes of beta activity and (b) individuals with chronic pain associated with neurological disorders, such as spinal cord injury, evidence higher amplitudes of theta activity and lower amplitudes of alpha activity than individuals who do not have chronic pain.

The purpose of this article is to summarize the extant evidence concerning the associations between EEG-asscssed brain activity and pain, and then to discuss the implications of these findings for understanding the mechanisms of treatments that modulate cortical activity such as neurofeedback. hypnosis, and noninvasive brain stimulation. We also include a discussion of neurofeedback treatment approaches that may be used for chronic pain management that are based, in part, on the available evidence concerning the EEG activity most closely associated with pain. The goals of this article are therefore to (a) alert clinicians to recent findings on this field that might contribute to the development of effective chronic pain treatments now and in the future and (b) encourage more research to examine the efficacy of neuromodulator interventions and to understand the mechanisms of their effects.

INTEGRA T/ON AND PLASTICITY IN THE NEUROPHYSIOLOGY OF PAIN

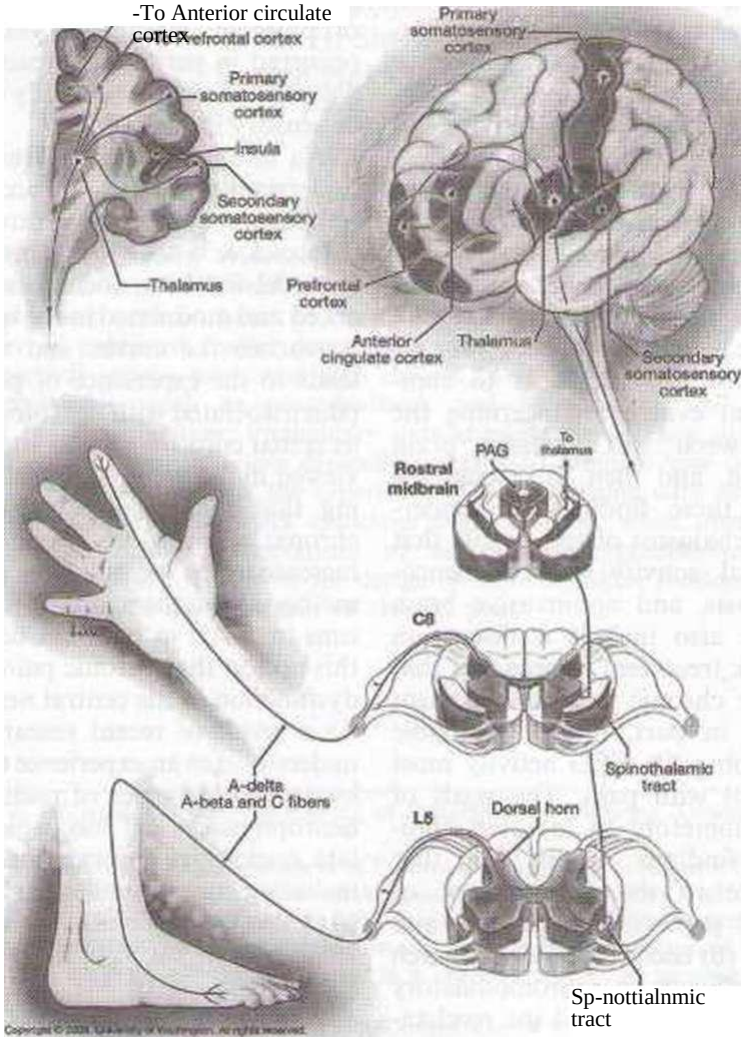
Before the middle of the 20th century, pain was viewed primarily as a simple reflexive response to physical damage. In that view, pain information (nociception) was thought to be transmitted directly from nerves in damaged tissue through a single channel directly to a "pain center" in the brain. When seeking to diagnosis or understand pain from this model, the area of primary interest was the periphery, that is, where pain was thought to originate from; the notion was that [i;]real pain" was mostly related to the amount of physical damage or inflammation that occurred in peripheral structures. The brain was viewed as an essentially passive recipient of sensory information.

An initial important turning point in our understanding of pain occurred with the publication of the gale control theory of pain (Melzaek & Wall. 1965). This theory provided a model for how nociceptive input is influenced and modulated in the spinal cord before it reaches the cortex and then, ultimately, leads to the experience of pain. In addition, pain associated with neurological lesions such as spinal cord injury and stroke started to be viewed in the context of this new understanding that the brain plays a major role in chronic pain. More recently, a significant increase in the use of advanced neuroimaging methods for understanding the brain mechanisms involved in pain has helped to confirm this notion that chronic pain can result from dysfunction in the central nervous structures. As a result of recent research, pain is now understood as an experience that is influenced by a dynamic series of multiple interlocking neurophysiological mechanisms that modulate nociceptive information at many levels, including supraspinal sites such as the cortex (Apkarian. Bushnell, Trecde. & Zubieta, 2005; Craig. 2003a, b; DeI.eo, 2006; Katz & Rothenberg, 2005: Melzaek, Coderre. Katz, & Vaccarino, 2001; Miltner & Weiss, 1998; Tina7zi et al.[f] 2000).

Moreover, we now know that, in addition to the effects caused by input from the periphery (e.g.. nociceptive information that is sent along the A-dclta, A-beta. and C fibers to the spinal cord and into the CNS) supraspinal structures such as the primary and secondary somatosensory cortex., insular cortex, anterior cingulate cortex, prefrontal cortex, and thalamic nuclei all work together to represent and modulate the experience of pain (see Figure 1). Thus, although activity in the peripheral nervous system and the spinal cord certainly can play an important role in the experience of pain, the key role that multiple *conical* and subcortical sites play in the perception and emotional response to pain is now more clearly acknowledged and understood.

Research has also shown that nociceptive input, via neural adaptation, may modify neural networks' responses to repeated stimuli (Flor. 2003; Katz & Melzack. 1990). For example, sensitivity to noxious stimulation increases as a result of ongoing nociceptive input (Bromm & Lorenz, 1998); in other words, the experience of pain itself makes the

FIGURE 1. The primary nervous system structures involved in the processing and experience of pain. Reprinted with permission.



CNS more sensitive to pain—this phenomenon is called nervous system sensitization. This hypersensitivity may have an evolutionary advantage as increased pain can promote healing by inducing behavioral changes, compelling a person to take special care of injured anatomy. However, this mechanism can at the same time extend discomfort and suffering beyond the time it takes for healing to occur, and potentially contribute to the development of a chronic condition. Some studies have identified the CNS changes that occur with chronic pain as a potential target of treatment to produce pain relief; interventions that reprogram or interrupt central sensitization, at the cortical level, could also possibly provide significant relief for some individuals with chronic pain (Flor, Braun. F.lbert, & Birbaumer, 1997; Maihofner. Handwerker, Neundorfer, & Birklein, 2003; Pleger et al., 2004; Tinazzi et al., 2000).

Another important issue related to focusing on supraspinal systems as a target for chronic pain interventions is that the brain should be viewed as a two-way system, in which the processing of information results in changes in efferent systems ihrough top down mechanisms such as regulation of endocrine and immune systems. It is therefore also possible that modulation of pain by altering CNS activity directly may promote health by stimulating salutogenic mechanisms (Fregni, Pascual-Iveone. & Freedman. 2007).

MEASURING THE NEUROPH YSrOE OGICA L CORRELA TES OF PAIN

Researchers have used a number of tools for studying and identifying the neurophysio- logical correlates of pain. Functional magnetic resonance imaging (fMRI) has been used to measure localized changes in blood flow in the brain (and therefore neuronal activity) associated with pain. Positron emission tomography (PET) has been used to assess localized brain metabolic changes induced by aversive stimuli. EEGs have also been used to infer changes in brain electrical field activity after experience of pain. Finally, transcranial magnetic stimulation (I MS) has been used in two different manners to assess chronic pain: (a) via single and paired pulse TMS to assess cortical excitability changes associated with chronic pain (e.g.. Lefaucher. Drouot. Menard-Lefaucheur. Keravel, & Nguyen. 2006) and (b) via repetitive TMS (rTMS) to functionally and transiently disrupt activity in the anatomical sites of pain experience (inducing "virtual lesions" that can link brain anatomy and its functional behavior) or by facilitating activity ¿titer the end of stimulation. Each approach has its advantages and limitations.

A primary strength of fMRI and PET is that these imaging strategies can localize activity throughout the brain. For fMRI. localization can occur at a relatively high degree of spatial resolution. However, as measures of the correlates of experience, the ability of these imaging methods to establish cause-effect relationships is limited. Also, with these methods of neuroimaging. temporal resolution is relatively poor. Measurement of cortical excitability via single and paired pulse TMS has the advantage of providing reliable functional measurements. However, this approach is limited to motor (and to a less extent, visual) cor- tcx. rTMS. on the other hand, has the advantage of having a good temporal resolution, and it can also allow for inferences about causal relationships. Because pain is a complex experience associated with activation in an extensive neural network, some of the temporal resolution of rTMS may be lost. In addition, this method assesses function by instituting changes; it does not itself directly measure activity (Pascual-Leone et al.. 1998) except when using single and paired pulse TMS.

EEG measures, although less commonly employed than fMRI and PET studies, can provide information complementary to fMRI. PET. and TMS/rTMS. Specifically, EEG can assess cortical rhythms in specific frequency bands, which are associated with different brain states. Significant support for the potential of EEG measures for contributing to our understanding of pain processing comes from evidence that the power of different EEG band widths has been shown to be associated with pain severity. Data from acute (induced) pain models to study the

effects of pain on HEG measures have shown a consistent pattern. Specifically, these data have shown that with more intense painful stimulation, all EEG frequencies increase in power, but beta frequencies increase relatively more than other bandwidths. and the relative power of alpha activity tends to decrease (Bromm. Ganzel, Herrmann. Neier, & Scharein. 1986: Bromm. Meier. & Scharein, 1986; Chang. Arendt-Nielsen. Graven-Nielsen. Svenson. & Chen, 2001: Chen. D work in, & Drangsholt. 1983: Huber. Bartling, Pachur, Woikowsky-Biedau, & Lautenbacher. 2006: see also reviews by Bromm & Lorenz. 1998; Chen, 1993, 2001): in summary, more acute pain appears to lead to more relative beta and less relative alpha activity. At the same time, this research indicates that acute pain relief is associated with decreases in the relative power of beta activity and increases in the relative power of alpha wave activity (sec also Kakigi el al.. 2005; Pclletier & Pepcr, 1977).

There is much less research examining the effects of chronic pain on EEG measures. The findings from the few studies that have examined EEG activity in patients with chronic pain are generally consistent with those from acute (induced) pain studies, with one interesting exception: A significant increase in relative very slow (theta) activity is found in individuals with chronic pain. One of the first of these studies compared resting EEG bandwidth activity between 15 patients presenting with a variety of chronic neuropathic pain problems (who were also candidates for a central lateral thalamotomy (C'LTJ) with 15 otherwise healthy individuals (Sarnthein. Stem, Aufenberg, Rousson, & Jeanmonod, 2006). About half of the patient group was taking centrally acting medications (e.g., sedatives, opioids, antiepileptics, and antidepressants). Consistent with the acute pain research, and at rest, the patients with chronic pain had elevations in all EEG frequency bandwidths. Moreover, and also consistent with the acute pain research, patients with pain had more relative (relative to overall activity) beta activity and less relative alpha activity. However, unlike the findings from acute pain research, the patients with chronic neuropathic pain in this study also evidenced more absolute and relative slower activity (in theta band). The patients with pain who were taking centrally acting medications showed the same pattern of findings as those with pain who were not taking any medications, although the differences between these (medication-taking) patients and the otherwise healthy participants were less pronounced than those between the controls and patients with pain who were not taking medications. Of interest, following the C-'LT, which resulted in pain decreases, the patients' EEG patterns, including the differences in theta bands, normalized after 12 months. The authors of this study hypothesized that the EEG differences found may have been the result of a thalamocortical effects (i.e.. postulated increased thalamus theta activity resulting from decreased input into the thalamus. which then contributes to an increase in theta activity throughout the cortex).

These findings were replicated in a second sample of patients with chronic neuropathic pain who were also candidates for a CLT (Stem, Jeanmonod. & Sarnthein. 2006). In this second study, the patients with neuropathic pain were found to have higher levels of both theta (6-9Hz) and beta il2-16Hz) activity relative to healthy controls. Also, and consistent with the findings of Sarnthein ct al. (2006), successful treatment with a CLT resulted in gradual decreases in EEG activity in the theta and beta range over the course of 12 months. The authors concluded that the "spontaneous, ongoing, frequency-specific over-activations may... serve as an anatomo-physiological hallmark of the processes underlying chronic neurogenic pain" (Stern et al.. 2006. p. 721).

A more recent study compared EEG- assessed cortical activity in three groups: (a) patients with spinal cord injury and chronic pain (/? — 8), (b) patients with spinal cord injury without pain (w = 8), and (c) healthy controls (n = 16: Boord et al., 2008). Consistent with the finding from both Stern et al. (2006) and Sarnthein et al. (2006), these investigators found that the peak activity in the chronic pain sample was in the theta range, on average, whereas peak activity in the nonpain samples was in the alpha range. Similar to the findings of Sarnthein et al., Boord et al. reported that the use of centrally

acting medications among the patients with pain was associated with some differences in EEG activity, relative to those who were not taking medications, such that EEG activity in those taking medications was shifted a little in the direction of activity that was a little more like those without pain. However, this effect occurred at only 3 (P3, P7. and Pz) of 14 assessment sites. Also, overall, the differences observed between those with and without pain were found over *many* sites, suggesting a diffuse effect of pain and raising the question of whether some cortical areas may contribute more or less to the differences found than others.

NEUROFEEDBACK TRAINING AND PAIN RELIEF

Based on the evidence showing that EEG activity is linked to the experience of pain, it is possible that neurofeedback training could be used to Leach patients to increase or decrease relative power of different EEG band widths as a way to treat chronic pain, specifically to alter brain activity in such a way that it reflects the EEG activity that has been shown to be associated with less pain (Batty. Bonnington, Tang. Hawken. & Gruzclier, 2006; Egner. Strawson, & Gruzclier. 2002; Vernon et al., 2003). Preliminary evidence is consistent with this hypothesis (see Table 1).

One case study, one laboratory study, and a case series were published in the 1970s that address this hypothesis. In the first of these. Gannon and Sternbach (1971) developed a procedure for training alpha activity (measured from the occipital region) in a patient with 3-year history of severe headaches following multiple head traumas. After a little more than 32 hr of training (sixty-seven 29-min sessions), and during no-headache periods, the patient was able to increase his alpha activity from 20% to 92% of the time with eyes closed. He was also able to increase alpha activity to 50%i of the time with eyes open, supporting the efficacy of EEG biofeedback training for making changes in bandwidth activity. However, when he began training during a headache period, lie was unable to concentrate enough to increase alpha activity the headache appeared to interfere with his ability to generate alpha. On the other hand, the intensity and duration of headaches did decrease gradually over the course of treatment for this patient. The patient also reported that after the first 20 sessions, he had a larger attention span and was able to read for 30min without getting a headache (whereas prior to treatment. reading for 15 min induced a headache). Also, following 50 treatment sessions, other activities that prior to treatment induced a headache (swimming, attending concerts) no longer did so.

Andrcychuk and Skriver (1975) treated 33 individuals with migraine headaches with 10 sessions of one of three treatments: hand- warming biofeedback, autogenic relaxation instructions, and alpha enhancement feedback. EEG activity for the alpha (8 13 Hz) enhancement feedback was assessed via bipolar measurement from electrodes placed over the right and left occipital areas, using the right ear as a common ground. Thirty min of training, provided in two 15-min blocks, were provided al each session. Participants in all three treatment conditions, including those in the alpha enhancement group, reported significant reductions in headache rates, and there were no significant differences in improvement between the treatment conditions.

Melzack and Perry (1975) recruited 24 patients with a number of different chronic pain conditions (including back pain [// = 10], peripheral nerve injury pain [/> = 4J. and pain from cancer [/i = 3J, among other chronic pain conditions) and provided them with both self-hypnosis and alpha enhancement training (12 participants), hypnosis training alone (6 participants), or alpha enhancement training alone (6 participants). Alpha bandwidth activity and subjective measures of pain were assessed before and after each treatment session. They found larger pre- lo possession decreases in pain (as measured by the MeGill Pain Questionnaire, which assesses different pain qualities and scores them into Sensory and Affective subscales) during training for those participants who received both hypnosis and neurofeedback

TABLE 1. Summary of findings from neurofeedback studies of chronic pain.

Author (Date); Type of Pain	Type of Study	*N*-. No. of Sessions	Electrode Placement	Bandwidth(s) Reinforced	Bandwldth(s) Inhibited	Findings
Gannon & Sternbach (1971); Headache following multiple head injuries.	Case report	N— 1 ; 67 29" sessions	Occipital region. right side	Alpha (9-11 Hz)	None	Treatment resulted in increases in eyes open alpha, although the patient was un-able to generate alpha during a headache. Intensity and duration of headaches decreased from pre- to post-treatment. - After 20 sessions, the patient reported an increase in attention span, and after 50 sessions, that he was able to attend a rock concert and swim without developing a headache.
Andreychuk & Skriver (1975); Migraine headache	Treatment comparison (alpha enhancement [*=11]. hand-warming biofeedback [n=11]. autogenic training *[n*= 11})	*N*= 33; 10 sessions (that included 2 15" training sessions each)	Occipital region, right and left sides	Alpha (8-13 Hz)	None	-Participants receiving alpha enhancement training reported significant reductions in headache rates, as did participants in the other two treatment conditions.
Melzack & Perry (1975); Mixed chronic pain conditions	Treatment comparison (alpha enhancement alone *[n*=6]. hypnosis alone *[n* = 6], both treatments [n=12]).	*N* = 24; 8 20" sessions	Occipital	Alpha (specific frequen cies not specified)	None	- Participants receiving both neurofeedback and hypnosis reported larger pre- to post-sessions decreases in pain than those that received only one treatment.

Cohen et al. (1980); Migraine headache	Treatment comparison (forehead cooling/hand warming bio-feedback [n=11]. frontalis EMG biofeedback [n=11]. temporal artery vaso-constriction biofeedback (n 10]. alpha enhancement neurofeed-back [n-10]).	N= 15; 40 or more sessions	02 and P4
Caro & Winter (2001); Fibromyalgia	Case series N- 42; 24 20" sessions		CZ
	Case study		
Sime (2004); Trigeminal neuralgia		neurofeed-back preceded & followed by EMG/ respe ration	biofeedba ck. Multiple sites used, including T4-A2, C3-A1,
N~ 1; 29 sessions of			

C4-A2.
C3-C4. &
T3-T4.

Alpha (8-13 Hz)	None	- All participants reported reductions in the number of headaches per week; no between-group differences found. - No changes in headache intensity or duration found. - No changes in alpha activity observed in the neurofeedback group.
SMR (12-15 Hz)	4-7 Hz and 22-30 Hz	- Participants demonstrated significant improvements in attention. - There was a strong association between improvement In attention and a decrease (improvement) In the mean tender pain assessment score, and a moderate association between improvement in attention and decrease (improvement) in fatigue.
Variable, including 7.5-10.5 Hz, 12-15 Hz. 7-10 Hz, 11-14 Hz. 8.5-11.5 Hz.	2-7 Hz and 22-30 Hz	-Training using T3-T4 sites (7.5-10.5 Hz reword. 2 7 and 22-30 Hz inhibit) resulted in the greatest pre- to postsession pain reductions. -The participant reported reductions in pain and improvement in sleep quality -Benefits were maintained at 13-month follow-up.

(Continued)

TABLE 1 (continued)

Author (Date); Type of Pain	Type of Study	Af; No. of Sessions	Electrode Placement	Bandwidth(s) Reinforced	Bandwidth(s) Inhibited	Findings
Jensen et al. (2007); Complex regional pain syndrome - Type 1	Case series	A/-18; analyses focused on pre- to postsession changes.	Multiple sites used. including P3-P4. FP1-FP2, T3-T4. FP02-A2. CZ-FZ. F7-F8.	Variable, ranging from 0-3 Hz to 14-17 Hz.	Not specified	- Significant pre- to postsession improvements were found on patient ratings of pain intensity (at the primary, secondary, and tertiary pain sites), muscle spasm, muscle tension, and global well-being.
Kayran et al. (2007); Fibromyalgia	Case series	*N* 3; 10 30" sessions	C4	SMR (12-15 Hz)	Theta	- All three participants reported significant pre- to posttreatment decreases in pain intensity. tatigue, depression, and anxiety. -The participants showed variability in changes in EEG activity; one showed minimal changes and two showed substantial decreases in theta activity

training than in participants who received only one type of training. Moreover, although participants in both of the neurofeedback conditions showed an increase in alpha output, those who received both hypnosis and neurofeedback demonstrated the most increase in alpha output over the course of treatment, whereas those who received neurofeedback training only demonstrated the most increase in pre- to post*session* alpha output.

Cohen, McArthur, and Rickles (1980) assigned 42 patients presenting with migraine headache to 24 sessions (over the course of 8-10 weeks) of one of four biofeedback conditions: (a) forehead cooling/hand warming. (b) frontalis EMG reduction, (c) temporal artery vasoconstriction, and (d) alpha enhancement. Alpha EEG activity (8—13 Hz) was measured from 02 and P4. with feedback provided as tone-off (alpha above threshold with the threshold adjusted according to performance) or tone-on (alpha below threshold). All of the participants reported a significant reduction in the number of headaches per week, although there were no changes in the intensity or duration of headaches that did occur, nor were there any significant changes in alpha activity from pre- to posttreatment in participants in the neurofeedback group.

Caro and Winter (2001) provided 15 patients with fibromyalgia 40 or more sessions of sensorimotor rhythm (SMR) training (reinforcing 12 151Tz and inhibiting 4 7Hz and 22 30 Hz). The study participants evidenced significant improvement in a visual test of attention (TOVA scores), and there was a strong association between improvements in attention and improvements (decreases) in physician-assessed tender point scores (e.g.. rs — —.64, -.85, and -.69 for the associations between the TOVA ADHD, Commission Errors, and D Prime scores and the tender point score, respectively). Weak to moderate correlations (rs=-.29. -.46. and .16. respectively) were also found between the TOVA scores and patient ratings of fatigue.

Sime (2004) presented a case report of a patient with trigeminal neuralgia treated with both neurofeedback (29 sessions) and peripheral biofeedback (10 sessions). The electrode placement and bandwidths reinforced varied as treatment progressed and included training at T4-A2, C3-A1, C4-A2. C3-C4. and T3-T4. The bandwidths reinforced also varied, although 2-7 Hz and 22 301 Iz were consistently inhibited in each session. Sime reported that rewarding low alpha (e.g.. 7.5 10.5 Hz) measured from T3-T4 was associated with the most immediate improvements in pain. Following treatment. the patient chose to avoid a planned surgery (severing the trigeminal nerve) for pain treatment and discontinued the use of an opioid/acetaminophen combination analgesic. Moreover, the benefits of treatment were maintained in this patient at a 13-month follow-up assessment.

We recently reported our experience in a retrospective analysis of 18 patients with CRPS-1 who had been given neurofeedback training as part of a muitidisciplinary pain treatment program (Jensen. Gricrson. Tracy-Smith, Bacigalupi, & Othmer, 2007). In the study, participants 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 (e.g., muscle tension), before and after a 30-min neurofeedback training session. The specific neurofeedback training used varied from patient to patient and from session to session, depending on the needs of the patient and goals of each treatment session. Self-reported changes in symptoms were statistically compared using a series of r tests. Across the different treatment protocols, a substantial and statistically significant pre- to postsession decrease in pain intensity at the primary pain site (from an average intensity of 5.2 to 3.2 on a 0 10 scale) was reported, with half of the study participants reporting changes in pain intensity that were clinically meaningful (30% or greater). Five of seven secondary outcome measures also showed statistically significant improvements following neurofeedback treatment. These included pain at secondary and tertiary sites, muscle spasm, muscle tension, and global well-being.

Finally. Kayran and colleagues (Kayran. Dursun, Ermutlu. Dursun. & Karamursel. 2007) described a ease series of 3 individuals

with fibromyalgia who were given ten 30-min sessions ofSMR (12-15 Hz activity) training. During training, EEG was assessed from C4, and SMR activity was reinforced and theta activity was inhibited. Each participant reported decreases in pain (absolute pre- to posttreatment intensity rating decreases were 4.0, 1.5. and 3.0 on a 0-10 numerical scale), fatigue, depression, anxiety. However, the 3 participants also showed variability in pre- to posttreatment changes in EEG activity. One participant showed minimal changes in SMR activity, theta activity, or the theta/ SMR ratio. The other 2 participants show no or minimal changes in SMR activity but substantial decreases in theta activity (and therefore associated decreases in the theta/ SMR ratio).

As a group, the case and case series reports suggest that neurofeedback training may be associated with decreases in pain and improvement in other symptoms (such as depression and anxiety). Although controlled trials comparing neurofeedback to no treatment (standard care) or placebo treatment have not yet been performed, at least three studies have compared neurofeedback to other established treatments (e.g., hand-warming biofeedback, EMG biofeedback, hypnotic analgesia; Andrcychuk & Skriver, 1975; Cohen et al., 1980*; Melzaek & Perry-, 1975). In each of these studies, the neurofeedback intervention was shown to be at least as as effective as the comparison treatments. When specified, the goal of the neurofeedback training in the published studies has most often been to increase relative alpha activity, although treatment protocols were also sometimes developed to decrease theta and increase in SMR (12-15 Hz) activity. Beta activity was rarely directly targeted, and when it was, the goal was to decrease this activity.

OTHER TREATMENTS THAT ALTER EEG ACTIVITY ALSO PRODUCE CHANGES IN CHRONIC PAIN

Cortical Stimulation

If cortical activity is related to the experience of pain, then any intervention that alters cortical activity has the potential to impact the experience of pain. Recent data studying the effects of cortical stimulation for this purpose are promising. There are several techniques to stimulate cortical areas such as invasive (epidural cortical stimulation) and noninvasive approaches using TMS or transcranial direct current stimulation (tDCS). It is also possible to implant electrodes in deep areas such as periventricular/ peraqueductal gray matter, internal capsule, and sensory thalamus, and stimulation of these areas has shown promising results for chronic pain management (Green et al., 2005; Wallace, Ashkan, & Benabid. 2004).

Although there have been some promising results using deep brain stimulation, the more common approach is the stimulation of motor cortex. The rationale here is that stimulation of the motor cortex can inhibit pain relays in the thalamus (perhaps by impacting thalamocortical dysrythmia). In fact, investigators have studied the efficacy of electrical stimulation applied directly to the motor strip of the cortex via surgically implanted electrodes and have demonstrated 28% to 47% reductions in pain intensity in patients with chronic pain who have received this procedure (Nguyen et al., 1999; Nuti et al., 2005).

However, in addition to the elevated costs, surgical implantation and maintenance of electrodes inside the brain carry substantial risks. Noninvasive brain stimulation techniques can be used instead of invasive ones to address these risks. One such procedure, already mentioned, is rTMS. with which pulses of electromagnetic currents are used to induce electric currents inside the skull. Depending on the stimulation frequency and amplitude, rTMS can stimulate or inhibit activity a focal cortical area. A number of studies have found at least temporary decreases in pain experience in chronic pain sufferers following rTMS applied using inhibitory frequencies to the motor cortex (Lefaucheur. Drouot, Keravel. & Nguyen. 2001; Pleger et al., 2004). Unfortunately. rTMS equipment is expensive and lacks portability, making it less practical than other approaches. In addition, depending on the intensity of stimulation, rTMS can

be uncomfortable and the procedure is difficult to administer in a blinded fashion. Finally, rTMS induces a strong electric current in the brain that results in action potentials. It is still unclear whether supra- threshold stimulation is the best approach to modulate conical activity.

Another noninvasive technique studied is tDCS. In tDCS. very weak electrical currents (1 to 2 mA) are applied directly onto the scalp via one of two electrodes. Most often, the active electrode is placed over a site of interest, and the other electrode is placed on the contralateral side of the forehead or at an extracephalic area. There is evidence that corneal activity under the scalp where a positive electrode (anode) is placed increases, and activity under a negative electrode (cathode) decreases (Antal. Nitsche, & Paulus. 2001; Nitsche & Paulus, 2001). Additional modeling studies suggest functionally significant amount of electric current may reach the cortex from appropriately large electrodes suitably placed (Miranda. Lomarev. & ITallett. 2006: Wagner et al., 2007). tDCS has promise over the other available stimulation techniques in that (a) it does not require implantation of invasive hardware: (b) it is easy to apply; (c) the tDCS equipment is inexpensive and easy to maintain: (d) given the very low currents involved, active tDCS is very difficult to detect by patients (making a sham-stimulation condition in clinical trials possible); and (e) some evidence suggests that the modulatory effects of tDCS may be stronger than r'lMS (Nitsche & Paulus, 2001). Finally tDCS has an interesting advantage as it modulates spontaneous neuronal firing via modulation of resting membrane potential; therefore, this technique may be suitable to enhance learning effects associated with behavioral tasks. In the context of pain treatment. it is possible to envision the use of tDCS coupled with cognitive restructuring therapy or self-hypnosis training, which might work synergistically to enhance overall treatment effects.

Evidence suggests that tDCS holds promise for treating chronic refractory spinal cord injury pain. Fregni and colleagues randomized 17 patients with spinal cord injury and chronic pain to receive sham or active motor cortex tDCS (2 mA, 20min each. 5 consecutive days; Fregni, Boggio, et al.. 2006). They found (a) a significant reduction in pain intensity ratings after active anodal (positive electrode) stimulation of the primary motor cortex in the active, but not the sham, condition; (b) the reductions in pain intensity following each session lasted at least 24 hr until the next treatment session: and (c) there was a cumulative analgesia effect with multiple treatments, such that each treatment produced further reductions in pain from one day to the next. After 5 days of tDCS, average pain scores decreased more than 50% from baseline (6.2/10 to 2.9/10) in the active group, whereas they actually increased slightly, on average, in the sham group.

In another study of 32 patients with fibromyalgia randomly assigned to receive active or sham stimulation over the motor cortex or dorsolateral prefrontal cortex, significant benefits were found only for active tDCS over the motor cortex (Fregni, Gimenes. et al., 2006). This second study supports not only the specificity of tDCS over placebo effects but also the specificity of site placement for the effects of tDCS. However, the extent to which effective tDCS treatment is associated with changes in EEG has not yet been examined.

Hypnosis

Controlled trials, published over the past decade, have demonstrated that hypnosis training can result in reductions in the severity of both acute and chronic pain (Montgomery. DuHamel, & Redd, 2000; Patterson & Jensen, 2003). Moreover, self-hypnosis training in persons with chronic pain appears to have two primary effects: a short-term reduction in chronic pain that occurs during the treatment session or hypnosis practice that lasts for several hours in about 70% of persons with chronic pain, and a longer term permanent reduction in baseline daily pain, experienced by a smaller subset (about 25%) of patients (Jensen. Barber, et al., 2008).

PET and fMRI studies show that the effects of hypnotic analgesia are "real." in

the sense that hypnosis with suggestions lor analgesia produces reliable reductions in activity in the sensory cortex and other areas of the brain that are associated with the experience of pain and are known to process nociceptive information (Hofbauer, Rainville. Duncan. & Bushnell. 2001; Rainville, Duncan. Price, Carrier. & Bushnell. 1997). However, imaging research has not identified a mechanism for the effects of hypnotic analgesia, as it is possible that the observed changes in cortical activity could be due to a number of factors (e.g.. increase control over subsystems that process nociception, distraction).

A relatively large number of studies have examined the EF.G correlates of hypnosis. Two of the consistent findings from this literature are (a) more highly hypnotizable individuals tend to show greater slow wave (theta and alpha) activity than less hypnotizable individuals, both at baseline (i.e., before hypnotic inductions) and during hypnosis, and (b) hypnotizable, and especially high hypnotizable, persons show an increase in slow wave t'theta and alpha) activity following hypnotic inductions (Crawford, 1990; Williams & Gruzelier. 2001). These findings are consistent with the possibility that the presence of slow wave EEG activity patterns is correlated with the effects of hypnosis on pain. Also, in one study, neurofeedback training to increase both theta (4-7.5 Hz) and alpha (8 12 Hz) activity, as well as the theta/alpha ratio, was shown to increase responsivity to hypnotic suggestions, providing further support for a possible impact of hypnosis on EEG-assessed bandwidth activity (Batty ct al., 2006). These findings, when considered in light of the fact that the majority (about 70%) of persons who receive hypnosis report decreases in pain, are consistent With the possibility (not yet adequately tested, however) that hypnosis's effects on pain might be directly associated with in EEG-assessed cortical rhythms; specifically because of the relative increases in the slow wave activity that accompanies hypnosis (Williams & Gruzelier, 2001). Of course, even if consistent associations between specific cortical rhythms (e.g.. less beta and/or theta and more alpha) and pain relief arc found, this could not be used as evidence proving that changes in cortical rhythms mediate the impact of some treatments on pain experience. Such evidence must come from experimental studies in which cortical rhythms are systematically altered (perhaps through the use of targeted neurofeedback protocols) in some patients and not others, to determine if changes in certain specific rhythms lead to changes in pain experience. Another important point that needs to be considered is that pain may inhibit an individual's ability to be hypnotized, as it is possible that in some patients, the cortical activity associated with chronic pain could inhibit some of the necessary conditions for hypnosis.

SUMMARY AM) IMPLICATIONS OF RESEARCH ON THE ASSOCIATIONS BETWEEN PAIN AND NEUROPHYSIOLOGY

Research performed over the past decades has confirmed that the brain is not a passive recipient of nociceptive information, but modulates and is itself influenced by nociceptive input. The central sensitization that can occur in the CMS with ongoing nociception, and that can contribute to ongoing pain, could also potentially be reversed or interrupted with interventions that alter pain- related cortical functioning. This possibility provides a rationale for the use of interventions that target pain modulation at the level of t he cortex, including nonpharmacological novel interventions that could potentially benefit patients with chronic refractory pain and with the additional advantage of being a more specific and focal treatment. Indeed, there has been a dramatic increase in interest in such treatments in recent years.

Recent, albeit preliminary, research suggests that the cortical modulation of chronic pain may be reflected in EEG bandwidth activity, such that chronic pain relief is associated with a relative increase in alpha activity and a relative decrease in beta. Research also suggests that increased theta activity may be associated with some chronic neuropathic pain conditions. However, further research

is still necessary- to confirm the specific EEG >ignature(s) of chronic pain.

Our understanding of the associations between EEG activity and pain is just beginning; much more research is needed to determine which EEG activity patterns, if any, are consistently associated with the experience of chronic pain. However, if future research supports the relationships that preliminary research suggests exist, this research could provide an empirical basis for designing interventions that target brain activity for pain management (such as a neurofeedback) •r be used to guide parameters of stimulation when using tDCS.

NEUROFEEDBACK TREATMENT APPROACHES FOR CHRONIC PAIN MANAGEMENT

l'his section provides some suggestions regarding how one might utilize neurofeedback in the treatment of chronic pain, based :n large part on the literature review just presented. However, it is also important for the clinician to keep in mind that, because •f the lack of controlled studies, no single protocol or neurofeedback approach has proven efficacy lor pain management at this point in time.

In general, an increase in relative rnagni- :udc alpha frequency band (generally defined as 8-12 Hz) is thought to reflect decreases cortical "activation" or directed active engagement. For example, the alpha band has been shown to be associated with an alert vet idle state, or more simply stated, cortical receptivity (Sherlin, 2008). Conversely an increase in relative magnitude beta frequency (generally described as 13-32 Hz) is thought to reflect increased active (dircc- :ed) cortical engagement. We can therefore hypothesize that if the cortical areas associated with the processing of pain can be conditioned to produce decreases in cortical arousal and increases passive receptivity (through decreasing beta and/or increasing dlpha relative magnitude), then the experience of pain may decrease.

The setup required for protocols that would increase relative magnitude alpha and decrease relative magnitude beta is easy using most software and hardware systems currently available for neurofeedback application!.. However, questions may be raised concerning the ideal or most practical electrode placement. Two placement protocols that have been described are (a) a T3-T4 sequential montage (i.e., bipolar montage; Sime, 2004) and (2) a C4 placement (Kayran et al.. 2007). Although Sime reported an immediate beneficial effect of training using the T3-T4 montage placement, there is the possibility that this protocol could reduce the alpha magnitude and increase the relative beta magnitude at the referential site to achieve the training objective (e.g.. T3 active minus T4 reference activity).

An additional important knowledge gap in the field that should be recognized is also related to the issue of electrode placement. Alpha frequency activity can be enhanced globally or regionally. Moreover, global and regional changes in bandwidth activity can influence each other and are probably (somehow) related. For example. T3/T4 alpha is likely driven by occipital alpha, which may have something to do with alert relaxation. C3/C4 for frontal alpha, on the other hand, is probably an enhanced Mu rhythm, which can also be achieved by relaxing hand muscles. One can make similar arguments about regional and global influences on beta or gamma bands. More research is needed to determine how comorbidities in the pain patient influence global brain patterns. In the meantime, and until our knowledge concerning these potential mutual influences is increased, or research demonstrates the superiority of one placement over another, it might make sense for clinicians to compare different options (e.g.. T3-T4 vs. C4 vs. other possible sites) in the same patient, and then use the placement that results in the most benefit for that individual patient.

Some recent studies have also identified the dorsal anterior cingulate cortcx (dACC: Brodmann Area 24) as critical in the affective experience of pain (e.g., Rainvillect al.. 1997). Recent advanced ncuro-/fMRl-feedback techniques have targeted this location. One study, for example, used fMRl feedback to

demonstrate how the ongoing experience of pain may be modulated by training participants to modify dACC activation accessed via real-time fMRI (DcCharms ct al., 2005). Tn another study, an advanced cortically targeted neurofeedback technique called Standardized Low Resolution Electromagnetic Tomography (or s LOR ETA) targeted this same region with similar results (Ozier. Whelton. Mueller, Lampman. & Sherlin. 2008). Although such advanced feedback techniques are not available to most practitioners. one may postulate targeting the same areas using conventional neurofeedback with a single channel at approximately FZ or just anterior to FZ. or alternatively with two channel referential montage of electrode sites F1 and F2 as active sites. The training goal would be to increase the relative magnitude alpha while decreasing/inhibiting relative magnitude beta in the ACC. The clinician should closely monitor client progress of the training, and particularly focus the client on being able to identify and replicate any state of comfort achieved during training at home, when pain levels are perceived as particularly high.

Although the goal of these protocols is to teach the client to identify and utilize a state of increased alpha and decreased beta for the control of pain, there is also a potential risk that if the client increases the overall (baseline) alpha and decreased beta relative magnitude, he or she could potentially suffer cognitive deficits (Chabot & Serfontein. 2006). However, we have yet to notice this possible side effect in the individuals we have treated using this approach for pain management. Nevertheless, this possibility should be carefully monitored in participants in any neurofeedback training protocol.

As previously noted, in individuals with spinal cord injury and chronic pain, there is evidence for decreased alpha and increased theta frequency band relative magnitude peak, relative to individuals with spinal cord injury who do not have chronic pain. For these patients, a potential goal of treatment would be to shift the peak frequency from the theta frequency band range to the alpha frequency band range to determine if this is associated with improvements in pain. However, the neurofeedback protocol to achieve this goal would be quite similar to that used for increasing alpha and decreasing beta band activity, as both involve increasing alpha. A shift in peak frequency band can be achieved, and has been demonstrated in a variety of populations in our clinical experience, although in our work it has primarily been applied to increase cognitive processing speed and thalamic processing of incoming cortical and sensory information.

The application of this model for neurofeedback training would be very similar to that used in the previously cited study addressing the occipital region (Gannon & Sternbach, 1971). That is. the peak frequency is first identified in both baseline conditions of eyes closed and eyes open in the occipital region. This allows the clinician a very easily detectable and testable hypothesis in determining if this protocol might be potentially useful. In our clinical experience the best electrode placement for this purpose is along the midline in the parietal and occipital region. Typically we choose the active electrode site of POZ referenced to the ear (or other neutral site such as nose) for the eyes open condition; if training in the eyes closed condition we either use site OZ or a two-channel referential montage using sites Ol and 02. The protocol goal here again is to increase the alpha frequency relative magnitude, with the difference that with this protocol, we now inhibit both the beta frequency relative magnitude and the theta frequency relative magnitude.

CONCLUSION

Chronic pain is a significant health problem for many individuals that is not being adequately addressed with the treatments that are currently available (Turk, 2002). Moreover, the available pharmacologic treatments that tend to be used for chronic pain are often associated with significant adverse effects (e.g., opioids can lead to tolerance, constipation, and altered mental states). The understanding that pain experience is modulated at many levels of the CNS, including the cortex, opens the door to interventions that might affect pain at the cortical level, and that may not have as many negative side

effects produced by analgesics. Clinicians knowledgeable in neurofeedback approaches might consider opening their practices to patients with chronic pain and then reporting to the community the outcomes of their clinical work in the form of published case studies and case series. This sharing of clinical experience provides an important foundation for hypothesis generation, which would then contribute to the design and implementation of more definitive clinical trials. Ultimately, the results of such work would help us to understand the extent to which neurofeedback benefits individuals with chronic pain, and if it does, the specific interventions, protocols. and approaches that are most effective.

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Alpha Neurofeedback Training for Performance Enhancement: Reviewing the Methodology

D. Vernon. PhD T. Dempster. BSc O. Bazanova, PhD N. Ruttcrford. PhD M. Pasqualini. PhD S. Andersen, PhD

ABSTRACT. *Introduction.* Considerable interest has been, and still is, generated by the potential performance enhancing benefits of alpha neurofeedback training (NFT) for healthy participants. A plausible rationale for such training, with an aim to improve mood and/or enhance cognition, can be made based upon what is already known of the links between alpha EF.G activity and behavior. However, designing an optimal NFT paradigm remains difficult because a number of methodological factors that may influence the outcome of such training remain largely unexplored.

.*Method.* This article focuses on these methodological factors in an attempt to highlight some of the unanswered questions and stimulate future research.

Results. Specifically, this article examines the NFI training schedule; the variety, basis, and setting of reward thresholds; the nature and modality of the feedback signal provided: unidirectional as compared to bidirectional NFT; the establishment of a target frequency range for alpha: whet her NFT should be conducted with eyes open or closed; and the identification of a clear index of learning.

Conclusions. Throughout, the article provides a number of suggestions and possible directions for future research.

KEYWORDS. Alpha. LEG, methodology, neurofeedback, peak performance

D. Vernon is affiliated with the Department of Applied Social Scienccs, Canterbury Christ Church University. T. Dempster is affiliated with the Department of Applied Social Scicnccs, Canterbury Christ Church University. O. Baza nova is affiliated with the State Research Institute of Molecular Biology and Biophysics. Siberian Branch, Russian Academy of Medical Science.

N. Rutterford is affiliated with the Department of Psychology, Anglia Ruskin University. M. Pasqualini is affiliated with the Department of Psychology. Avila University. S. Andersen is affiliated with the Department of Psychology, Swansea University.

Address correspondence to: D. Vernon, PhD. Department of Applied Social Sciences, Canterbury Christ Church University. Canterbury, Kent, CTllQU, United Kingdom (E-mail: david.vernon@canterbury.ac.uk).

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INTRODUCTION

Ever since Kamiya (1968) suggested that it was possible lor healthy individuals to perceive and obtain a degree of conscious control over the production of their own alpha brainwave activity and that this in turn may influence their behavior, there has been interest in the potential performance enhancing applications of neurofeedback training (NET; see e.g.. Gruzelier, Egner, & Vernon. 2006; Vernon, 2005; Vernon & Gruzelier. 2008). However, the potential performance enhancing benefits of NFT remain unclear because a number of methodological factors that may impact the effectiveness of such training are unexplored. Hence, this article explores the research to date in an effort to provide some useful insights into developing more effective NFT procedures, which in turn may offer guidance and stimulate additional research.

NFT, also referred to as electroencephalographie (EEG) biofeedback and brain- computer

interface training, is often defined as an operant conditioning paradigm based on a sophisticated form of biofeedback (Vernon, 2009). The aim is to provide the individual with explicit information regarding specific aspects of his cortical activity in an easy-to-understand format and in doing so encourage him to alter particular target components, such as amplitude or frequency. Outside of the clinical arena alpha NFT has been aimed at relieving anxiety or improving mood (e.g., Moore, 2000: Norris, Lee, Burshteyn, & Cea-Aravena, 2001: Putman. 2000) and/or enhancing cognition (e.g., Angelakis ct al.. 2007: Bazanova & Aftanas, 2006; Bazanova, Mernaya. & Shtark. 2009; Hanslmayr, Sauseng, Doppclmayr. Schabus, & Kiimesch, 2005).

The rationale for undertaking alpha NFT to alleviate anxiety and enhance mood is based originally on research showing that individuals in meditative states exhibited increased amplitude alpha activity along with greater levels of relaxation (Kasamatsu & Hirai, 1969). Such findings have been replicated a number of times with researchers showing that advanced meditative practitioners, that is. those with more than 10.000hr of practice, exhibited elevated levels of alpha activity compared to nonme- ditating controls (Aftanas & Golocheiminc, 2005; Herbert & Tan, 2004; for a review see Cahn & Polich, 2006). Furthermore, Singer (2005) reported that enhancing 11 16 Hz, which overlaps with the upper alpha range, led to a reduction in the level of anxiety for healthy dancers. Not all. however, have found that alterations in mood are reflected by concomitant changes in alpha activity. For instance. Frost, Burish, and Holmes (1978) reported that induced stress, which elicited changes in pulse rate and skin conductance levels, failed to produce any changes in alpha activity. Such findings have led to suggestions that alpha is not sensitive to changes in stress and/or arousal and as such alpha NFT would be expected to have little or no effect. Indeed, Potolicchio, Zukerman. and Chernigovskaya (1979) found no changes in mood, as measured by the Profile of Mood States questionnaire, for those showing increases in alpha as a function of alpha NFT. In addition. Holmes, Burish, and Frost (1980) found that alpha NFT was ineffective in helping participants decrease their levels of arousal during a stressful situation, and Hardt and Kamiya (1978) reported that alpha enhancement training was associated with reduction in state anxiety but only for high trail anxiety participants. These conflicting findings have been suggested to result from methodological differences, particularly in terms of level and measures of anxiety, measurement of the EEG as well as sensor placement across the scalp (see Moore, 2000). As such, the notion that alpha NFT can enhance the mood of healthy individuals has yet to be firmly established.

In terms of cognition, it may have been the case that alpha was originally viewed as the idling rhythm of the brain (Adrian & Matthews, 1934). An alternative model is that alpha works in a top-down fashion (von Stein & Sarnthein, 2000) to actively inhibit nonessential or conflicting processes within the brain, thereby increasing the signal to noise ratio and improving efficiency (Cooper. Croft, Dominey, Burgess, & Gruzelier. 2003; Kiimesch. Doppelmayr,

Rohm. Pollhuber, & Stadlcr, 2000). According to the *neural efficiency hypothesis* (e.g., Doppclmavr, KJimcsch, Hodlmoser, Sauscng, & Grubcr, 2005; Haicr ct al., 1988), effective cognition is not a function of how *hard* the brain works but rather how *efficiently* it works. Thus, if alpha makes completion of a task more efficient by inhibiting nonessential processing, then a greater level of available alpha may enable the individual to inhibit more nonessential activity, which in turn may facilitate performance on the task. Although speculative, this idea is supported by research showing that people classified as more intelligent exhibit greater levels of alpha power compared to those with average levels of intelligence (Anokhin & Vogel. 1996; Doppelmayr et al., 2005; Jausovec, 1996). Jausovec suggested that this is because the intellectually competent, or gifted, individuals activate only the task relevant areas of the brain in a more focused manner, whereas those classified as intellectually average may activate nonessential task irrelevant areas when attempting to complete a task, which in turn interferes with their ability to complete the task. Additional support for this idea comes from Doppelmayr ct al.. who found that during a particularly difficult semantic processing task participants with higher intelligence exhibited a larger reduction in alpha power over their left hemisphere relative to those with lower intelligence. This was taken to indicate that the more intelligent participants recruited a wider range of conical processes to complete the difficult task. Taken together, results from these studies appear to show that people with higher levels of resting alpha power may be able to actively inhibit irrelevant processes, or not, depending on the needs of the task.

Of course such findings are associative, in the sense that changes in behavior have been associated with alterations in psycho- physiology, and as such caution should be exercised to ensure that such findings are not overinterpreted. Nevertheless, there are some intriguing findings which suggest that the changes in alpha may be more causal than correlational. The first focuses on how modifications in alpha can elicit changes in behavior (Bazanova, Verevkin, & Shtark, 2007; Hanslmayr ct al., 2005; Klimesch, Sauseng, & Gerloff. 2003), and the second shows that changes in behavior can produce changes in the alpha component of the EEG (Fink. Grabner, Benedek, & Neubauer, 2006). For example, Klimesch et al. (2003) showed that inducing the upper individual alpha frequency range using repetitive transcranial magnetic stimulation elicited a change in the EEG in line with the stimulation. that is, an increase in upper-alpha power, and was associated with improved performance on a mental rotation task. Hanslmayr et al. (2005) extended this work to show that NFT to enhance upper alpha also led to increased alpha power for some of those undergoing the training. In addition, they reported a clear link between those who were able to increase the power of their upper alpha activity and improved performance on a mental rotation task. Bazanova et al. (2007) have also found that musicians undergoing NFT to enhance their upper alpha were able to show clear changes in their EEG along with enhanced musical abilities. Such findings are consistent with suggestions that increased alpha is associated with improved performance (Bazanova & Aftanas, 2006; Doppelmayr et al.. 2005). Conversely, Fink et al. (2006) found that a 2-wcck training course in divergent thinking led to an increase in the level and originality of ideas generated and an increase in alpha (8-10 Hz) over the frontal regions. They suggested that the increase seen in frontal alpha may be due to an inhibition of the "critical frontal brain" (p. 2245) needed for the individual to produce more novel and/or uniquely original ideas. Overall, these findings suggest a strong link between alpha and cognition, with increases in alpha, leading to benefits in cognitive processing, and vice versa.

Such findings provide a plausible rationale for alpha NFT, which in addition to the possibility of enhancing performance also represents a useful mechanism for exploring the links between EEG and cognition. However. identifying an optimal training paradigm for NFT remains difficult as many methodological factors have yet to be

systematically investigated. It is a deceptively simple question to ask. What is the best method to ensure an optimal outcome when conducting alpha NET? Not surprising, however, it is tar more difficult to provide a simple unambiguous answer. Of course, it may be that there is no single "optimal paradigm" eliciting beneficial effects for one and all, and it is entirely possible that the best way forward will be to design bespoke NFT procedures tailored specifically to an individuals needs and desires. Nevertheless, exploring the research to date will help to provide useful insights into developing more effective NFT procedures.

Demographic and methodological factors including age (Woodruff, 1975), gender (Nowlis & Kamiya, 1970: Travis. Kondo, & Knott, 1975), use of strategies (Plotkin. 1976), motivation levels (Kondo. Travis. & Knott. 1975), lighting conditions (Cram. Kohlenberg, & Singer. 1977; Paskewitz & Orne, 1973). and montage (Fehmi & Co 11 lira, 2007; Putman. 2001; Roscnfeld. 2000) have been explored elsewhere. Thus, here we focus only on methodological factors that have received relatively little research attention ,ind/or require additional exploration: These include training schedule, reward thresholds, feedback information, unidirectional versus bidirectional training, the frequency range of interest, training with eyes open versus eyes closed, and the index of learning.

METHODOLOGICAL FACTORS \ FT

Schedule

Given that the goal of NFT is to elicit changes in the EEG and thereby alter behavior/cognition, three questions emerge. First, how long should each training session last? Second, how often should participants complete such training sessions? Finally, how many sessions are needed?

In terms of how long the session should last, there are no clear guidelines, and past research has utilized sessions that last from minutes to hours (e.g.. Bauer, 1976; Nowlis & Kamiya. 1970; Prewetl & Adams, 1976; Regestein, Pegrant, Cook, & Bradley, 1973). Some have suggested that very short training sessions lasting for only a few minutes may be insufficient to allow learning to occur (Ancoli & Kamiya, 1978: Plotkin. 1976). Such a proposal is consistent with the work of Travis, Kondo. and Knott (1974), who found that it took between 2 and 3min for participants to produce increments in alpha. However, it is also important to ensure that the duration of the training is not so long that the trainee becomes fatigued and drowsy. Such a possibility could explain the failure of Regestein et al. (1973) to find evidence of changes in alpha following a 4-hr NFT session. Thus, sufficient time needs to be provided lor the trainee to obtain some understanding of the relationship between the feedback and the different states experienced. in order to be able to adopt a strategy that will be useful in helping to alter alpha activity but not so long that it has a deleterious effect on the outcome. Given the success many have shown with sessions of between 20 and 30min. this may be a good place to begin (see, e.g.. Angelakis et al.. 2007: Bazanova et al.. 2007; Fell et al., 2002: Hanslmayr et al., 2005; Norrib et al., 2001). Of course, it may be that the most effective approach is to begin with a short duration session and then increase its length as the trainee becomes more adept. However, there are as yet no data available to help inform this decision.

In terms of how often the NFT should be conducted possible options include the notion that all sessions are given in a single day, or that they are spread out across different days, or over a period of weeks. If NFT is similar to other types of learning (see Bahrick. 20(H)), spacing training out over a period of days and/or weeks should be more effective than training that is massed within a single day. Unfortunately, comparisons of massed versus spaced NFT in the literature have revealed contradictory results. For instance. Albert, Simmons, and Walker (1974) compared the effects of five NFT sessions massed within I day to five sessions completed across 5 separate days. They found that the group receiving the spaced NFT at daily intervals exhibited greater levels of alpha compared to those given the

massed NFT. This led them to suggest that spaced practice, carried out daily, is more effective than massed practice because it allows greater time for rehearsal and adaptation to the setting and equipment. If this is the case, then weekly practice sessions, which would allow the individual even greater time for rehearsal and provide more opportunity to habituate to the setting, could potentially prove to be more beneficial than daily sessions. However, Yamaguchi (1980) reported that massed training delivered in a single day was more effective at increasing alpha compared to NFT delivered on separate days. Yamaguchi found that only those completing the massed NFT exhibited an increase in alpha, whereas those completing the training spaced across three days failed to show any change in their EEG. Yamaguchi suggested that the benefit seen for massed practice may be due to a reliance on insight used during NFT to help discover possible relationships between the feedback and various states of consciousness associated with the production of alpha and that massed practice makes it easier for the individual to obtain such insights. In addition. Yamaguchi noted that methodological differences between his study and the earlier one of Albert et al. (1974) may account for the distinct pattern of effects. As such, it remains unclear at present whether massed or spaced practice is more effective.

The final question regarding the NFT schedule is how many sessions are needed for changes in the EEG to be seen. Some have suggested that multiple sessions are needed for the individual to learn to habituate to the experimental setting and establish the associative relations between modifications in the EEG and changes to internal states (Hardt & Kamiya, 1976a: Konareva, 2005). This is consistent with reports of changes in the EEG following multiple NFT sessions taking place over a period of weeks (e.g., Angelakis et al., 2007; Cho el al., 2008; Norris et al.. 2001). However, others have found changes in the EEG following a single NET session (e.g.. Bazanova et al., 2007; Fell et al., 2002: Hanslmayr et al.. 2005). Furthermore, Bazanova et al. (2007) found that single sessions were more successful for those with an alpha peak frequency of greater than 10 Hz. Hence, it may be the case that success with a particular training schedule is influenced by each individual's alpha range and peak. However, there are many methodological differences between these studies, which makes attempts at cross-comparison difficult. Nevertheless, such findings would suggest that a single session may be sufficient to elicit changes in the EEG via NFT. Of course, such changes may be short lived, and it may be that for longer term effects more sessions would be needed. However, at present there are no data addressing this issue.

Overall, it would seem that a single NFT session lasting for between 20 and 30min should be sufficient to ensure that short-term changes occur in the EEG. However, for longer term and/or permanent changes to occur more sessions may be needed, although whether it would be more effective if such sessions were spaced out or massed together remains to be seen.

Reward Threshold

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The reward threshold refers to the level at which feedback information is provided, and this may be fixed or variable. For example, if the reward threshold is fixed at 10 jaV during NFT, when the amplitude of alpha exceeds this level an audio and/or visual signal is relayed back to the participant, providing feedback. In contrast a variable reward threshold may change over time, starting at 8pV and gradually increasing to 12^V. Unfortunately, it is not always made clear why a particular reward threshold has been chosen and in some cases such information is not reported (e.g., Angelakis et al., 2007; Beatty, 1971; Hardt & Gale. 1993; Johnson & Meyer, 1974; Konareva, 2006; Wacker, 1996). Nevertheless, when such information is reported there is little consistency in its use. For instance, the most common measures reported are amplitude, as measured in microvolts, and measures based on a ratio of the amount of EEG activity seen when at rest. However, reward thresholds based on amplitude have ranged from lOpV up to

40 nV (e.g., Ancoli & Green. 1977: Hardt & Kamiya, 1976a: Holmes et al.$_t$ 1980; Kuhlman & Klieger, 1975; Nowlis & Kamiya, 1970; Valle & DeGood, 1977) with some setting additional upper limits of 75pV and 100 nV (Marshall & Bentler. 1976: Tyson, 1982). There is a similar level of variety when using thresholds based on a proportion of resting EEG activity, with thresholds set at between 50% and s5% of the amount of alpha seen when at rest (e.g., Cho et al., 2008; Cram, Kohlenberg, & Singer, 1977; Norris et al., 2001; Prewett & Adams. 1976: Travis et al., 1974, 1975).

Clearly, identifying the chosen reward threshold would seem an essential aspect of NTT because it needs to be set at a level that ensures an adequate amount of feedback information is provided, allowing the learner to identify states, feelings, and cognitions that elicit the required activity, if the threshold is set too low, making the task very easy, :here may be little motivation and/or need for the individual to do anything to elicit positive feedback. In contrast, if it is set too high, insufficient feedback information will be provided and the participant is likely to become frustrated. Both scenarios could potentially inhibit the participant's ability :o learn to alter his or her EEG via NFT. However, there is very little guidance identifying optimal reward thresholds. For instance, Knox (1980) suggested that for a threshold to be relevant participants need to exhibit between 25% and 75% above threshold activity during an eyes closed resting baseline period. If they exhibit less than 25% above threshold activity it is likely that participants would receive too little information for the feedback loop to operate effectively. However, this leaves a broad range open for possible use. and it is likely that a threshold based on resting activity, which is only exceeded by 25%, would be substantially more difficult and may involve distinct processes than one that is exceeded by 75%.

Furthermore, it is likely that thresholds based on a ratio of resting EEG activity are more meaningful and possibly more effective than thresholds based on an arbitrary level of amplitude. This is because each threshold relates directly to the individual's natural resting level of alpha activity. For example, Knox (1980) measured the amount of alpha exhibited by participants that exceeded an arbitrary fixed threshold of 15jiV when resting with their eyes closed. She found that the majority of participants (68%) exhibited less than 25% of alpha when using this cut-off point and argued against the use of such arbitrary fixed thresholds based simply on level of amplitude. Thus, setting a reward threshold that fails to relate to the individual's resting level of alpha EEG activity may make the task of NFT more difficult for some and in doing so reduce its effectiveness. As such, additional research is needed to identify an optimal level, or range, of reward thresholds, comparing fixed versus variable thresholds as well as directly comparing the effectiveness of the different measures used, to establish which is the more effective.

Feedback

Neurofeedback researchers and practitioners assume that feedback relating specifically to changes in psychophysiological functioning is both necessary and sufficient. Indeed, it has been shown that feedback contingent upon the presence of alpha activity can help improve the participant's self-control of alpha beyond that which can be achieved by instruction alone (Plotkin. 1976). However, it is still not clear how the modality of feedback and its relationship with the presence/absence of alpha can influence the outcome of NFT. In general the modality of feedback includes audio, visual, and combined audio-visual information, and its presentation may be initiated once alpha exceeds a preset reward threshold.

With regards to audio feedback, pleasant sounds may be more effective than unpleasant ones. For instance, Tyson (1982) found that audio feedback in the form of a sine wave led to the production of more alpha compared to a sawtooth stimulus. He suggested that this is because the sawtooth stimulus can act as a mild stressor, leading to the suppression of alpha, making it more difficult to enhance alpha via NFT. If so. providing participants with audio feedback that is rated as "highly pleasant" may help them to relax, facilitating enhancement of alpha. Further, it may be worth exploring whether sounds rated as generically pleasant are more effective than ones identified by each individual as highly pleasant. For instance, Brctelcr. Manolova, de Wilde, Cans, and Fowler (2008) recently reported a relationship between changes in SMR (12 15 Hz) via NFT and participants' subjective ratings of pleasantness of the audio feedback stimuli, but only when it was combined with visual feedback. In addition to the nature of the sound used, the relationship between changes in the sound and changes in LEG may also influence the effectiveness of NFT. For instance, some researchers have utilized audio feedback, which turns on or increases in tone and/or volume as levels of alpha increase bevond a set point (e.g.. Cho ct al., 2008: Holmes et al., 19S0; Plotkin. 1976; Schwartz. Davidson. & Pugash. 1976). In contrast, others have used audio tones that decrease in frequency as alpha exceeds a preset threshold or are absent during the presence of alpha (Fell et al.,

2002: Kuhlman & Klieger. 1975; Yamaguchi, 1980). Although successes have been reported using both approaches it is interesting to note that only those adopting an inverse relationship between feedback and presence or level of alpha have shown that NFT can lead to enhanced levels of alpha beyond that seen when resting with eyes closed (Kuhlman & Klieger, 1975: Yamaguchi, 1980), a state that may represent an optimal level of alpha activity (Lynch. Paskewitz, & Orne. 1974; Orne <& Paskewitz, 1974; Paskewitz & Orne, 1973; Strayer. Scott, & Bakan. 1973). As such, it may be that an inverse feedback relationship between the tone and the level/ presence of alpha provides a more effective method of feedback. Such a possibility may be due to the well-known inhibiting effect that attending to a stimulus can have on alpha activity (Jasper & Shagrass. 1941). As such, a reduction or absence of the feedback signal indicating the presence of alpha may have less of an inhibiting effect.

allowing the individual the opportunity to enhance their alpha levels beyond an eyes closed baseline. This is a speculative possibility, as no research has yet directly compared the effectiveness of audio feedback tones that vary in their relationship with changes in alpha.

In terms of visual feedback, again there has been a variety of visual stimuli used including lights that simply come on (Kondo & Knott, 1974: Travis et al.. 1974). change color (Hanslmayr et al.. 2005: Lynch et al., 1974) or patterns that fill in as amplitude increases (Putman. 2000). Once again, however, the relationship between these distinct forms of visual feedback and their effects on the outcome of NFT remains unexplored. Furthermore, given that alpha power is normally blocked or desynehro- nized during opening of the eyes, training to increase alpha amplitude during eyes open may represent a more difficult task.

With regard to combined audio-visual feedback, two distinct information streams may be more beneficial than one. because a greater amount of information is provided, and if attention to one modality fades the remaining signal may command continued focus. For instance. Hardt and Kamiya (1976a) stated that audio feedback alone may be inadequate as it fails to indicate how well a

participant performed overall on each trial of NFT. They suggested that combining the audio signal with visual feedback in the form of a "score" at the end of each trial may be more effective at maintaining motivation and avoiding drowsiness. However, Breteler et al. (2008) found no difference in the efficacy of NTT aimed at enhancing SMR (12-15 Hz) when using combined audio-visual feedback or visual feedback alone. Nevertheless, this work is at an early stage, and at present there is no research directly comparing the effectiveness of combined audio-visual feedback to that of audio feedback alone.

Unidirectional versus Bidirectional Training

The ultimate goal of NFT is for the participant to obtain a degree of conscious

control over a particular psychophysiological component of his EEG without the need for feedback. This may be achieved by having the participant learn to enhance or inhibit his or her alpha activity using NET, often referred to as unidirectional training, or by- having the participant alternately enhance and then inhibit alpha, which is described as bidirectional training (Ancoli & Kamiya. 1978). The majority of unidirectional training has been aimed at encouraging participants to learn to enhance alpha (e.g., Angelakis et aL, 2007; Bazanova el aL, 2007; Cho et aL, 2008; Fell et al., 2002), which some suggest is more preferable for participants than inhibiting it (Kamiya, 1969; Lynch et al., 1974). However, inhibiting alpha may be easier than enhancing it (Lynch & Paskewitz, 1971; Paskewitz & Orne. 1973; Peper & Mulholland. 1970; Prewett & Adams. 1976) although findings have been inconsistent (see. e.g.. Regestein el al., 1973). Nevertheless, adopting a unidirectional approach that involves isolated training sessions either enhancing or inhibiting alpha may be less effective than a bidirectional training regime, which incorporates both enhancement and suppression, for al least two possible reasons. First, providing NET that incorporates both enhancing and inhibiting alpha activity is likely to provide more information concerning the underlying mechanisms responsible for dynamic changes in the EEG and as such may enable the participant to obtain a greater degree of conscious control in less time. To some extent this is supported by the findings from Regestein et al., who found no correlation between participants' ability to enhance alpha during a single 12-hr session and their ability to inhibit it. They suggested that ihis is because distinct and possibly independent mechanisms underpin the augmentation and inhibition of alpha activity. Therefore, providing bidirectional training, which incorporates both, could conceivably pro- \ide information on multiple mechanisms of change with regards to alpha activity, which in turn may facilitate the process of conscious control. The second point is more speculative and relates to the notion of natural limits. For instance, research within the field of traditional biofeedback has shown that it is easier to increase heart rates than to decrease them (Stephens. Harris. Brady. & SchafTer. 1975). This may be because there are natural regulators that restrict or limit the variability of such a physiological process. Given this, despite the aim of many to simply enhance alpha activity via NFT. it is unlikely that such activity can be increased ad infinitum. Indeed, some have suggested that it is not possible to enhance alpha beyond that seen at rest with eyes closed (e.g.. Lynch et al.. 1974; Orne & Paskewitz. 1*974; Strayer et al.. 1973) although a few have exceeded this (see Kubzan & Klieger, 1975; Yamaguchi, 1980). Nevertheless, there may be natural limits as to how much, or how little, alpha activity can be produced. If this is the case it may make more sense to utilize a bidirectional training regime lo help the individual learn to obtain a degree of conscious control over their alpha activity. As noted this represents a speculative possibility because we are aware of no direct comparison exploring the effectiveness of a bidirectional training regime to a unidirectional approach.

Target Frequency Range

It has been known for some time that alpha occurs predominantly in the parietal region, has been recorded with average amplitudes ranging 30-50 nV (Kamiya, 1968; Lynch & Paskewitz. 1971), and can be seen in the majority (90%) of the population when resting with eyes closed (Drennen & O'Reilly, 1986) and that opening the eyes can reduce the amount of alpha by 80%. or more (Wacker, 1996). However, identifying the specific frequency range of the alpha component of the EEG seems less certain. For example, previous attempts to enhance alpha using NFT have identified alpha as operating between 7-15Hz (Brown, 1970), 7.5-13 Hz (Prewett & Adams. 1976). 8-12 Hz (e.g., Albert et al., 1974; Cho et al.. 2008; Fell et al., 2002). 8.5-12.5 Hz (Bauer, 1976), 8 13 Hz (e.g., Angelakis et al., 2007; Hardt & Kamiya, 1978;

Nowlis & Kamiya, 1970). 8.5-13.5 Hz (Valle & Levine, 1975), 8-14Hz (Konareva. 2005, 2006), and 10Hz±lHz (Drennen & O'Reilly, 1986). Such inconsistencies in identifying the frequency range of the training component not only make comparisons between studies problematic but also fail to take into account individual differences. For instance, research has shown that the alpha frequency range can vary to a considerable extent in normal age-matched participants (see. e.g., Klimesch, Schimke, & Pfurtscheller, 1993). Such findings have led some to define individual alpha frequency (1AF) ranges, which have been used during subsequent NFT sessions with positive results (Bazanova et al., 2007; Hanslmayer ct al., 2005). Calculation of the individual alpha band is a relatively straightforward procedure that involves comparing EEG spectral power during an eyes-open recording to that of eyes closed and using the individual alpha peak frequency as an anchor point (see Bazanova & Aftanas, 2006). It may be that NFT based on 1AF ranges will be more efficient than training based on traditional fixed frequency ranges. Indeed. NFT using IAF has been shown to lead to enhanced levels of alpha (Bazanova et al.. 2007; Hanslmayer et al.. 2005). However, as yet, no direct comparison has been conducted between the effectiveness of NFT based on IAF relative to traditional fixed frequency ranges to ascertain which is more effective.

Eyes Open versus Eyes Closed NFT

Alpha amplitude is normally a function of reduced sensory input from the thalamic nuclei to the cortex and keeping the eyes open will naturally increase sensory input to the thalamic structures and thus suppress alpha power by default. Furthermore, alpha amplitude at parietal-occipital regions, where alpha NFT is often conducted, is greater when the eyes are closed, reflecting not only a reduced level of stimulus input but also the inhibition of cortical activity, such as visual information processing (see Wackcr, 1996). This shows that simply opening or closing the eyes can elicit reasonably robust effects on alpha amplitude. Nevertheless. NFT has been conducted both with eyes closed (e.g.. Bazanova et al., 2009; Cho et al., 2008; Fell et al., 2002; Yamaguchi, 1980) and eyes open (e.g., Angelakis et al., 2007; Ilanslmayr el al., 2005; Putman, 2000). Unfortunately, it is not always made clear why one approach is selected over another.

For eyes closed there seems to be an implicit assumption that such training mirrors the relaxed approach utilized by meditators attempting to achieve a calm state of restfulness and that it may also engender an inward focus of attention (Hardt & Kamiya, 1976b). In contrast, some have suggested that NFT with eyes open provides a lower "baseline" from which to attempt to increase alpha amplitude (e.g., Travis et al., 1974) and as such is more likely to exhibit positive effects from NFT. However, not all agree with this rationale: in fact Hardt and Kamiya (1976b) criticized the idea that NFT should be conducted with eyes open because of the naturally- suppressing effect this has on alpha amplitude. They argued that this represents a contradictory training regime, in the sense that opening the eyes naturally suppresses alpha amplitude, which participants then attempt to overcome by using NFT. They suggested that this is "rather like asking persons to experience a state which they arc prevented from experiencing" (p. 102). Furthermore. Travis et al. (1974) suggested that eyes open alpha NFT is primarily concerned with reducing the alpha suppressing effects resulting from oculomotor processes, whereas Hardt and Kamiya (1976b) put forward the idea that eyes closed alpha NFT is influenced more by what they call "central processes" (p. 105). They argued that such central processes are more likely to determine states of consciousness than are the peripheral processes involved in eyes open NFT. The notion that eyes open compared to eyes closed NFT may rely on distinct processes gains some support from the work of Travis et al. (1974), who found that participant's ability to enhance alpha amplitude with eyes open was uncorrected with

their ability to enhance alpha amplitude when eyes were closed. They suggested that such a pattern supports the notion that the two approaches to NFT may rely on "different internal controls" (p. 680). If this is the case, then Ancoli and Kamiya (1978) may have been correct in their assertions that research utilizing an eyes open paradigm should not be compared with data obtained from eyes closed NFT. Furthermore, if eyes closed NFT does rely more predominantly on internal "central processes" it may be the case that such an approach would elicit greater changes in behavior and/or cognition, relative to an eyes open approach.

Index of Learning

It may seem obvious to suggest that the method of assessing learning can influence the perceived outcome. However, when examining the efficacy of NFT a variety of measures have been used, begging the question. Which measure(s) provide;, the best index, or indices, of learning and how can those that exhibit learning best be identified? The most common measures used include changes in mean amplitude or amplitude ratio (e.g., Clio et al.f 2008; Fell et al., 2002; Hansimayr et al., 2005; Putman, 2000), changes in the percentage of time alpha is evident (e.g., Angelakis et al,, 2007; Nowlis & Kamiya, 1970; Peper & Mulholland, 1970; Yamaguehi, 1980) or an integrated measure combining both amplitude and time (e.g., Knox, 1982; Plotkin & Rice. 1981; Tyson. 1982). We have made a case elsewhere suggesting that both amplitude and percent time should be reported separately and that such measures need to be examined in relation to appropriate baseline levels of activity and as such do not repeat it here (see Dempster & Vernon, in press). However, no clear criteria have been proposed to help delineate learners from nonlearners. In the past, researchers have simply classified those showing some change in their EEG in the desired direction as "responders" in a post hoc fashion (e.g., Hansimayr et al., 2005). Given that the goal of NFT is to encourage the individual to learn to alter his EEG without the need for feedback, we would suggest a more stringent criterion for classifying a participant as a learner. For example, an individual could be classified as having learned to control his EEG when he is able to enhance and inhibit it relative to an appropriate baseline with and without feedback information. The adoption of such a criterion is conservative but would provide a clear indication of the level of control achieved by the participant undergoing NFT. In addition, such a criterion, if adopted, could facilitate cross study comparisons.

SUMMARY

Given the clear associations between changes in alpha EEG and alterations in mood and/or cognition alpha NFT represents a potentially useful technique for influencing such behaviors. Unfortunately, it is not clear at present what the most effective method to achieve such changes would be. Some headway has been made in attempting to identify an optimal training paradigm; however, a review of the literature highlights that there is still some way to go. For instance, with regards to the NFT schedule it may be possible to elicit changes in the EEG and behavior following a single short duration session of 20 to 30min. However, such changes may be short-lived and additional sessions may be required to engender long-term effects. Whether such additional sessions will be more effective if massed within a short period or spread out across a number of days/weeks remains unclcar. In terms of the reward thresholds set during NFT it is not clear at present whether a variable or fixed threshold would be more effective. Nevertheless, it is likely that a threshold based on some aspect of resting EEG will be more relevant than an arbitrary' level of amplitude and/or time. The feedback signal used may also influence the outcome of the NFT with pleasant sounds potentially eliciting a more positive outcome than unpleasant ones, particularly if coupled with visual feedback. However, this area needs to be explored further as it is not yet clear whether

combining audio-visual feedback signals will be more effective at encouraging learning and eliciting change in the EEG than audio signals alone. Furthermore, we suggest that a bidirectional NFT regime may be more effective compared to unidirectional training. We also highlight the fact that the alpha frequency range can vary across participants, and as such NFT based on IAF ranges may be more effective compared to training regimes that utilize a traditional fixed frequency range for all. Furthermore, it is possible that eyes closed NTT may elicit distinct behavioral and/or cognitive changes relative to eyes open training. Finally, we propose a criterion of learning where the individual in question can be classified as having learned to control his EEG when he is able to enhance and inhibit the specific component relative to an appropriate base-line with and without feedback information.

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PERSPECTIVES

Rhythms of Healing: A Case Study

Richard L. Jacobs. PsyD

Imagine for a moment living with a brain that cannot remember a simple tune or even a few words to a song, a brain that does not recall that there is music to life.

PRESENTATION

Woami (pronounced WOE-ine) is a single Asian woman in her mid-60 s employed by a local hospital for clerical work. She maintains a license as a physical therapist but has not worked in the field for decades as "it was too hard on my body." She lives alone in an apartment and is reminiscent of one of those wooden Russian dolls, one doll within another within another within another. With a round face, glasses, and straight black hair cut at the chin line, this 5-ft woman wobbles into my office carrying a backpack, fanny pack, and other bags filled with things from her world. And she always carries her cassette Walkman to audiotape our sessions.

Woami was referred to me 5 years ago by a respected psychoanalytic psychiatrist in the area. He had worked with her weekly for 11 years but was no longer seeing insurance patients. Further, he felt he was not helping her and recently found himself fighting off sleep during sessions. She insisted she had Dissociative Identity Disorder, which he considered likely, so he felt she should see someone who had an expertise in DID. He believed she experienced some form of trauma in her childhood, perhaps in part because her mother had boundary problems. ("My mother doesn't know the difference between you aud me. She doesn't understand why she can't wear my T-shirt.'*) Woami also participated in a long-term psychotherapy group.

Woami is the second of four children born to Asian immigrant parents. She has an older brother whom she feels has Asperger's syndrome and a younger lister and brother whom she says have difficulty tolerating her. The older brother lives nearby, helps with chores, and often gets very angry with her. at which point Woami often decompensates.

1 was immediately intrigued by Woami. In the first session, she spoke of having "three pieces: the baby-kid. the kid. and ihe one- who-goes-to-work. The baby-kid is the body

Richard L. Jacobs «s affiliated with The Trauma Center at Justice Resource Institute. Address correspondence to: Richard L. Jacobs. PsyD. Director of Supervisory Services, The Trauma Center at Justice Resource Institute. 1269 Beacon Street. Brook line. MA 02446 (E-mail: richard-jacohs@comcast.net).

and »lie's in real trouble, and the work one is always angry with her. The kid's angry with the work one—Can you help me?"

1 felt initially hopeful, even though this woman did not report typical dissociative experiences that many others with this disorder do. Her Dissociative Experiences Scale (DES) was below the DID range. After being hospitalized in her 20 s for a mental breakdown. she had seen a therapist who told her she had parts. This is quite remarkable in itself because 35 years ago therapists were largely unaware of DID. She liked this doctor, and I wondered if she look the diagnosis on to please him. Still, this was how she understood herself and made sense of her inner life. She was hospitalized again in her 30s. She later had a therapist for a while she says yelled at her, and then she was assigned to Dr. G. a supervising therapist at the hospital.

Dr. G had warned me that Woami could talk for hours on somatic complaints and worries to the point of psychosis, and I quickly encountered it. Many sessions were taken up with her logging doctor visits she'd had each week: neurology, rheumatology, internist, orthopedist, physical therapist, and so on. "My spine is crumpling... the toe's been dislocated... I'm gonna stroke out..."* 1 spoke with her primary care physician, who said the ailments were subclinical. This diagnosis greatly angered Woami, and she was out to prove him wrong.

Yet Woami also had a gentle, childlike appeal, and a great interest in Eastern religion. especially Mahayana Buddhism. She had chanted for many years and believed it was helpful to her. Many of the few human connections she has are through this Buddhist chanting group. She also attended intermittent tai chi classes.

FIRST YEAR: TRYING TO REACH HER

Our first task was to deal with the loss of her previous therapist. Dr. G, whom she felt did not appreciate the need she had to coordinate her pieces. Simultaneously, Woami was very worried about the impending death of her 93-year-old father, whom she deeply loved. She described him as a withdrawn, even taciturn, but loving man, someone "who lives in the Tao. who moves with chi, and loves nature and music."

Our sessions overlapped her termination sessions with Dr. G. In a moment of insightful clarity, she said, "There's trouble ending sessions. I don't want to hurt him. but I need to see someone who knows about trauma. I think he needs help ending with me.... Why didn't Dr. G want to learn about the dissociation? He said he wasn't going to feel guilty, but I think he does."

Over the next few years I would come to hear infrequent but impressive statements of clarity like this from her. They indicated to me that she had much greater capacity, a state of integration within her. but one to which she could not find her way with any frequency. They seemed to come out of nowhere. 1 also met with Dr. G. He spoke of her concerns about cruelty in herself, about her fear of intimacy, her terror, and a possibly sexualized relationship with her father. He was frustrated that they could get nowhere with these issues because of her constant somatizing.

In the second session, as she was exploring my office Woami commented on several stuffed animals I have, and told me about her own stuffed rabbit, Muchie, which she often slept with. She liked mine, so 1 wondered if she might like to buy herself a new one (that I hoped would be a representation of our budding relationship). At the next session she told me her horror story of the week. She had gone to F AO Schwa rz and. while admiring all the animals. "I don't know. I got dizzy and lost my balance; I couldn't gel over to the store person, couldn't walk. Maybe the baby-kid came out and she couldn't decide which one she wanted, and the work one goi angry with her for wanting animals in the first place; and I froze. I sat down on a little wood stool and couldn't move. The sales people tried to talk to me. but I couldn't talk. They finally called an ambulance, and I was taken to the hospital. 1 had trouble forming words. The baby-kid freaks out with medical things. They thought I'd had a stroke and gave me a neurological exam. I was there all night, and in ihe morning I could talk and walk and they sent me home."

"There was conflict among the pieces over buying the bear—the piece who works would not have it in the house!" This gave me the opportunity to introduce my mantra to all dissociative clients: The three C's: communication. cooperation, compromise. As I explained this, she seemed to be in a trance. We would continue to emphasize these concepts over the next 12 months. 1 also learned the lesson not to make any suggestions without careful forethought. She took in everything I said with childlike trust and literalness.

As the last session with Dr. G approached, she was able to say that he did the best he could. "When I started with Dr. G, I was a puddle. He kept helping me find words, keep functioning. He let the kid be. He did it first, now I'm doing some_____ Maybe he has trouble with one of his pieces." She wrote a very moving good-bye poem to Dr. G. and I

was very surprised when she read it to me. This was the first of what would be many poetry readings in session. Woami would stand up. her posture would change, and she would appear taller, balanced, almost regal. Her voice completely changed into a mellifluous, musical, soft yet strong sound. She would recite her poems from memory like Maya Angelou at the White House! How can I help her access this state more often? was my initial response. How can 1 help her bring this person into the world rather than the fragile, fearful, confused child she often fell into? The good news was that she didn't shatter when she and Dr. G ended.

Woami describes her decompensation as "trauma-ing out": "It's shattering; all the pieces go to pieces. You're the only one who's helped the baby-kid." I wasn't sure what I had done to help, besides appreciating the need for a stuffed animal, but 1 think now that my soothing tone and pacing spoke directly to her inner experience of shatter and helped reconnect the pieces.

Over the initial months of therapy I learned that doctors became frustrated with her, sometimes angry, perhaps because they couldn't help her physical complaints (which also included allergies and hypersensitivity to most medications). She complained that when taking Omega-3s she could feel the oil being exuded into her hair and thought they gave her rashes. Likewise, she thought she was allergic to Lipitor and was frightened to take it. For a while 1 encouraged her to pursue psychotropic medication, but she was too frightened of the side effects. I finally gave up on this path.

I was beginning to worry that 1 would get no further with Woami than Dr. G. had. Even if I understood the pieces, 1 fell discouraged by her unremitting somatic obsessions and could see no way to access the more integrated state. She was always taking off time from work to go to doctor's appointments. She was behind in her taxes, her apartment was a mess, and always she feared shattering when her father died. I was sinking into despair, even though Woami assured me that I was one of her good doctors. I was troubled that maybe her goal was to amass a platoon of healers who could tolerate her and continue seeing her, rather than to gel well and live a satisfying life. A year into treatment, other doctors concurred, including her primary care physician, that the medications route was more risky than beneficial. Dr. Bessel van der FColk, with whom 1 consulted, said Woami was "like a patient at *La Salpctrierc.* and would have been a challenge to Janei, too!" I was left feeling the best diagnosis was MDD-NOS, Multiple Diagnosis Disorder, Not Otherwise Specified. Though with hindsight, Complex Post-traumatic Stress Disorder (*Journal of Neurotherapy*, 2002).

TRYING NEW APPROACHES

Once the psychopharmocology route was closed, I decided to follow her lead in what she felt she could tolerate and what she thought helped her: that is chaniing and tai chi. T asked if she'd teach me to chant, which she did. Beyond the initial *Namyoho-renge- kyo*, she could chant from memory about five transliterated pages of a Buddhist sutra. to my amazement. She brought in the text, which 1 began to chant with her at the beginning of every session. I purchased a meditation bell to ring at the beginning and end of every session, and I came to insist that this be an opening and closing ritual. Not only did I like the chanting myself, I found it a way to help her settle right at the outset, and for us to "get in synch with each other." The number of repetitions varied from time to time, and I d have to listen closely to her cadence to anticipate the end and stay right beside her. It was like walking together, making music, and was at the same time somewhat playful. The kid, she told me, was the chanter, the work one did not chant, and the baby-kid was helped by the tones. "The sound goes out to the edges of the Universe; it means that all people can be happy, that everyone is included."

Before the chanting it was usually hard to find any point of connection with Woami. She'd often come in frantic, arms flailing, and ramble on about doctors and physical ailments and fears, and look to me to refer her to another doctor. I found sometimes when I spoke in a hypnotic voice—when she let me—she could calm down somewhat. But to ask her to talk about feelings was invariably blocked by more physical fears. I tried to mirror for her how scared she was. but to no avail.

Although now we had achieved a way to calm her. my worry remained that she just liked her sessions with me more. Doctors would find some problem—arthritis, for example, which Woami perseverated upon and magnified to life-threatening proportions. She would trip one week in a subway station and go to the emergency room and insist that her neck was dislocated. Her toe bones were sliding one under the other, and she feared she wouldn't be able to walk or get to see me. More referrals were made, but she was also spending great sums of money out of pocket for doctors' visits. She had paid for three different pairs of orthodics and twice as many shoes to try to help her toes and make her feet go straight, so she wouldn't fall. Once, after seeing

an orthopedist who told her she was hyperflexible, she told me. "That's what's wrong with my brain, too, Dr. Jacobs, hyperflexible!" 1 worried she would be lired for so many absences, but somehow her boss tolerated her. I wondered if there were any other ways to help balance and coordinate her body.

Because Woami attended some tai chi classes and loved that her teacher look her seriously, I asked if she would teach me some tai chi. She gladly agreed, and soon we developed a tai chi sequence, which always followed chanting. 1 taught her a Reiki movement I knew", which she said was just right lor the baby-kid. Woami look some pride in her teaching abilities, and how she could adapt tai chi to her frail body. She signed up for a tai chi teacher's course, and T had the hope that maybe she could draw on some of her P.T. training and leach tai chi at nursing homes and senior centers. 1 was particularly worried about her job, because one week she had "trauma-ed out" at work when her boss yelled at her. "People like you have to take pills." she mimicked tearfully.

So now, for ihe most part, the talk therapy part of our sessions was 20 or 30min. and the rest of the time we chanted and did tai chi, paying attention to her posture and body tension. When she demonstrated various tai chi movements I was again struck with the beautiful poise and grace with which she moved, contrasted to her usual robotic- body. To try to help her with her balance (and what I conjectured was a poorly functioning vestibular system), I introduced her to a Bosu ball, a rubber hemispheric ball about 24-in. in diameter upon which you stand to improve balance, and then do movements to build core strength. It also stimulates integration of the vestibular, visual, and motor systems, and for months we practiced balance and played games like tossing a stuffed bear back and forth while she balanced on the ball. I was also trying to work her attachment system in these exercises, asking her to focus on me, then look away, make a movement while maintaining balance, and then reconnect with me. I found myself getting re-energized about her therapy, again more hopeful as 1 had been at the beginning, the more creative we became.

It was during these years that Woami shared several of her other poems with me. She had written two very dark ones during her hospitalizations and worried they would be too difficult for me to hear. One. "Be Near" begins, "Be near, go away, not touched, not felt, not even for a day _____ " (This author has changed Woami's poetry to protect her confidentiality.) Although I could resonate with the feelings of despair, and relate it to her shatter experiences, we never understood where il came from in terms of her history. Another was titled "Child in the Cellar." It was haunlingly dark and desperate, and the way she recited it gave me chills. She said the kid wrote these poems, she thought, and I asked who is reading them now. "I don't know. I don't know who I am when I read my poems," she responded with pleading in her eyes, hoping I could tell her who she was. I encouraged her to write more, and wondered if she would share a poem with my associate who covered for me and met with Woami on my vacations.

There were times when I'd interpret her somatic symptoms in feeling words, which almost always bombed. She would get angry with me and make me feel bad. saying that the kid never came to therapy with me because she didn't trust me. "The kid goes to see Dr. K (a psychiatrist she'd meet with once or twice a year); he's comfortable with his kid and says you're more comfortable with the baby-kid." The implicit challenge was not lost on me. Aside from the poems, though, how could 1 reach the kid?

Woami got herself into professional conferences on trauma and mind/body healing because she kept her P.T. license active. She had no hesitation in approaching expert presenters and asking questions that only superficially veiled her personal concerns. At one point she admitted to me that this was the reason she kept her license active. She knew she would never practice P.T. again, but the credential gave her unlimited access to some of the best minds in the country. I admired and was surprised by her shrewdness. Here again she demonstrated her capabilities, her reasoning, and higher function, albeit in the service of her somatic defenses.

The therapy went on like this for 4 years, with crises and ups and downs. T could see how Woami had ensconced me in a special position in her life. She fell I was indispensable. which concerned me. even though 1 saw her self-esteem improving and her pieces definitely communicating and cooperating more. We had not achieved compromise yet. however. The work one still refused to chant. (Ironically, the therapy was changing me: T began doing tai chi and chanting even when I didn't see Woami. and as well took training in several other new approaches to reenergize my professional life.) Her father lived on amazingly, family conflicts persisted, Woami would trauma-out for shorter and less intense episodes, and 1 developed a certain complacency with her therapy. We began to talk about geriatric planning, living situations, and other life-stage issues. Woami went to a senior center, took a writing course, met some new people, joined a Unitarian Church, and decided to call herself a "Tao-Buddhi-tarian." Then 1 was introduced to neurofeedback.

ON BECOMING A PERSON: THE EGG THA 7 NEVER HA TCHED

After 5 years of weekly treatment I had a patient who thought the world of me, who had taught me chanting and tai chi, and who forced me to extend my creativity in treating her. In the way of a demoralized therapist. I could say that she hadn't gotten worse or lost her job; she had a few new connections, albeit tenuous: she had made some progress cleaning her apartment, and her taxes were still overdue. Generally, I was approaching Woami as having DID: we had at best a fragmented and not very meaningful jumble of her history that included a "trauma-inducing" tonsillectomy at age 4'/2. the birth of her two younger siblings, a narcissistic mother, a kind but distant father, and separation anxiety on the first day of school, when she "couldn't stop crying so the teacher sent me to the bathroom for a very long time, and then 1 kept flushing the toilet over and over till they got angry with me." Again here was the theme of people losing their tolerance of her. not understanding, getting frustrated, and Woami retreating further into herself. Was this the fate to which we were headed? I would have hoped for more after 5 years and wondered if this was a wild goose chase.

In 2008 Dr. van dcr Kolk, who had tagged Woami as a descendent of *La Salpe triere*, invited me to attend an introductory training in neurofeedback (NF). I was very interested, and had impressive results on myself. Several months later, with more training, I introduced NF into my practice. I had not initially thought of trying it with Woami, but as many sessions with other clients confirmed its efficacy. I decided to introduce her to it. Right after my vacation, in July while her father was still alive but failing, I asked if we could try it. Woami was willing to cooperate.

Although I always do an extensive eight- page NF assessment to guide my initial decision on electrode placement and starting frequency. I chose to avoid this with Woami, anticipating that we

would get mired in descriptions of the myriad biological symptoms and would risk her taking on even more symptoms as medical students do. Because of her hypersensitivity to substances, her autoimmune dysregulation. her general tendency to panic, and just a feel of an "unbalanced brain." I chose to start with interhemispheric training. Because the session- to-session changes were so impressive, from here on 1 record notes from each session.

Session 1: T4-T3 reward 8- 11 Hz. inhibit 0-6. Woami was interested and had many questions. She caught on quickly to the feedback. And after several minutes she commented on the colors, which I took as a good sign that she was engaged in a calm yet focused way with the feedback. Her associations 10 the pictures were pleasant. Dropping down to 7.5-10.5 she noted it was harder to breathe, and clearly liked 8-11 Hz better. I2min total.

Session 2: T4-T3 8-11 "Ooh. the kid likes doing this. She likes the pictures. Before she was staring at it. now she is looking!" Alter lOmin I tried 8.5: "My right hand feels numb, and 1 feel muscles that are sore." We went back to 8 -11 and finished at 12min.

Session 3: Same protocol for 15min. "The kid's here: she likes the pictures, except the one with the birds eating a fish." I told her she could close her eyes when that one began to come on.

The content of the rest of these first three sessions was not much different. We discussed geriatric planning, an appointment with a geriatric specialist, and an upcoming family reunion in New York City. She said she fell the NF helped her be "more organized and less like the trauma will get triggered off by my family." I was interested to hear that the kid was here during the training. She also was terminating her therapy group at this time, and bearing it well.

Two days later. I got a call from Woami that her lather had died. She was crying and sounded quite disorganized in her message. We spoke later that day for 30 min. and she was already reorganizing. When she started to discuss with me what she would wear to the funeral. I felt she was put together enough for now. I suggested she bring a recent poem with her possibly to read.

Session 4 *'by phone):* We spent the entire session on the funeral preparation, how she was going to cope with her family, logistics, and so on. She complained that her family was acting crazy, and felt "maybe a different kid part, who's lost her daddy" inside herself.

Session 5: The following week, having returned from the funeral, Woami reported it went fine. She had read her poem, and chanted in front of the congregation, "even though only my cousin chanted with me." Her nieces and nephews appreciated the grace in her readings: "You're spiritual and spirited. You should read for books on tape people will want to listen." She spoke about the funeral in an emotional, yet controlled way, describing how she looked out the windows at the tall green trees and felt her father's spirit was in them. "Do you think that's crazy? Then we took the bus back to Manhattan, and the way the clouds and the sun was late in the day. I saw the skyline like I had never seen it, it was all silver and blue and gold, and I thought that this is for my fattier. If there are angels to welcome him, they are having this beautiful display. And everyone else on the bus was asleep, so 1 thought it was just for him...and me." 1 was struck by her ability to hold herself together, to not shatter, and to be able to describe the experience in such poetic terms.

NFl P5-P6 8-11 and 4-7 lor 20min. 1 wanted to experiment with a protocol that has been helpful for sensory integration. Her response was markedly different. To help her differentiate the effects of lowering the frequency 1 dropped to 7.75: "It's harder to breathe; I'm worried about dad." Back to 8-11: "a Utile smoother, less emotional, more calm. The work one is evening out. It's not as engaging as last week. More worry and a little neck pain." I was very impressed with her ability to report and find language for the sensations she was experiencing, and decided that next week we'd return to the original protocol. I never expected the phone call I got about 4 days later.

Voice mail: "Dr. Jacobs [in an agitated tearful way], I think there's a new part, she's the daddy-kid. She's the one that was crying because she lost her daddy. She speaks in baby Asian-ese. The kid says can you ask someone if there's another frequency for her. The kid thinks the frequency we were using brought her out, and now she doesn't know what to do with her." I called back and reassured Woami that we'd figure it out, but I really wasn't sure what to do.

Session 6: I had decided that since Woami was seemingly so sensitive to the NF, 1 would ask her for her thoughts on how to proceed. She was a step ahead of me: "The kid says go back to the first protocol we did—that was for the daddy-kid, she says." 1 felt fine with that and we set up T3-T4 again. "The kid says you helped the daddy kid when you said we didn't have to look at the bad pictures, now it's OK to though." 1 wasn't sure what that suggested, but after 3min. Woami (or the kid?) said. "We need to save some time to talk about the feelings." (*What!* 1 said to myself), and 1 replied. "We can do that while you're doing ihe NF if you like."

"Maybe the daddy-kid trauma-ed oui during the tonsillectomy." – Well, when [my next younger sib] was born, she [the daddy kid?] lost her mother, when I was 2, so my father took care of me. but he couldn't hold me or talk to me. Then [the youngest sib] was born when I was 3, and my father would have taken care of him. My older broihcr couldn't have held me because of his Asperger's. Then, at 4V£ I had the tonsillectomy, that's the daddy-kid, and daddy took her to the hospital, and she cried and cricd when he left her there. There were no other Asian children or nurses, and she wasn't treated very well. That's when she felt she lost her daddy forever. That's the trauma!" My jaw was already on the floor hearing such a coherent and sad narrative, but Woami just kept going.

"So she didn't have her mommy or her daddy. There was an aunt they sent me to. and she gave me a jam jar with a pink spoon. I guess to play with. It wasn't much, and all the brothers and sisters were home. Then there was that trauma the first day of school. Oh!...That was the daddy-kid. too; she cried and cried, and the teacher sent her to the bathroom. *Then,* that's when the kid came; she wasn't crying, she just started flushing the toilet to get rid of that daddy kid who was such a pain!" It had been !6min of NF; I asked how she was feeling. "Kinda sad."

"Yah, this is a very sad story,'" 1 said seeing her eyes welling with tears. "Could we try another placement lor a few minutes that may help the daddy kid?" She agreed. I tried T4-P4. at 7-10, reward to help settle the traumatic affect 1 feared was bubbling. A few tears spilled over and down her cheeks, then after 3min, Woami said, "it's OK. now, we can stop."

1 was stunned. She left the session smiling, wishing me a good week as she always does. An hour later 1 called her. She sounded fine. I asked if she would bring the tape recording of the session back with her next week, "because I think it was an important session." "Yes, I think it was helpful." she replied nonchalantly.

Session 7: We listened to that portion of the tape where she told her trauma narrative. It was hard to hear because of the beeping. The magic seemed gone. But Woami had a lot to say. She had a poem that the kid had written to the daddy kid. She spoke in Japanese what the daddy kid kept repeating. Without knowing a word of Japanese, I could almost understand: "Daddy don't go, daddy don't leave." The kid translated and said this was baby Japanese, and she was working hard to understand. (This is real cooperation between pieces.) She said the kid finds the daddy-kid surprisingly appealing. She'd been gone inside for 60 years after that first day of school. Everything was beginning to make sense, like a mess of pictures finally being put in the right order. A lively part of Woami had been "gone" and she lived her life as if in a bubble, a fragile bubble that without the energy of this daddy kid could break beyond repair.

Session 8: I am eager to do more NT[7] with Woami, so at the beginning of the session ask how she thinks we should use the time. She has written another poem she wants to read me. and asks if I want to do NF. "Well, we could." 1 say. "Don't you think we should process more what the NF brought up before doing more of it?" which is less of a question that an admonition. 1 sat fully back in my listening seat. Woami had gone to a big Buddhist meeting that was on life and death, and in two small groups had read two of her poems about her loss, her pride almost shining through her somewhat blank face. Again I wondered aloud if she'd ever do a book. She recalled the artwork she had done while hospitalized, again with clarity and coherence never before heard. "There were finger paintings 1 did. very chaotic, like things were then. And, oh, isn't this interesting...! had drawn little people in the center! Little people." She was making the connection to her parts, and especially the daddy-kid. who was lost in the storm.

"Dr. C had suggested that maybe there was earlier trauma before 2 or 3. I was born at home, but then my mother was put in isolation because she was sick. She had taken laxatives, and thought that's why I came out (was her mother really psychotic?), and I was put in a broom closet... not really, but that's what they always said. I was isolated. too, in the hospital for the first week."

"You were separated for that long? In isolation?"

"That's what they say... Oh!...'*Be near ... go away, never touched, never fell, not even for a day,..*'" She recited the now-familiar poem as if for the first time. We both sat in awe, aware that she had discovered where that poem, so much the story of her life, may have come from.

I closed the session saying, "Remember how you've always asked me if we'd ever get to process the trauma? You're doing it now, you're really doing it!" There had been no overt somatizing lor 6 weeks, now.

Session 9: (I never would have thought of writing up this case a mere 6 months ago. Now[r] I feel as if I am witnessing and participating in something impressive, and 1 have to tell the story.)

Woami came in more anxious and obsessive than in the past 6 weeks. She was worried about taking statins, was looking for a specialty gynecologist to talk about her estrogen, and showed me that the skin

on her hands was red and shiny (it was). But then she moved on: she thought we should try T4-T4 again, and maybe try chanting while doing NF to see the effect. Starting at 8-11 Hz. after 9 min she said there was still room for worry, she was still feeling "yidg-ety, and breathing is hard." We agreed to return to the original protocol. T4-T3, 8 11 and 4-7 Hz.

In three minutes she said there was another part here, because "she's felt mad at the birds (in the picture). That's not the daddy-kid. she only feels scared." I wondered to myself if this were a displacement of her feelings towards the gynecologist who could not see her for 9 months. Nevertheless, I made note of her ability to report her inner experience of anger in feeling words rather than physical symptoms. "Before the daddy kid was scared of them. Now someone's angry — The kid says this breathes better. It feels like it's going by itself, like we're not pulling, more like water." T thought this was good.

Then "Oh, she's started chanting!" We chanted out loud and the average reward band went up by 10. After 11 min she reported feeling much better and then she chanted on her own some more. We stopped at 15 min. Woami stood up, looking very calm and said. "Now we're not pieces. I don't know who I am, but I'm all one."

Session 10: Woami wanted to start on NF immediately and do the entire Sutra chant while training. Her average reward amplitude started at 20 microvolts which is where she ended last week. At the outset she said.

"We're feeling a little sad about daddy. I miss him—This feels like the right selling." At 11 min she closed her eyes and appeared to go into a meditative stale for the next 6 min. She opened her eyes and said, "There's space in my brain to think about the lawyer. Sometimes there no space to think I'm not so tired now."

We then had about 20 min left for talking and she spoke very cogently about her estate planning, talks with her family about inheritances. 1 commented that the family seems to be communicating better than in the past. Her face darkened momentarily, then brightened and she hesitantly spoke about how it's easier lor everyone now, in a way, thai dad is gone. Even her mother is "being more herself." I could see her struggle with admitting to this since she had spoken earlier about missing him. Rut it appeared she was doing the work of grieving. She spoke for a minute or two about her neck "being out" and her fears of having a stroke, but quickly returned to the discussion at hand, as if this was just and echo in her mind that didn't merit much discussion.

She closed saying that the kid doesn't understand how she and the daddy-kid are connected, "how can they both be? But the daddy-kid has ihe feelings, has her own poetry, and her own resonant chant lhat is different from the kid's, and the kid appreciates it."

Session 11: T3-T4. 8-11 and 4 7, 18 min. Woami now begins sessions with how she wants to use the time, in contrast to our first several years where she asked me to keep track of the time and let her know every 15 min how much time we had left. So today she said, "Let's talk for 5 minutes, then do the machine for 30, and have about 15 to wrap up." She led with some somatic concerns, but quickly moved to reporting that her older brother had yelled at her twice during the week, and she found she didn't get so upset or "trauma-ed out. Part of me spoke up and it wasn't so bad."

During training she wanted to chant again. (Her average reward can double while chanting, and does so more easily when she chants silently to herself.) "I'm feeling calmer. Tt (the feedback) didn't flow as well until we started chanting." She closed her eyes for several minutes and appeared to go inio a light trance. Aflcr the 18 min she looked calm and cheerful.

For the rest of the session, Woami described in lucid detail her meetings with a geriatric lawyer. She learned about various trust arrangements, and had spoken individually with each of her three siblings and her mother about financial planning for the future, having raised with them difficult emotional issues of who has greater needs, etc. I was so impressed with her coherence and emotional equilibrium about such difficult subjects. At the end of the session I shared that with her. She looked pleased and said "I sort of thought so too." In a way T imagined her right brain felt the change, but it took my putting it into words for her left brain to recognize it.

Session 12: T4-T3. 7.875 10.875. 4 7, 21 min. Woami began by showing me a photo of the extended family which she had gotten at her father's funeral, taken when she was *2]A.* "What do you think of these people?" she asked me as if it were a test. 1 shared my impressions: she looked very sad in the photo; her older brother looked frozen and scared. Her falher had her propped up against his arm but was not really embracing her. Her mother looked pleasanl but stiff in contrast lo her two sisters (Woami's aunts) who looked more naturally relaxed. She agreed with all my comments. "This was when my sister had just been born, and I lost my mother to her. My father really couldn't connect with me. My brother was diagnosed with Asberger's and was not emotionally present. My aunts... well, we really don't want to talk about them." I was curious but respected her boundary'. We moved to NF.

Woami said she thought the last training "hyped me up a little, it was harder last session. Last time I *had* to chant to feel good inside." So I lowered the frequency just slightly. After 9min we chanted together. For the first time the reward average exceeded the low inhibit. At 14 min she commented, "Nothing reached the daddy-kid till we chanted inside melodically. The daddy- kid was held by it. Then she was just floating like on the waves, like when my daddy look me to ihe beach. When she's not floating she's sad, We have to chant." And she resumed again, the reward average frequency went back up, and she looked calm and relaxed. She will be going to New York Ciiy this weekend to see her mother, and then next week will meet with a New York lawyer to work on the family finances. As she left I noticed that her face, her skin particularly, looked a bit older, but in a good way, more appropriate to her age, more weathered, as if this was skin ihat had really lived in life, rather than just served as a protective coating. I realized lhat prior to this her skin and face had a wooden or pla.stic appearance (like the dolls).

Sessions 13 *and* 14: Woami has become almost business like when she comes in, going immediately lo the NF chair to start. She has planned what she wants to talk about later in the sessions, loo. For the first 6min, each time the kid or daddy-kid comes forth, enchanted with a small bear hanging on the bookshelf. She is chatlering on about it. and then begins to seltle. We chant the sutra, and then she closes her eyes and later says it is like TM. In #14. I dropped the frequency to 7.25. "Daddy is gone...the kid's sad, but now T'm getting ready for the mommy to go." Her mother has been declining, and Woami has been very involved in her care, even directing the medical staff in resuscitating her.

Woami also reported that her Asperger's brother has yelled at. her more, "and I lold him 10 stop yelling at me. Some people think 1 have some useful things to say." This is truly remarkable for her to have done. She had not reported being triggered, nor has she had any physical complaints for these 2 weeks. She has remained impressively cogent about what she is learning from meetings with the family lawyer, learning about how to deal with her mothers long-term care, and, as well, thinking about what her own needs may be in the future, and what steps she should take to insure her own care.

Sessions 15 *and* 16: We continued to use the same protocol at the beginning of each session for IS or 21min. Woami has noled that ihe pieces feel different. Her mother has been failing, and Woami is trying hard to keep her alive, talking with caregivers several times a day. She easily takes in ray comment, however, that she can't be responsible for keeping her mother alive, that it is her mother's decision.

While training Woami has wanted to talk more about her history, to understand when the various pieces came to be. She especially asked me about the first year of life, and did I think the isolation was traumatic. I explained some about newborn's needs from caretakers, drawing on atlachmeni theory'. She then became very thoughtful and said her mother was under stress at her birth, may have been ill. Her (mother's) father died 2 weeks later, and that was very lough for mother. She was entertaining the idea that maybe her mother wasn't to blame for the shortcomings Woami experienced. "Maybe it was my karma, like they say. to come into the world this way. Then that means I feel different about mom. Maybe it's important for me to understand this before she goes, even though I won't talk to her aboul it."

Sessions 17 20: During this month Woami has been occupied with the care of her failing mother. She has maintained an emotional equilibrium that I have never seen in her before. She is often calling doctors and other caretakers to intervene on her mother's behalf, and has "led the charge" amongst her siblings in advocating for the best care her mother could receive. She seems well prepared for her mother's passing, and has been very insightful about her mother's needs in the final phase of her life. "My mother is missing her mother; she never got to say goodbye when she died. So I placed my hands over her heart and told her. 'She's right here.'"

When I commented on how well she was coping, and that the NF seemed lo be helping, she added, "li was finishing that poem [for the daddy-kid] that helped first, then ihe NF: then I could use the rhythms. It's like when my mother plays on the piano— the rhythm helps her brain. So does the chanting." However, in a phone session I remarked to myself how Woami was really- unable to relate to me except as a sympathetic ear; the ability to allow space for another still needed development.

After a month of not doing NF due to vacations and snow, we resumed with the same protocol. I experimented with changing the frequencies, but she preferred the same one without even knowing where I had "set the dial." Within 9min she was calm and clear. Later in that session as we spoke again about how she well she was coping, she noted with curiosity that for the first time in her life she was able to carry a tune and the words to a song ("You've Gotta Have Confidence") in her head. She was quite amazed by this, and so was I. 1 thought about Levitan's book *This is Your Brain on Music*, and the central role the temporal lobes play in helping for memories of tunes and lyrics, similar to speech, and

that we were training points on both temporal lobes with NF.

POETIC MOVEMENT

Six months have passed. Woami requested we stop neurofeedback after the 24th session, saying she felt it was making her "yidgety." For the first time in our relationship, she took me to task: "You think that machine is God!" she said angrily. "Do you remember what things 1 have to work on in therapy?" 1 responded, saying the accusation about God was unfair, but she had a point that we had lost some of the thread of her treatment. We resumed talk therapy full-time, and to my amazement, it was no longer like treating someone with multiple diagnosis disorder. Woami stopped somatizing completely, and although she sometimes made reference to the pieces, basically she spoke of herself as one person with a multi- faceted self. There were no indications of regression to a more fragmented state or to the somaticizing defenses. Occasionally she noted some physical problem, but quickly moved off it to discuss real-life matters. And she made space for me to be a separate person; we even had some disagreements.

Almost imperceptibly Woami was putting her energies into living, spending less and less time with doctors. She organized another writing group at a church, look a course in da ling, and met with a gynecologist to discuss sex. She was determined to have a relationship with a man. She began producing more poetry and found places and people to whom she could recite her work and be greatly appreciated. And five months' postNF she said. "1 don't think I want to be a patient anymore."

I think her therapy may be drawing to a close. Perhaps stemming from the movements of tai chi, Woami says that now her life is about "poetic movement." It seems that the NF embedded itself within a therapy about movement, rhythm, and music. The rhythm and workings of this woman's brain clearly changed. She knows it and I know it, and now the music that is playing is seeking out others with whom she can harmonize. What has persisted is that we chant every session beginning and end: *Namyoho renge kyo.* Woami tells me this can roughly be understood to mean "with devotion to the universal law, the lotus flower blooms eternally out of the muddy swamp."

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PROCEEDINGS OF THE 2009 ISNR CONFERENCE

Selected Abstracts of Conference Presentations at the 2009 International Society for Neurofeedback and Research (ISNR) 17th Annual Conference, Indianapolis, Indiana

The 17th annual confcrcnec of the International Society for Neurofeedback and Research (ISNR) was held in Indianapolis, Indiana. Labor Day weekend with more than 400 people in attendance. If you happened to miss the

meeting, or a talk or two. what follows are abstracts along with e-mail addresses of the presenters, when available. Abstracts have been edited for length and clarity and most references removed. Please contact author(s) for further information on this research or purchase the DVD of the presentation from ISNR.

David A. Kaiser. PhD
Editor

Mela-Analysis of the Efficacy of Neurofeedback in ADHD on Inattention, Impulsiv- ity & Hyperactivity: Level 5 Efficacious & Specific

Martijn Ants, MSc. Sabine de Ridder. Ute Strehl, PhD, Marmus Breteler. and Ton Coenen
Brainclinics Diagnostics, Nijmegen, The Netherlands
< martijn@brainclinics.com >

Introduction

Since the first reports of neurofeedback treatment in ADHD in 1976. many studies have been carried out investigating the effects of neurofeedback on different symptoms of ADHD such as inattention, impulsivity, and hyperactivity. This technique is also used by many practitioners, but the question as to the evidence-based level of this treatment is still unclear.

Method

In this study selected research on neurofeedback treatment for ADHD was collected and a meta-analysis was performed. In total, 15 studies were incorporated with a total sample size of 1,194 individuals. For all studies means, sample sizes and standard deviations for measures of inattention, impulsivity. and hyperactivity were used to calculate the effect sizes (ES: Hedges' D). Forest plots were made and the grand-mean ES was calculated for all three measures.

Results

Both prospective controlled studies and studies employing a pre-and postdesign found large ES for neurofeedback on impul- sivity and inattention and a medium ES for hyperactivity. Randomized studies demonstrated a lower ES for hyperactivity suggesting that hyperactivity is probably most sensitive to nonspecific treatment factors.

Conclusions

Due to the inclusion of some very recent and sound methodological studies in this meta-analysis, potential confounding factors such as small studies, lack of randomization in previous studies, and a lack of adequate control groups have been addressed and the clinical effects of neurofeedback in the treatment of ADHD can be regarded as clinically meaningful. Four randomized controlled trials have shown neurofeedback to be superior to a (semiactive) control group, whereby the requirements for Level 4: Efficacious are fulfilled (criteria for evaluating the level of evidence for efficacy established by the AAPB and ISNR). Three studies have employed a semiactive control group, which can be regarded as a credible sham control providing an equal level of cognitive training and client-therapist interaction.

Therefore, in line with the AAPB and ISNR guidelines for rating clinical efficacy, we conclude that neurofeedback treatment for ADHD can be considered Efficacious and Specific (Level 5) with a large ES for inattention and impulsivity and a medium F.S for hyperactivity.

Acknowledgment

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Holtmann. Ulrike Leins, Domenic Greco. André Achim. and Geneviève Moreau.

Neurofeedback for Children and Adolescents with Tourette's Syndrome: A Case Review

Blair Aronovitch. BA, and Andrea Reid, MA The ADD Centre <blair.aronovitch@gmail.com>

Gilles de la Tourette Syndrome is characterized by a pattern of motor and vocal tics that persist several times per day for 1 year or more. Current research suggests that neurofeedback, or EEG biofeedback training, is an effective treatment for attentional deficits and seizure disorders, and may also be helpful for movement disorders. Research on neurofeedback and tic disorders including Tourette Syndrome has produced positive results (Dopfner &*l* Rolhenbereer, 2007: Poncin, Sukhodolsky, McGuire. & Scahill. 2007: Tansey, 1986). The purpose of this case review is to investigate whether 40 sessions of neurofeedback focused on sensorimotor rhythm (SMR) training, often in combination with biofeedback and mctacognitive strategies, may be an efficacious intervention for the reduction of symptoms associated with Tourette Syndrome. This article presents the results from a chart review of data collected before and after neurofeedback training conducted with children and adolescents with a diagnosis of Tourette Syndrome.

Method

This study consists of approximately 15 participants from 8 to 18 years of age who meet the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.: American Psychiatric Association. 1994) criteria for Tourette Syndrome. Participants who received an initial assessment but did not proceed with neurofeedback training serve as a control group. All training was done over the sensorimotor strip at CZ, C4, or C3 to increase SMR. SMR range was either 12-15 IIz or 13 151 Iz. Theta was decreased, with ranges determined based on Dr. Lynda Thompson's individual assessment, as well as the presence of any comorbid disorders. The broadest range for theta was 3-10 Hz.

All client ranges tell between these values, initial assessment data will be compared with data collected following a minimum of 40 treatment sessions. In some cases, participants have completed more sessions (up to 100 sessions). Metacognitive strategies were taught when feedback indicated that client was relaxed, calm, and focused. Data are reported according to which tests were administered at baseline and after training (pre and post). For each client this includes at least one of the following: Intermediate Visual and Auditory Continuous Performance Test, Tests of Variables of Attention,

Wechsler Intelligence Scales, Wide Range Achievement Test, and EEG data (such as theta/beta power ratios), as well as questionnaires and self-reports. Symptom severity is collected through self- report measures before and after neurofeedback. Change in presence of tics as well as change in medication were discussed in initial assessment and follow-up appointments with Dr. Thompson. Success is defined in terms of symptom reduction. Participants who received an initial assessment but did not receive neurofeedback are contacted for self-report updates in regards to their symptoms. Change in symptoms including reduction in frequency and severity are taken into account, as well as any medications taken after initial assessment. A chart review of pre- and posttrcatment data is conducted.

Results and Conclusions

Because of the small number of participants and multiple interventions (neurofeedback, biofeedback, metacognitive strategies), no definitive conclusions are drawn about efficacy of neurofeedback from this chart review. There is, however, a case review, which, with favorable outcomes, is used to encourage further controlled studies. The review also indicates which of the various measures used are the most sensitive for tracking change.

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Perioperative Sensorimotor Mapping by Task-Related EEC Activation: Method Validation Rased on a Series of 10 Surgical Epilepsy Patients

Helen Barkan, MD, PhD, and Terranee Darcey, PhD
SUNY
< barkanh@ upstate.ed u >

Introduction

The objective of this work was to demonstrate clinical utility for an adjuvant method for preoperative sensorimotor mapping in patients with intracranial grid implants for the localization of epileptic foci who are at risk for postoperative motor deficits. Task- related EEG activation has a wide range of potential uses, yet clinicians are still to be won over, possibly because of lack of validating studies showing clinical utility. Here we validate a clinical application of this method, which relies on the analysis of task-related spectral changes after Pfurts- chellers notion of event-related desynchronization of EEG (ERD).

Methods

ERD in the beta (13-35 Hz) frequency band was quantified by using a statistical Z score comparison of average beta power during and prior to sustained motor contraction. ERD maxima localized the hand and mouth areas in 10 patients with subdural grids with frontoparietal coverage, then the localization was compared to that of widely adopted techniques of electrical stimulation (ES) and median nerve somatosensory evoked
potentials (SSEPs), obtained from the same grid electrodes.

Results

In 7 patients who had unequivocal sensory and/or motor hand-area findings on ES and SSEPs mapping, the maximum ERD was concordant. In 7 patients who had definitive mouth-area findings on ES, the maximum ERD was in agreement. In cases where the hand (n = 2) or mouth (n = 3) area was not localized with ES due to prolonged seizures or lesions, ERD mapping was either in agreement with SSEPs for hand area, or localized to plausible anatomical locations for mouth area.

Conclusions

The beta ERD method for preoperative sensorimotor mapping is as reliable as ES/ SSEPs and is superior to both in terms of efficiency and safety. We suggest that ERD mapping be adopted as a technically simple and reliable adjuvant to standard-of-care clinical mapping with ES and SSEPs.

Internally Generated Cell Assembly Sequences in the Service of Cognition

Gyorgy Buzsdki. Ml). PhD Rutgers University
<gbuzsaki@axon.rutgers.edu>

How cell assembly sequences underlie cognitive processes was discussed.

Self, Other and Objcct Processing in the Addicted Brain

Rex Cannon. MA. Dehora Baldwin. PhD. and Joel Luhar, PhD University of Tennessee
<rcannon2@utk.edu>

Introduction

To investigate the ncurophysiological differences between recovering substance abusers (RSA) and controls using quantitative electroencephalography and standardized low-resolution electromagnetic tomography when evaluating photographic images of a hammer, another face, and the self.

Methods

This study was conducted with 38 participants: 18 recovering substance abusers and 20 nonclinical controls. EEG data were recorded in three experimental conditions: while viewing an image of a hammer, while viewing an image of another's face (a novel female face, the same for all participants), and while viewing an image of their own face. We performed voxel by voxel r tests between groups for each condition. The subjective reports were rated by three independent raters; two were blind to experimental conditions.

Results

The RSA group processes each of the images in different regions of the cortex in both alpha and beta frequencies as compared to controls. The specific regions of difference between groups occur within Brodmann Areas (BA) 24/32, 25, 9/10, and 47 in the anterior regions and BA 19. 7. and 31 in the posterior regions.

Conclusions

The regions of significant difference are shown active during fMRI experiments during tasks related to self-recognition, autobiographical memory, and self-reference, as well as emotional, social, memory, visual- spatial, and cognitive processes. The subjective reports provided by all participants at the end of the sessions indicated RSA viewed the hammer more as a weapon rather than a tool and tended to focus on perceived negative attributes of the other and their own image, whereas the controls tended toward practical elements of the hammer and rated the other and self in more neutral or positive ways. In this population of RSA the content of self report during the recordings while processing photographs of other, an object, and self is more negative than controls. This may reflect negative perceptual and maladaptive self-referential cortical processes: alternatively, it may represent processing differences in general or substance- related changes inperceptual processing. This is a topic for future study. Clinical implications are discussed relative to alpha/theta training and Periston's work.

Infrared Images of Migraine, Head Injury, ADD, Depression. Anger. Autism, and Other Common Disorders

Jeffrey Carmen. PhD Private practice
<¿armen5272@aol.com>

PIR HEG as a clinical procedure has now been in use for 11 years. This presentation reviews its development, along with clinical observations.

Assessment of Mild TBI in Three Retired NFL Football Players

Neil Bockian. PhD. and Eliezer Schwartz. PhD
Adler School of Professional Psychology
<nbockian@adler.edu>

QEEG has been shown to be a useful component of a comprehensive evaluation for mild traumatic brain injuries such as concussions. Three former NFL football players received comprehensive QEEG and neuropsychological assessment. The presenting complaints were fairly similar in all three cases, primarily involving problems with headaches, memory, and concentration. All played receiver and/or special teams positions. and therefore received multiple blows to the head. The blows were mostly received from contact of the helmet to the ground, but some were from helmet-to-helmct contact. QEEG was sensitive to damage, even though it had occurred about 3 to 10 years prior. Tn these cases, QEEG revealed diffuse delta in large areas of the brain, which was especially concentrated in the left temporal and tempero-parietal regions as well as in either or both frontal lobes. Neuropsychological evaluation confirmed functional impairments in memory', auditory and/or visual processing, and attention. The integration of QEEG and neuropsychological testing was synergistic in all cases, with information from one complementing and augmenting the other. Neurofeedback was

recommended in all three cases, as research supports neurofeedback as an intervention for the concerns they mentioned. Biological, psychological, and social implications are discussed.

Out of Injury Comes a New Discovery of Neurofeedback for a Baseball All-Star

Sean Casey
Boston Red Sox
Wes Sime. PhD. and Leslie Coates. PhD Private practice <wes.sime@gmail.eom>

The use of biofeedback to improve baseball hitting and mental performance was discussed by a Major League Baseball All- Star athlete and his associates.

EEC Coherences Validated by MR I Diffusion Tensor Imaging: An Autistic Case Series

Robert Cohen, PhD Private practice
<robcoben($optonline.net>

Normal brain functioning depends on synchronization within distributed brain networks. Breakdown of such connectivity correlates with behavioral and cognitive deficits (WoIters & Raffone, 2008). EEG coherence is the clearest indicator of this synchronization and coherence anomalies have been associated with such diverse conditions as autism, traumatic brain injury, and childhood sexual abuse (Coben & Hudspeth, 2008). However, there are different methods to assess coherence that provide disparate information (Kus, Kaminski. & Blinowska, 2004), and coherence is not considered to be necessarily equivalent with physical neural connectivity that can be measured in other ways (Teipel et al., 2009). MR I Diffusion Tensor Imaging (DTI) has emerged as the premiere measurement of physical and functional neural connectivity. MR1-DT1 measures the diffusion of water molecules in three dimensions across the fiber tracts of the brain. As such, it is considered a measurement of how information flows within and across the white matter tracts of the brain.

Autistic disorders have been conceptualized as dysfunctions in neural connectivity (Coben & Myers. 2008; Rippon, Brock, Brown, & Boucher. 2007). In a case series of children with autism, data are presented including both MRI-DTI and EEC data. EEG data was acquired with a high-density array of 64 cephalic electrodes all digitized with a three-dimensional tracking system. This enables localization of electrode sites for precise matching of spatial localization of activity across EEG and MRI platforms. Data are presented, including multiple forms of coherence (pairwisc, multivariate, source coherence) and their relation to MRI-DTI findings in these patients. Such analyses allow a comparison of the functional and neurophysiologies significance of such cohcrencc measurements such as has never been available previously. Implications for assessment and intervention are discussed.

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Group Independent Component Analysis of Brain Resting-State Networks: Nearly Identical Findings on Two EEG Databases

Marco Congedo. PhD. Dirk De Ridder, MD. PhD. E. Roy John. PhD. Leslie Prichep. PhD. and Robert Isenhart. PhD Centre National de la Recherche Scientilique <Marco.Congedo@gmail.com>

Interest in brain function in a resting state has recently increased considerably. On average the human brain extracts about 40% of available oxygen in the blood and disposes about 20% of the energy for the whole body. Still, it amounts to only 2% of the total body- weight. The aim of this study is to extract eyes-closed resting EEG networks using group independent component analysis. We employ a test-retest strategy using two independent large sample normative databases (A^{r} = 57 and A'=84) and retain as many- independent components as we can replicate. We characterize the cortical structures involved in each component by a distributed source localization of the spatial maps and their spectral profile. We also study their out-of-phase (lagged) coherence using recent advances on connectivity measures adapted to EEG data. We are able to replicate on the two databases seven components with nearly identical spatial and frequency distribution, explaining about 93% of the total EEG variance. Furthermore, we are able to replicate the organization of the extracted components in two networks, within which components oscillate coherently with a complex multiple-frequency dynamics, and exchange information at multiple time-lag rates.

Positive Subjective Experiences Related to Clarified Gamma Brainwave Neurofeedback from the Prefrontal Cortical Region of Meditators and Nonmeditators

Jonathan Cowan. PhD. and Beverly Rubik, PhD Peak Achievement Training <jon@peakace.com >

Introduction

Previous studies showed that 25 to 42 Hz brainwaves from the prefrontal cortical region in advanced Tibetan Buddhist meditators were found to be correlated with heightened experiences of compassion and clarity. In the present study, participants who were either advanced practitioners of Transcendental Meditation (TM: n = 6) or nonmeditating controls (n — 6) were engaged in a single session of neurofeedback in this same brainwave region using the Peak Brain- Happiness Trainer (PBHT). The PB HI is a novel type of neurofeedback instrument that can assess and train various dimensions of mental processing, including the Clarified gamma experience, which is hypothesized to be related to the processing of new learning and its reinforcement by positive feelings. To create the Clarified gamma neurofeedback protocol, the PBHT clarifies the 40Hz band of gamma EEG production from the prefrontal region by filtering out signal artifact from muscle tension or movement.

Methods

Real-time unlabeled auditory and/or visual neurofeedback Irom this clarified gamma protocol was provided to the participants in a controlled laboratory setting. They were asked to do the following sequential tasks: (a) to explore I he Clarified gamma-related experience and to subsequently describe it in their own words; (b) to engage for 2 min in each of 16 different emotional and cognitive states spoken to them as a sequence of descriptive words or phrases, and to decide, by comparing their momentary- experience to that moment's clarified gamma neurofeedback, how strongly these states correlated with the clarified gamma neurofeedback; (c) to engage in a neutral state to measure baseline values of clarified gamma; and (d) to quickly produce their maximum value of clarified gamma neurofeedback.

Results

Self-assessed descriptions of the clarified gamma experience were comparable for both groups. Associations of 11 of the 16 descriptors with the clarified gamma neurofeedback were positive, with the largest scores for "happiness" and "loving" and 3 of the 16 descriptors with the clarified gamma neurofeedback were negative with the largest scores for "stressed" and "disappointed." Baseline measurements of the clarified gamma band were indistinguishable for the two groups. Although both groups were able to significantly increase clarified gamma neurofeedback values, meditators were better able to quickly increase these gamma brain-waves at the prefrontal region than controls (p — .02).

Conclusions

We conclude that the clarified gamma experience appears to involve positive emotions of happiness and love, and lowered stress, and that TM practitioners have greater facility than controls in achieving it in a single neurofeedback session.

Significant Cognitive Improvements from Neurofeedback in Five Sessions: A Controlled Study

Jonathan Cowan, PhD, Nada Pop-Jordanova. MD. and Irena Chakalaroska. MD Peak Achievement Training <jon@peakace.com>

Introduction

A study of thirty 16- and 17-year-old high school students found that the In All Focus Training Protocol used in the Peak Achievement Trainer produced very substantial improvements in measures of concentration, attention, and memory in just live sessions. They were trained to focus their attention using this patented prefrontal wideband suppression protocol once a week for 30 to 45 min each.

Methods and Results

Performance on one of the attention measures—The Trail Making Test (TMT) Part A from the Halstead-Reitan Test Battery—nearly tripled, whereas the group average on the more difficult TMT Part B doubled.

TMT Part A consists of encircled numbers from 1 to 25 randomly spread across a sheet of paper. The object of the test is for the participant to connect the numbers (follow the dots) in order, beginning with 1 and ending with 25, in as little time as possible. TMT Part B is more complex than A because it requires the participant to connect numbers and letters in an alternating pattern (l-A-2- B-3-C, etc.) in as little time as possible. The improvements due to Peak Achievement Training were significant on both Part A and Part B. The study also included control groups using the Freeze Framer (now Em Wave PC) from IleartMath and the Inner Tuner Expert System, Ultra Mind International. Neither the heart rate variability feedback training nor the

electrodermal response feedback training produced significant gains on these tests in five sessions.

In addition, performance on both the Forward and Backward Digit Span Tests improved significantly with the In(hibit)AU wideband suppression protocol. The number of digits remembered when quizzed in the forward direction increased from 7 to 8, whereas the number remembered while stating them in reverse order increased from 4 to 4.5. Of the other two biofeedback groups, the only one that showed a significant improvement on Digit Span was the heart rate variability feedback training in the forward direction.

The study also showed that five sessions of wideband suppression training significantly enhanced the participants' abilities to focus. This is indicated by how long they could keep their concentration going without a lapse, as measured by the InAll Protocol.

Conclusions

These results are consistent with the idea that neurofeedback protocols that are easier to understand are rapidly learned. Our clinical experience with the Concentration protocol and the newer Focus protocol indicate that almost everyone who tries one under proper guidance can understand it and begin to control it in less than 2min.

Wideband suppression protocols are based on the concept of reinforcing a desyn- chronized EEC pattern, which indicates more underlying neuronal activity. We discuss the idea that the measurable EEG patterns are synchronized idling rhythms, based on what is known about the origin of thalamocortical EEC« patterns. Feedback based on wideband desynchronization versus synchronization is clearer than other types of feedback because it is based on a more robust phenomenon. Prefrontal feedback is more easily perceived by participants because it is more closely related to conscious processes.

Limbic Dysrhythmia

Dirk De Ridder, MD, PhD University Hospital Antwerp <dirk.de.ridder@ncurosurgery.be>

Introduction

Recent studies indicate that multiple thela generators exist in the human brain permitting integration of the limbic system activity with activity of the brainstem, the hypothalamus, and the neocortex. Except for the well-known link between theta and memory, theta is generated in emotion processing systems to both positive and negative stimuli. Thus the main domain of theta activity seems to be memory and emotional regulation.

In the resting awake state the dorsal anterior cingulate cortex oscillates at theta frequencies, driving prefrontal cortex to oscillate at the same rate and vice versa. In a combined EEG-MEG study it was found that the frontal midline theta is generated in the dorsal ACC. alternating with the ventromedial prefrontal cortex (PFC).

It has been suggested that this bidirectional coupling is influenced by the ventral tegmental area (VTA). The mediodorsal nucleus of the thalamus and VTA exert a complex dopaminergic (Dl. D2. and D4) gating action over PFC neural activity, either facilitating or inhibiting firing in the hippocampal PFC pathway depending on the frequency and relative timing of the arrival of afferent input. The electrical stimulation of the lateral, parvo- oelluiar pan of the mediodorsal thalamic nucleus only activates the anterior cingulate when the stimulus frequency is in the thela range (6-8 Hz). Thus the midline thela might be under influence of the dopaminergic VTA.

Nonthalamic subcortical delta generators are found in all parts of the mesolimbic dopaminergic reward system, that is. the VTA nucleus accumbens. ventral pallidum, and PET/EEG studies indicate a positive correlation between waking delta and PET metabolism in the medial frontal cortex, also related to the mesolimbic dopaminergic reward system. Therefore it has been suggested that awake delta activity is related to motivational drive for fulfilling basic needs such as food and sex. Titus delta oscillations activate brain motivational systems that signal salience and make the brain paying attention to biological relevant stimuli.

Furthermore, it has been established that frontal midline theta oscillations are involved in attentional processes and that both sympathetic and parasympathetic indices arc increased during the appearance of frontal midline theta. Theta band activities in the frontal area are correlated negatively with sympathetic activation.

Methods

A normative database of independent resting state EEG components has been developed by Congedo and John (NICA), in which three components are characterized by a theta spectrum, all anatomically located at the anterior cingulate, extending into the insula and amygdala and parahippocampal gyrus. The frontal midline theta corresponds to the activity of NICA component 1 (5 and 6) consisting of a

functionally connected network of the amygdala, subgenual anterior cingulate, dorsal anterior cingulate, and insula. The spectral analysis of NICA component 1 demonstrates this functional network oscillates at theta frequencies at rest. The amygdala anterior cingulate-anterior insula network might relate to the emotional significance and salience of internal and external stimuli, by combining networks involved in arousal and intrinsic alertness, interccptive awareness, and motivation.

Results

Analogous to thalamocortical dysrhythmia we present data suggesting that an absence of midline frontal theta with an associated increase of delta and/or beta activity might be an electrophysiological manifestation of a common pathophysiological mechanism underlying several distress and autonomic pathologies and propose to call this limbic dysrhythmia. Basically it is a dysrhythmia of component 1.5,6 in NICA.

Conclusions

Based on data in pain and tinnitus patients and on a literature research we suggest that this mechanism could potentially be extended from "distress" to include anxiety, major depression, PTSD, and autonomic dysregulation (irritable bowel, hypertension, syncopes, etc.). This group of clinical entities should be differentiated from motivational drive pathologies such as obsessive compulsive spectrum disorders and reward deficiency syndromes, which can be considered abnormal delta oscillation pathologies, in contrast to limbic dysrhythmia. which is suggested to be a dysrhythmic theta pathology.

This heuristic concept argues that limbic dysrhythmia pathologies should be treated by normalization of this delta-beta coupling to its resting theta rhythm, by neurobiofeed- back, tDCS. TMS, or implanted electrodes, whereas motivational drive pathologies should be treated with normalization to normal delta.

"The Thoracic Pump" Impetus for the Respiratory Arterial Pressure Wave and Breathing Induced Heart Rate Variability

Stephen Elliott. BS Coherence, LLC
<steve.elliott@coherence.com>

Human physiology is configured such that breathing serves to promote both blood flow and gas exchange. When we inhale, a significant volume of blood is ushered through the venous system into the lungs via the right heart. When we exhale an equal volume of blood exits the lungs via the left heart filling the arterial tree. This action gives rise to the well-understood but little recognized phenomenon of the "respiratory arterial pressure wave," which can be observed in the arterial blood llow plethysmographically, oscillometrically, and via catheterization. A view of the respiratory arterial pressure as measured in the finger with the J & J Engineering Physio-Data PPG is presented. An understanding of the relationship between the thoracic pump and breathing induced heart rate variability is offered.

Characterization of Impedance and Current Row in the Human Body as a Function of Connectedness to Earth Ground

Stephen Elliott, BS Coherence LLC"
<steve.elhott@coherence.com >

The human organism has an electrical relationship to Earth "ground." Although certain to be infinitely more complex than presently understood, initial findings are in themselves somewhat surprising. Impedance and resultant current llow in the human organism arc a function of connectedness to Earth ground. As such, impedance and current flow can be modified by modifying the resistance between human and earth. Characteristic impedance as measured across multiple adults and children is presented. Implications to electrically coupled biofeedback methods, that is, F.EG and EMG, are offered.

Examining Neurological Basis for Effective Leadership

Jeffrey Fannin, PhD
Center for Cognitive Enhancement
<jfannin@enhanccyourbrain.com>

Three different research studies are examined to establish the link between the potential neurological basis and effective leadership qualities. The first study used quantitative electroencephalographic procedures (qEEG); the brain activity of 46 senior leaders was recorded while at rest and when engaged in a visionary communication task. The findings support the expectation of frontal right-brain differences between leaders who engage in socialized, versus more personalized, visionary communication. Socialized visionary' communication, in turn, predicts follower perceptions of charismatic leadership. 1 discuss brain plasticity and the potential lo use neurological information for the purpose of leader development.

In the second research study examined, hope, optimism, confidence, and resiliency was found to be instrumental capacities for effective leadership. These capacities have generated interest among leadership researchers and practitioners primarily because they are considered to be open to development and have an impact on performance. 1 summarize some new and groundbreaking evidence that suggests the brain activity of leaders who are hopeful, optimistic, and resilient differs from those who are not.

The third research study examines Complex Adaptive Leadership, and its core component of self-complexity, is an emerging conceptualization of leadership that is based on the premise that complex operating environments require leaders to be highly adaptive in adjusting their behavioral responses to meet diverse role demands. 1 demonstrate that qEEG technology can provide valuable information about the neural correlates of various cognitive processes underlying leader self-complexity. With each research study I compare and contrast the correlations of leadership and LEG in the 40 Hz gamma band.

Transcranial Direct Current Stimulation (tDCS): Putative Mechanisms of Action and Clinical Effects of a Simple and Powerful Method of Cortical Electrical Stimulation

Felipe Fregni. MD, PhD Harvard University
<ftregni@bidmc.harvard.edu>

Transcranial direct current stimulation (tDCS) Ls a noninvasive method of brain stimulation that has been increasingly tesied for the treatment of neuropsychiatrie disorders. It has useful characteristics, such as low cost, ease of use, reliable sham methodology, and relatively powerful effects on cortical excitability. Because of its potential to modulate cortical excitability noninvasive!)-, tDCS has been tesied for the treatment of neuropsychiatrie disorders for several decades. In this presentation I review the mechanisms of action, the main characteristics, and the evidence on the use of tDCS for major neuropsychiatrie disorders. I also compare tDCS with other techniques of neuromodulation, especially transcranial magnetic stimulation, and suggest future directions for the use of tDCS in neuropsychiatry. Recent clinical studies on tDCS using novel approaches, such as different parameters of stimulation, have improved its neuromodulator effect thus resulting in larger clinical effects.

Findings to dale encourage further studies in this area that should explore novel parameters of stimulation. It appears that current methods of tDCS might not be fully optimized and, in fact, (a) individualized parameters of stimulation, (b) longer stimulation sessions, and (c) methods to focalize iDCS might be useful strategies to provide greater clinical benefits. Finally tDCS as compared to TMS might provide additional clinical benefits in specific situations such as when used to enhance learning.

Referenced LEG—Ready for Medication Implementation: A Review of the Recent Research

Daniel Hoffman. MD
Neuro-Therapy Clinic <
Daniel@hoffmanemail.c
om>

Referenced EEG is a tool for personalized medicine that helps identify biomar- kers for medication responses. By categorizing known medication responses to a patient's brainwaves, a clinician can be helped to identify the optimum individualized drugs for each patient. This talk presents the latest data on several recent studies including use in eating disorders.
SSRTs in children, substance abuse, medication washout, and a pilot study that served as the prototype for a large blinded academic study. Finally, the most recent results from the multisite controlled study- are discussed along with implications of use in clinical practice.

Self-Control Strategies for Modulation of Chronic Pain: Clinical and Research Implications

Mark Jensen. PhD University of Washington <mjensen@u.
washinglon.edu>

Although there remains much to be learned, a great deal is now known about the ncurophysiological processes involved in the experience of pain. Research confirms that there is no single focal ••center" in the brain responsible for the experience of pain. Rather, pain is the end product of a number of integrated networks that involve activity at multiple cortical and subcortical sites. Our current knowledge about the ncurophy- siological processes that subserve pain has important implications for understanding the mechanisms underlying the effects of various self-control strategies for chronic pain management, including self-hypnosis and neurofeedback training. For example, hypnotic analgesia interventions have demonstrated specific effects on activity in various cortical structures and F.EG measures of brain

activity, and these effects appear to differ as a function of the specific hypnotic suggestions used. Fewer studies have examined the effects of neurofeedback on cortical activity, although the research that has been performed suggests that training individuals to alter activity in specific band-widths may decrease the experience of pain. The research findings support the need for additional studies to (a) examine the effects and mechanisms of training patients in self-control strategies for pain management.

(b) study the effects of these interventions on different measures of cortical activity, and

(c) develop self-management training interventions that produce the most benefit for individuals suffering from chronic pain.

Relationship of Alpha-Theta Amplitude Crossover During Neurofeedback to Emergence of Spontaneous Imagery and Biographical Memories

Mark Johnson, MS, and Eugenia Bodenhamer-Davis, PhD
University of North Texas
<markjohnson2@my.unt.edu>

Introduction

Alpha-theta training is a brainwave biofeedback training protocol designed to facilitate a deeply relaxed state that is often associated with hypnagogic imagery. The clinical utility and effectiveness of alpha- theta training was demonstrated with military veterans treated for alcoholism and posttraumatic stress disorder (PTSD). Eugene Peniston, who conducted these early experiments, identified an alpha-theta amplitude crossover state that usually occurred during the course of this therapy and that was thought to represent a state of consciousness in which the individual could access hypnagogic imagery symbolic of issues in his life. Peniston believed that alpha-theta brainwave training facilitated the emergence of repressed anxiety provoking events from an individual's past through this hypnagogic imagery, and he suggested that the emergence of these abreactive imageries and/or memories should be the target and goal of alpha-theta training. In a significant observation, Peniston posited that increased beta and thcta activity reflects a brain process which helps us remember and relive past traumatic events. He further postulated that the healing process of self-awareness is manifested in high amplitude beta waves occurring in conjunction with the aforementioned cross-over of theta waves over alpha. Since the development of Peniston's successful brainwave training protocol, there has been some controversy among researchers in the field about the clinical relevance of the alpha-theta crossover phenomenon. This study is an attempt to clarify methodological and technical considerations related to alpha-theta crossovers during alpha-theta brainwave training to address controversial aspects of this biofeedback training protocol. This study attempts to answer the following research questions:

1. What constitutes a therapeutic alpha-theta crossover? Is the quality in terms of degree of amplitude of the theta-alpha crossover important to the emergence of spontaneous imagery and memory?
2. Are there relationships and ratios of specific bandwidths that are relevant to the type of imagery content that emerges?
3. Is a minimum amount of cognitive beta amplitude increase necessary to recall the content of imagery and memories evoked in alpha-theta training after a client returns to an alert state of consciousness?
4. Is there a relationship between delta brainwave activity and deeper states of consciousness?
5. Are higher amplitude crossovers related to better overall treatment outcomes?

Methods

Ten to 12 records of clients who received alpha-theta brainwave training as part of their neurofeedback treatment were obtained for analysis. A polynomial logistic regression analysis was performed to analyze the data for relationships among the variables of interest.

Results and Conclusions

A review of the data provides a number of tentative conclusions. Imagery recall appears to be dependent on higher amplitude and longer duration crossover variability and unrelated to very brief interactions of various bandwidth waveforms. Lower frequencies (i.e., theta to delta) correlate to deeper imagery experiences (i.e., biographical lo transpersonal). During crossover patterns, imagery occurs with greater frequency when cognitive beta is observed to rise concurrently with theta and delta frequencies as well. Delta activity correlates with deeper, transpersonal experiences. Greater crossover activity correlates with positive treatment outcomes.

The Role of EPA/DHA (Omega-3s) in Mental Health: Implications for Practitioners

Daniel Johnston, MD, PhD NaturalMedlnfo
<danjohnston@healthcasts.com>

The critical role of omega-3s in mental health and cardiovascular disease is poorly appreciated by most clinicians, and many- patients are left confused when confronted with a myriad of fish oil producl formulations on the market. This presentation focuses on detailed discussion of both epidemiologic and clinical trials of omega-3s in the realm of neuropsychiatry and why both EPA and DHA are important to ensure overall improved treatment outcomes as well as long-term

maintenance of healthy mental function and mood states. From nutritional and dietary perspectives on a population level to biochemical pathways, this presentation helps provide the attendee with a strong foundation in the neurochemistry behind omega-3s and how to help equip your patients from cradle to grave with nutrients that can optimize your desired practice outcomes. Last, a new area of interest where combining specific, powerful natural antioxidants with omega-3s for enhancing benefits is mentioned.

Quantitative EEG in Children with Early Tlistories of Abuse, Trauma, and Neglect

Jack Johnstone. Edward Hamlin, PhD, Jeff Atkinson. Andrea Meckley, MA, and Michael Vendetti
Q-Metrx. Inc.
<jack@q-metrx.com>

Introduction

In the present study we examine whether there is a pattern of quantitative EEG features that is consistent across individuals in the two groups of children diagnosed with reactive attachment disorder, all of whom have documented histories of abuse and/or neglect. Specific findings of cortical dysfunction would allow for a better understanding of the mechanism of this disorder and potentially assist in the development of more precise and effective treatment regimes.

Methods

This research used a two-cohort design allowing for independent replication of findings. All participants were seen in clinical consultation at one of two clinics specializing in treatment of behavioral disorders collaborating in this study. All participants were seen either at the Pisgah Institute. Asheville. North Carolina (Cohort I, A-" = 42) or the Attachment and Bonding Center of Atlanta, Georgia (Cohort 2, ,V=23). All individuals had a primary diagnosis of Reactive Attachment Disorder (ICD10: F94.1. F94.2; *DSM IV TR:* 313.89).

Results

Z-score analyses comparing each individual to an age-appropriate reference database showed a consistent group effect for relative power measures. There is significantly less relative delta power over frontal cortex in this population of children diagnosed with Reactive Attachment Disorder. In Cohort 1, the largest single deviation was for the F4-F8 sequential pair where the group average *z* score was 2.10 ($p < .05$). Frequency distributions confirm that these findings are not the result of a small number of extreme cases. Z-score deviations approach a normal distribution in this relatively small sample. The prediction that a comparable cohort of participants, with the same diagnosis, referred for clinical evaluation in a similar manner, and with data recorded and analyzed in an identical lash- ion would also show reduced frontal relative delta power was confirmed. In Cohort 2. the largest deviation was for relative delta power over the frontal regions (Fp2F4. r=1.69, /;<.04, one-tailed). Similar findings were seen with respect to effects of age and medication as in Cohort I. Findings again were not correlated with age and were seen in the absence of medications.

11 should be emphasized lhat the relative power measures for different frequency bands are interdependent. Relative power is a proportion of each frequency band compared to the whole frequency spectrum, in this study defined a* 1.5-25.0 Hz. This measure is sensitive to the shape of the frequency spectrum bul not overall power or amplitude. It is notable that relative delta power was decreased but no other single band was increased. In addition, there were no significant effects for absolute power measures. or coherence and symmetry measures. A mild increase in mean delta frequency was observed in anterior leads. These results speak to the specificity of the findings.

Results document decreased relative delta power recorded over anterior cortex in a population of children diagnosed with Reactive Attachment Disorder. These changes represent aberrant neurophysiological activity and are largely independent of age and medications used. This suggests that medications are used largely to ameliorate symptoms associated with relative attachment disorder but do not appears to affect the persistent finding of low relative delta power anteriorly.

Further studies should be directed toward the specific psychological correlates of low- frontal delta power, in addition, techniques such as F.F.G biofeedback could be employed to modulate phase relationships in the frontal EEG to modify effects of neglect and behavioral disturbances seen in reactive attachment disorder.

sLORETA and Independent Component Analysis of EEG in Obsessive-Compulsive Disorder: Implications for Neurofeedback Intervention

Jana Kopřivová, MA, Marco Congedo, PhD, Jan Prásko, MD, Michael Raszka, MD. Mariin Brunovsky, MD, PhD, and Jiri Horaček, MD, PhD. Prague Psychiatric Center & the Third Faculty of Medicine. Charles University Prague
<koprivova@pcp.lG.cuni.cz>

Introduction

Despite of medical progress, there are still a high percentage of obsessive-compulsive patients not responding or not responding sufficiently to current treatment. Accumulating evidence indicates that obsessive- compulsive disorder (OCD) has a distinct biological background and is conncctcd with dysfunctional f'ronto-striatal loops involving orbitofrontai and anterior cingulate cortex. It has been shown that the activity in deep cortical structures such as anterior cingulate can be modified through tomographic neurofeedback and possibly also through independent component neurofeedback. In OCD: however, source localization EEG studies that are necessary to guide a potential neurofeedback intervention targeting anterior cingulate or orbitofrontai cortex are missing.

Method

To fill the gap, we analyzed EEG of 50 OCD patients (20 drug free and 30 medicated with SSRIs) and 50 controls matched for age, sex, and handiness using standardized low-resolution electromagnetic tomography (sLORETA) and independent component analysis (ICA). Analyses were performed between 2 and 45 Hz with frequency resolution of 1 Hz. ICA was computed in the control group and resulting weights and norms were used to compare EEG of OCD patients. Symptom severity in the patient group was assessed using the Yale-Brown Obsessive-Compulsive Scale and Hamilton Anxiety Scale.

Results

sLORETA and ICA consistently showed an excess in power at low frequencies (2 6 Hz) localized primarily in the medial frontal cortex, including anterior cingulate and medial orbitofrontai cortex (/><.05, corrected). The only component abnormal in OCD compared with controls included signal also from insula (BA 13), superior temporal and parahippocampal gyri (BA 38), and lateral frontal cortex (BA 6. 8. 9). The pattern was present in drug-free as well as in SSRI medicated patients and was even more pronounced in medicated paiients. Symptom severity was not related to the increased low-frequency power, however, the medicated group had higher compulsion score *(p* = .04).

Conclusions

Our results are consistent with previous findings of medial frontal hyperactivation and performance monitoring hypothesis in OCD. Performance monitoring in OCD has been linked with anterior cingulate hyperactivation and with an enhanced error-related negativity that arises from ongoing theta generated in the medial frontal cortex. More-over. elevated theta activity in SSRI medicated group and a high percentage of SSRI nonresponders in our sample are congruent with previous reports of high theta power in OCD patients not responding to SSRIs. Our study is the first to apply sLORETA or ICA methods in OCD patients and has direct implications for neurofeedback intervention.

A ck no wledg men t

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QEEG and Event Related Potentials Endope-notypes: Applications for Diagnosis, Neurofeedback and Transcranial Direct Current Stimulation

Juri Kropotov, PhD Institute of the Human Brain
<jdkropotov@yahoo.com>

Spontaneous resting state EEG and cortical potentials in response to tasks provide two relatively independent windows to the human brain functioning. The spontaneous EEG is assessed by conventional spectral (power vs. frequency, coherence vs. frequency). The
EEG responses to tasks are assessed by ERPs (averaged potential vs. time). This presentation describes results of application of Independent Component Analysis (ICA) for (a» decomposing spontaneous EEG into spatially separated components associated with different types of oscillations (such as parietal, occipital and central alpha oscillations, frontal midline theta rhythm and beta activities) in the human brain, and for (b) decomposing ERPs into independent components associated with different psychological operations (such processing in dorsal and ventral visual streams, orienting response, engagement, motor suppression and monitoring operations). More than 1,000 healthy par ticipants and more than 1.000 patients with different brain disorders (ADHD,

dyslexia, depression, schizophrenia, OCD. stroke, and TBI) participated in the study. The results of application of the EEG/ERP ICA for diagnosis (discrimination) different brain dysfunctions are presented. In the final part of the paper T present a methodology for constructing protocols of neurofeedback and tDCS on the basis of comparison the individual QEEG/ERP parameters with normative data (I IB I reference database). Recently developed methods of neurotherapy such as sLORETA. ERP-based neurofeedback, and local source tDCS are introduced.

More Words Than No: Two Cases of Juvenile Autism Treated with the LENS

II. Stephen Larsen. PhD. and Nicholas Dogris. PhD
SUNY, Stone Mountain Center
<siephenlarsen@earthlink.net>

In this unique clinical comparison, two advanced clinical practitioners of the LENS from opposite sides of the country present two little girls: ZG and ES. both diagnosed as severely autistic, and with only one word each at the beginning of treatment: "No!!" Both were 4 years old at the beginning of treatment. ZG on multiple meds, diagnosed by conventional practitioners as hopelessly autistic, with very little hope for progress. A regional center challenged the legitimacy of the neurofeedback treatment, but the treatment led to big and obvious improvements in school and an independent evaluation of remarkable progress. ES was an amazingly cute little ball of negativity observed by many professionals but whose parents refused drug treatments. Both were almost impossible to get to sit still for the sensors to be attached at the beginning. At the current stage of treatment each is far more functional and pliable, and has many more words than "No!" ES is beginning to speak in sentences and spell and read aloud as well as play interactively with other children.

These cases are dramatic because of the thoroughness in which their disorders—and their remediation is documented: multiple reports from therapists and teachers, multiple brain maps done over 2 years, and in the case of ZG. a record of e-mails marking progress from the little girl's mother, and with ES comments from professionals astonished at the big improvements the little girl showed, and wondering what possible method could produce them (the LENS seems to empower other therapeutic modalities such as OT and LT). There were also movie clips and images as well as maps an unforgettable glimpse into the rescue of the Autistic child from solipsism and isolation.

QEEG Subtypes of Autistic Spectrum Disorder: Why are They Important?

Michael Linden, PhD ADD Treatment Centers <d rmike49@aol.com>

This presentation reviews the QEEG subtypes of Autism and Asperger's reported by other clinicians and based on 9 years of approximately 300 clinical case studies that were evaluated in our clinical practices and reviewed by Jack Johnson. PhD. Jay Gun- kclman, QEEGT, and several neurologists. The cases were qualitatively evaluated for patterns in both EEG and QEEG measures. These observable patterns (subtypes) allowed the following benefits:

1. Clearer diagnoses and exploration of possible etiologies for Autism and Asperger's.
2. Rule out abnormal EEG and possible seizures.
3. Easier explanations of Autism (High Functioning) and Asperger's to parents, physicians, and educators.
4. Improved selection of neurofeedback protocols.
5. Increased ability to individualize and predict medication response.
6. Greater ability to monitor & measure the results of neurofeedback treatment.

Intensive Neurotherapy Facilitates Recovery from Severe Brain Injury and Seizures

Denise Malkowicz. MD, Diana Martinez, MD. Jorge Leon Morales, MD, M. Barry Sterman, PhD. and David Kaiser, PhD The Institutes for the Advancement of Human Potential <denisemmd2@aol.com>

Introduction

Patients with severe brain injury and refractory' seizures often have poor recovery. Intensive neurotherapy reinforcing sensory motor rhythm (SMR) may promote neuro- plasticity in thalamocortical circuits, significantly improving outcome.

Method

A 29-year-old man had a severe traumatic brain injury after a motor vehicle accident 10 years ago. He had spastic quadriparesis, uneoordination. dysphasia, aphasia, and sleep disruption and refractory secondary' generalized seizures with postictal impairment lasting up to 10 days. All previous therapies failed to improve his condition. Twcniy-four-channel EEG recordings (NeuroNavigator) were analyzed using SKIL software. It showed excessive diffuse delta and thcta (—12 *z* score) compared to healthy adults, with little SMR or alpha activity.

Daily neurotherapy aimed to progressively reinforce SMR in central regions and 8.6 to 10.6 Hz activity in other brain regions.

Therapy sessions continued to increase in length and complexity as he improved. He underwent three 30-day periods of neu- rotherapy with the same protocols, separated by 5 months each.

Results

After the first session his sleep integration increased from 2hr to 8hr per night. Seizures

decreased in frequency, intensity, and duration without postictal impairment. Speech, swallowing, coordination, and motor control in trunk and extremities improved by at least 50% significantly increasing his abilities. Post- training QEEG showed more normalized delta and thcta (+2 r score), and SMR and alpha activity were present. Despite stopping neurotherapy for 5 months he continued to improve in all areas including seizure control, allowing him to be independent in his daily life. His posttraining QF.EG revealed more SMR and alpha activity.

Conclusions

Intensive neurotherapy facilitated recovery from brain injury and seizures 10 years after injury and despite failure of other therapies. Ncurophysiological and clinical changes were robust, durable, and self-regenerating. We believe that this intensive neurotherapy protocol normalized thalamocortical circuits by facilitating Long Term Potentiation (LTP). LTP increases neural protein synthesis. growth, and remodeling.

Efficacy of Neurofeedback as a Treatment for Children and Adolescents with a History of Early Relationship Trauma

Alexis Meinhold, MC. A Iberio Texidor. PhD. and Sarah Wyckoff, MA Private Practice
<lexi.meinhold@cox.net>

This study addresses the long-term efficacy of neurofeedback as a treatment for children and adolescents with a history of early relationship trauma. Pretreatment, posttreatment, and longitudinal data using the Vanderbilt Assessment Scale (child and adolescent version) has been collected. Initial assessment of the data indicates 80% of clients do not meet diagnostic criteria for attention deficit disorder, oppositional defiant disorder, or depression/anxiety at the end of treatment. Longitudinal data, collected 6 months to 3 years following termination of treatment, indicates that 80% of clients continue to maintain behavioral gains. Datacollcction is ongoing at this time and a complete statistical analysis will be made available at a later dale.

Attention Déficit Hyperactivity Disorder: The New Approach in Diagnostics with Neuropsychological and Electrophysiological Endo- phenotypes

Andreas Mueller. PhD. ami Gian Candrian, MA
Brain and Trauma Foundation
<andreas_mueller@swissonlihe.eh >

ADHD is one of the most prevalent dysfunctions in children and increasingly in adults. ADHD people poorly perform in school and in work, have a low self-esteem, have deficient social skills, and are at high risk for drug abuse. Until recently, the only diagnostic criteria for ADHD were behavioral symptoms, and the only officially accepted medicine was stimulant treatment. With newcriteria from the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.), diagnoses have to be done on the base of endophenotypes.

The brain and trauma foundation in Switzerland performed a large study in ADHD in adults. Behavioral, neuropsychological, and ncurophysiological data of the whole sample (178 participants) is analyzed and is compared with a control group (same size).

Multidimensional analyses of the data set show very surprising results. The prominent biomarkers, which we used before (e.g., Thcta/beta ratio, spectra) are not longer valid and have to be redefined. The view of the working brain, measured with ERPs. shows much better results. We propose a new method of diagnoses ADHD based on ICA ERP-componcnts in a multidimensional space. The space is defined by several dynamics of neurobiology. This brings the diagnose close to an effective treatment.

The oral presentation shows the results of the adults ADHD study. We demonstrate that ERPs of executive system taken in visual, auditory, and emotional continuous performance GO/NOGO tasks give significant results between ADHD and controls. Furthermore we discuss which elements of the diagnosis (questionnaires, interview, neuropsychological testing, QEEG/ERPs) arc helpful for treatment.

EEG Suppression: A Theoretical/Clinical Talk on an Important New Variable in Neurofeedback and Neuroscience

Len Ochs. PhD
Private practice
<lochs@earthlink.net>

This presentation introduces a new concept of EEG suppression that differs from its appearance in the neurology/anesthesia literature. This definition of EEG suppression shows the importance of standard deviation and amplitude reductions in the EEG. how to assess them, and how this can help the clients in neurofeedback. The presentation covers its definition, early signs of its significance. its calculation as the coefficient of variation, its interaction with EEG amplitudes. and its influence on the recovery of human functioning. The ability to predict the course of EEG amplitude fluctuations has ramifications for evaluating lhe success in neurofeedback and understanding the making and breaking of connectivity. It also has ramifications for providing clients with a context for the changes in their EEGs. The presentation is supported by case histories accompanied by EEG topographic map series as well as charts showing changes in symptom ratings. Attendees are shown how to make their own suppression reports if the appropriate data are present in their neurofeedback systems. Implications for research are addressed.

Improving Decision Making with Noninvasive Brain Stimulation

AI vara Pascuai-Leone, MD. PhD Berenson-Allen Center for Noninvasive Brain Stimulation
<apleone@bidmc.harvard.edu>

In recent years, dual-process theories that contrast automated and controlled processes have been put forward to explain different areas of human cognition. In this context, will-power refers to goal-driven cognitive control or regulation of impulses, passions, cravings, and habits. Such regulation may be conceptualized as cognitive control over the balance between a "cool," reflective mental system that effortfully represents rational and reasoned goals, such as long-term mental and physical health, and a "hot," reficxic mental system that automatically guides quick, impulsive, and emotional responses to environmental stimuli.

In recent years, lesion and functional ncu-roimaging studies suggest that the prefrontal cortex is a critical component of the neural circuitry engaged when people voluntarily and consciously regulate their behavior. In addition to neuroimaging studies, lesion studies suggest that particularly the right prefrontal cortex plays a central role in behavioral regulation and the control of impulsive, reflexic tendencies.

Modulation of will-power and dual-process theories offers a valuable framework that can serve to guide translational insights from cognitive neuroscience into the clinic. Proof-of- principlc studies reveal that noninvasive brain stimulation of the dorsolateral prefrontal cortex with repetitive transcranial magnetic stimulation or transcranial direct current stimulation can influence decision making, enhance will-power, and promote reflective processes in healthy subjects. The same type of noninvasive brain stimulation can suppress alcohol, cocaine, nicotine, and even food craving in patients, who are known to have impaired decision-making behaviors. Modulation of decision making, and enhanced cognitive regulation of emotion, reward, and gratification, could have widespread mental and physical health benefits, including effective therapies for mood disorders, anxiety. ADHD, PTSD. substance abuse, smoking, and obesity.

EEG Source Localization of Object Processing

Jessica Paskwietz. BA, Kyle Dean. BA, Michelle Bledsoe. BA, Jeffery Inman. BA. Sempanghi Jones, BA. Amanda Barbara,

BA, Jecolia While, BA, Rex Cannon. MA. and Debar a Baldwin, PhD University of Tennessee <jpaskwieA@utk.edu>

Introduction

This study investigated the neurophysiology of object processing in a population of normal university students. We utilized standardized low-resolution electromagnetic tomography (sLORF.TA) to map sources of the EEG recorded at the scalp.

/Methods

We obtained 100 students (60 female) with a mean age of 21. EEC data were recorded for 4min while participants viewed an image of a hammer. We performed EEG source localization using sLORETA. We compared the image condition to baseline using all voxel by voxel / tests. Significant voxels of difference were mapped onto an MNI atlas containing 6,329. 5 mm voxels. The phenomenology of the recording was obtained at the end of the EEG recordings.

Results

The contrasts between baseline and object processing show specific differences in regions in the left hemisphere in delta, theta and alpha frequency domains, wheras alpha and beta activity show significant increase in right anterior cingulate (BA 24) and prefrontal regions in addition to right parietotemporal areas.

Discussion

The left hemisphere appears to play an important role in object processing. The increase is related to the evaluation, categorization. and experiential memories utilized while focusing on the image. The right anterior regions may also play a role in the identification of the object but may also be important to the meaning of the object and its known function in social and intrapersonal contexts. The subjective reports of mental processes and experiences of the participants offer evidence for the patterns of significant increase in these regions.

Incremental Gains in Self-Regulation Skills: Comparison After 20 and 40 Sessions of Neurofeedback

Andrea Reid. MA, and Blair Aronovitch. BA ADD Centre < a d d cen tre@gmail .co m>

Introduction

EEG biofeedback practitioners around the world have been publishing studies on the effectiveness of neurofeedback training on ADHD. This research has demonstrated that neurofeedback is an efficacious treatment for ADHD, but it has not clarified the number of neurofeedback training sessions that lead to optimal gains. Some practitioners have examined results after 20 sessions of feedback, whereas others have presented results following 40 sessions of training. This pilot project proposes to fill this void by analyzing the effect of the number of sessions of neurofeedback on attention. EEG, and short-term memory (digit span). This study will compare client scores on these measures before neurofeedback training, alter 20 sessions, and after 40 sessions of training.

Method

Clients range from age 6 to adult, and all met the criteria for diagnosis of ADHD or Asperger's Syndrome according to the *Diagnostic and Statistical Manual of Mental Disorders* (5th cd.). All clients will have been tested using the Integrated Auditory and Visual Continuous performance test (IVA) at their initial assessment, after 20 sessions of training and after 40 sessions of training. A subset of clients will also have data on EEG changes, W'esehler Intelligence Scale IV digit span subtest data and questionnaire data post-20 sessions and post-40 sessions of

training. There will be a minimum of 20 participants in this study. Training sessions are 50min. and most clients attend twice a week. Training parameters are based on an initial assessment of EEC performed by Dr. Lynda Thompson. Most clients already in the study have been doing training at either Cz or C4 reference to the left ear. The aim for the majority of clients is to decrease slow wave activity (3-7 Hz, 4-8 Hz. or 3-10 Hz), increase sensorimotor rhythm (12-15 Hz or 13-15 Hz) while decreasing any high frequency beta or spindling beta (23-35 Hz). EEG biofeedback training sessions are also combined with me la-cognitive strategies.

Results

This study is not yet completed. Results will include the 1VA. questionnaire data (Conners' Global Index for ADHD. ADD Centre's ADDQ. and DSM1V questionnaire for ADHD), and EEG. EEG ratios include thcta/beta and theta/SMR ratios.

Conclusions

This design will be implemented and findings may be reported at a future conference.

Neuroplastic Effects of Endogenously Entrained Brain Rhythms: A TMS-EEG Study

To mas Ros. MSc. Moniek A.M. Mutmeke, Diana Ruge, John H. Gruzelier, and John C. Rot/¡well
Goldsmiths, University of London
<t.ros(frgold.ac.uk>

Introduction

We investigated whether a 30-min session of EEG neurofeedback (NFB) at left motor cortex of 24 naive participants modified corticomotor plasticity.

Methods

Effects on corticospinal excitability as well as short intracortical inhibition and facilitation of either alpha (8-12 Hz) suppression or low beta (12-15 Hz) enhancement NFB were assessed by single-pulse and paired-pulse transcranial magnetic stimulation applied to right and left hemisphere motor cortex. Immediately before and twice after the NFB session, the motor evoked potential and intracortical parameters were measured.

Results

Net corticospinal excitability of the left hemisphere was significantly increased more than 20 min after the end of alpha suppression (desynchronization), as reflected in the average magnitude of the motor evoked potential (MEP; 130% of baseline), together with a significant reduction of short intracortical inhibition (165% of baseline). Of importance. MEP change was inversely correlated with percentage of alpha amplitude change during NFB (r> 0.5, $p < .05$), as well as with the ratio of pre-to-post alpha baseline at rest. Following low beta NFB training there was a significant enhancement, of intracortical facilitation, without reliable main effects in MEP amplitude, both seemingly a result of uneven entrainment. Nevertheless a significant negative correlation was observed between the magnitude of low beia synchronisation and single-pulse MFP change (r>—0.5, /;<.05). In contrast, no statistically significant alterations in TMS parameters were seen in the untrained (right) hemisphere lor either protocol.

Conclusions

Prolonged desynchronization of endogenous alpha rhythm, generally regarded as an indicator of conical activation, is associated with potentiation of corticospinal excitability and reduced intracortical inhibition, whereas synchronized low beta rhythms, albeit suboptimally entrained, correlate with reductions in corticospinal excitability. The current study provides the first evidence for the "missing link" between the historically reported but inadequately recognized effects of cumulative neurofeedback training and direct validation of LTP-likc neuroplastic change following a discrete training session. It furthermore supports an explicit and endogenous role for brain oscillations in the mediation of synaptic plasticity.

Note

This presentation won the Student Paper Award.

The Complex Trial Protocol in Detection of Deception and Malingering

J. Peter Rosen/eld, PhD
Northwestern University
<jp-rosenfeld@northwestern.edu>

Introduction

The P300 event-related EEG potential (ERP) is an endogenous ERP, evoked by meaningful stimuli presented rarely in a sequence of meaningful and non-meaningful items. Rosenfeld et al. (1991): Rosenfeld. Angell, Johnson, and Qian (1988): and Harwell and Donchin (1991) developed a "3-stimulus protocol" (3SP) for using P300 to detect deception and malingering.

Methods

In this protocol, on each trial, either a probe (P), a target (T). or an irrelevant (I) item was presented. Ps and Ts each had a probability of about .15, and Is had a probability of .7. Ps were guilty knowledge items such as the amount of money stolen in a crime, such as S500. Is and Ts were irrelevant to the crime but in the same category as Ps (e.g.. other amounts of money such as SI00, $200, S1000, $2000. $5,000)." One of the Is was a designated T. say, S200. It was incorrect but suspects were told to say "yes" when shown this T. They said "no" to all other amounts, including $500, the P. thus lying. The items were presented randomly, and it was expected that P would elicit a P300 because it was rare and meaningful. Is would not. Ts would because they elicited the unique "yes" response that made them meaningful as well as rare: however, the whole point of T was to force attention to all randomly presented stimuli. The test of guilty was guilty knowledge recognition, as provided by the fact that the P300 to the P would be greater than that to the I.

Results and Conclusions

This 3SP was used successfully in dozens of reports to detect malingering by head injury simulators as well as deception and guilty knowledge possession by lab-simulated criminals—until we finally successfully attempted to defeat it with countcrmeasures (CMs) in 2004. as replicated by Mertens and Allen (2008). It was thus necessary to come up with a new P300-based CM-resis- tant protocol, which we introduced in 2008. We hypothesized that the older 3SP was vulnerable to CMs because on each trial the subject was forced to do two simultaneous tasks that competed for attentional resources: the explicil target versus nontarget (NT) discrimination, plus the probe recognition task. The increased task demand produced by dual tasking is known to reduce P300. Thus Rosenfeld et al. (2008) separated the P-l recognition task in time from the T-NT discrimination. This modification allowed 90 to 100% accuracy in detection of guilty participants—whether or not they used CMs—with 0 to 8% false positives. This protocol has now also been used in malingering related protocols with detection of concealed autobiographical information detection, as well as in mock crime scenarios with detection of concealed crime detail information. Most recently, wc have developed an antiter- ror scenario in which we can detect planned details of terrorists acts while in the planning stage and before the acts have been committed. We can even do this when we do not know in advance what the correct answers arc.

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Integrating Cognitive Rehabilitation and Neurofeedback: A Review of the Research

Joseph Sand ford. PhD
BrainTrain
<jas@braintrain.com >

The clinical efficacy and effectiveness of cognitive rehabilitation has been recognized and accepted by the general scientific community based on numerous controlled research studies. Neurofeedback training has often been implemented simultaneously with educational and learning skill tasks. This cognitive- educational training methodology constitutes a "push-pull" technique that fosters both the generalization of neurofeedback and the development of divided attention. The application of specific computerized attention training exercises in conjunction with neurofeedback has been shown to significantly improve attentional functioning for both mTBI and adult ADHD populations in only 20 training sessions. In addition, cognitive training prov ides an ethically appropriate control treatment for neurofeedback research. These studies and additional research incorporating meta-cognition training in identifying effective means for the integration of cognitive rehabilitation and neurofeedback are reviewed in this paper.

Brain Oscillatory Correlates of Visual Attention and Short-Term Memory

Paid Sauseng. PhD University
of Salzburg
<pau!.sauseng@sbg.ac.at>

As we are continuously bombarded with visual information, we have to select relevant from irrelevant visual input. Based on a recent hypothesis on the functional meaning of electroencephalographic (BEG) alpha activity, local 10-Hz oscillations are discussed as a correlate of efficient suppression of irrelevant visual information. It is demonstrated that local alpha activity is increased at posterior brain sites during processing of irrelevant visual input in visuospatial attention tasks as well as during short-term memory retention. Thereby, cognitive processing of relevant information will be increased in efficiency, a mechanism that can be supported (as prove of principle) by repetitive transcranial magnetic stimulation (rTMS). In addition, evidence is presented indicating interregional alpha activity to be relevant for the control of visual attention and selection mechanisms. Finally, the role of theta activity (around 5 Hz) during processing of relevant information in visual short-term memory tasks is discussed. Data are presented suggesting theta to be important for encoding of relevant information into short-term memory and indicating phase synchronization between theta and fast oscillations to be a correlate of short-term memory retention of relevant information.

Effects of Neurofeedback-Based Behavioral Therapy on FRP Measures of Executive Functions In Drug Abuse

Estate Sokhadze, PhD, Christopher Stewart, MD. Guela Sokhadze. Margaret Husk, MD. and Allan Tasmcm, MD University of Louisville Ctato.
sokhadzeiiiJouisvillc.cdu>

Introduction

Neurofeedback training integrated with other behavioral techniques could be one of the potentially efficacious intervention options for cocaine addiction treatment. Our study combined SMR neurofeedback treatment with motivation enhancement therapy for the treatment of outpatients with cocaine addiction. EEG changes in beta and theta power are typical for withdrawal from cocaine. Executive prefrontal functional deficits have been reported for both active users and recovering addicts. We proposed that cocaine abusers may benetlt from SMR and SMR/Theta neurofeedback protocol. Motivational interviewing techniques were employed to engage outpatient subjects in neurofeedback and retain them during 12-session-long neurofeedback training course. Cognitive test based on Eriksen Hanker task with dense-array event-related potential (ERP) recording was used to assess intervention effects on such executive functions as cortical inhibition, motor response conflict detection, and error monitoring along with more traditional clinical outcome

measures. We report immediate post-treatment effects in 14 subjects and 6 months follow-up effects in 11 subjects.

Method

ERPs were acquired with a 128 channel Electrical Geodesies Inc Net Station EEG device prior and following 4 week long bio-beliavioral intervention using a speeded forced-choice reaction time task (Eriksen danker tests) with NoGo trials. Follow-up test was conducted after 6 months. Beside behavioral and ERP measures during flanker test, the treatment outcomes included cocaine and marijuana use rale (urine and saliva screens), maintaining treatment retention, and psychiatric status (PTSD. depression). From 20 outpatient participants with cocaine addiction initially enrolled in the study, 14 participants completed whole course of neu- rofeedback. motivational interviewing sessions, and pre- and posttreatment F.RP tests and clinical evaluations. Only 11 of them were available for 6-month follow-up tests and evaluations. Most participants tested positive both on cocaine and marijuana use on the intake stage. Each of these SUD participant participated in 12 sessions of SMR up/Theta down training (30min, twice a week) and up to 3 sessions of MI. The neurofeedback session included two block* with "SMR increase" and single blocks of"SMR increase and The ta decrease" and "SMR/ Theta" ratio increase.

Results

Most of the participants successfully learned to increase SMR rhythm (mean increase per session = 11%) at C3 site but were less successful in simultaneous SMR-up/ Theta-down blocks. Participants who completed whole course of combined neurofeedback and Ml intervention showed improvement on behavioral and ERP measures of executive functions in posttreatment flanker test. Frontal N200 latency indicative of motor interference detection functionality increased from 289 to 319 msec, whereas frontocentral P300 amplitude indexing cortical inhibition function in NoGo trials increased from 1.39 to 3.4 V ($p < .05$). Frontal P300 latency in Go trials also increased from 371 to 431 msec. Error-Related negativity (ERN) amplitude at the fronto-central area increased from -2.52 to 4.99 V, pointing at an enhanced error monitoring functionality in the posttreatment period. Follow-up flanker test showed that positive changes in frontal N200 and P300 components were still maintained, whereas the ERN measure did not show significant difference from the intake level. Among the clinical outcome measures the most significant was a decrease of depression scores (BDI II, $p = .01$) and a decrease of PTSD scores (p — .02). Depression scores on follow-up remained lower than at the pretreatment level (pre. 25.8; post, 14.7; follow-up, 12.5, follow-up vs. pretreatment, $p < .05$). The drug screens did not show- significant decrease in cocaine use posttreatment; however, number of positive tests for marijuana use decreased siguificantly (post- vs, pre-NFB urine drug screens: cocaine use. nonsignificantly decreased by 14%. $p = A6$. marijuana use rate decreased by 71%, ¿><.01). Lower rate of marijuana use was confirmed at follow-up tests. Cocaine use rate at follow-up assessment was lower than at intake but still did not reach significance level.

Conclusions

The results of this pilot study support our suggestion that a combination of motivational interviewing with neurofeedback might be a promising approach to biobeha- vioral intervention for addictive disorders, and specifically for treatment of cocaine addiction co-occurring with marijuana use in outpatient population. The project showed feasibility of such biobehavioral intervention in both active users and recovering outpatient cocaine addicts. Application of cognitive neuroscience techniques in a form of cognitive ERPs to test executive functions can significantly improve methodology of posttreatment assessment of cognitive and electrocortical outcomes of neurotherapy.

The Effects of Different Breakfasts on a Child: A Data Analysis of Three QCEGs

Ron Swatzyna, PhD, and Bianco Gonzalez The Tarnow Center for Self Management <drron@tamowcenter.com>

Introduction

Many U.S. children have very poor eating habits, which have greatly contributed to a rise in their obesity and diabetes rates. In addition, studies suggest poor nutrition diminishes mental functioning and exacerbates mental and behavioral disorders. Nutritional scientific investigation has run the

gamete of study from malnutrition through a multitude of dietetic combinations. These studies have measured a variety of mental functioning including IQ. cognitive abilities, processing speed, and memory. Decades of research suggest that optimal brain functioning is proportional to a well-balanced nutritional diet that minimizes glycemic swings with calories adjusted to level of activity and metabolism of each individual. In a search of the literature. John Polich studied the effects of intake on event related potentials. However, no investigation has assessed the effect of intake on QEEG data. The goal of this study is identify any statistical differences in QEEG data under three typical breakfast choices of children: ia) no food for breakfast, (b) a breakfast made up of high sugars and high carbohydrates, and (c) a nutritionally balanced breakfast.

Methods

The participant in this study was a 12- year-old healthy female volunteer who came to me with a desire to do a brainwave study for her school's science fair. The variables that were controlled were time of day, intake after breakfast, and sleep. Each qEEG was done on the same participant, at noon on three different school days after the participant sleep approximately the same amount of hours with the participants' eyes closed. The rationale for doing the qEEGs at noon prior to lunch was to assess the expected differences in the qEEG data due to hypo-glycemia from not eating breakfast and from the insulin response to a high sugar, high carbohydrate breakfast.

The three EEGs were recorded (Deymed Diagnostic, TruScan 32) from 19 scalp locations. The first qEEG was done after the participant skipped breakfast altogether. The second qEEG was done after eating a breakfast consisting of a Pop-Tart and a glass of orange juice. The third qEEG was done after she eating a nutritionally balanced breakfast consisting of a glass of milk: a half slice of whole wheat toast; two eggs: one half cup of a combination of strawberries, bananas, and apples: and one fourth cup of tomatoes.

Results

The results were extrapolated from the qEEG statistical data of relative power in the eyes closed condition from all three qEEGs. The most significant differences were found in the participant's anterior lobes (F7, F3, FZ, F4. F8. C3, CZ, C4) in 26 30 Hz.

Conclusions

The 26 to 30-Hz high beta activity are correlated with irritability and anxiety and this activity in the anterior lobes would affect brain functions such as executive function, working memory, motor control, and so forth. This pilot study suggests that at least for this 12-year-old female participant.
eating no breakfast greatly increases her high beta activity especially in her anterior lobes. When she eats a breakfast consisting of high sugar, high carbohydrates, her high beta activity is somewhat diminished but is still significant. Finally, when she eats a nutritionally balanced breakfast, her high beta activity comes very close to normalizing. The direction of future investigation should study larger numbers of children both with and without psychopathology and learning issues. It would also be interesting to track how changes toward nutritionally balanced diets affect scholastic achievement.

Autism and EEG Phase Reset: A Unified Theory of Deficient GABA Mediated Inhibition in Thalamocortical Connections

Robert Thatcher, PhD. Duane North. MS. Car/ Biver, PhD, James Neuhrander, MD. Stuart Culler. PhD. and Philip DeFina. Phi) Applied Neuroscience. Inc. < rwthatcher@yahoo.com >

Introduction

The purpose of this study was to explore the relationship between EEG phase reset in autistic spectrum disorder (ASD) participants as compared to age-matched normal participants.

Methods

The electroencephalogram (EEG) was recorded from 19 scalp locations from 54 autistic participants and 241 normal participants ranging in age from 2.6 years to 11 years. Complex demodulation was used to compute instantaneous phase differences between all pairs of clcctrodcs and the first and second derivatives were used to measure phase reset by phase shift duration and phase lock duration.

Results

In both short (6cm) and long (21 24cm) interelectrode distances phase shift duration in ASD participants was significantly shorter in all frequency bands but especially in the alpha-1 frequency band (8 10 Hz; p< .0001). Phase lock duration was significantly longer in the alpha-2 frequency band (10- 12Hz) in ASD participants (pc.OOQl). An anatomical gradient was present with the occipital-parietal regions the most significant.

Conclusions

The findings in this study support the hypothesis that neural resource recruitment occurs in the lower frequency bands and especially the alpha-1 frequency band, whereas neural resource allocation occurs in the alpha-2 frequency band. The results are consistent with a general GABA inhibitory neuro-transmitter deficiency resulting in reduccd number and/or strength of thalamocortical connections in autistic participants.

Multi-Channel Z-Score EEG Biofeedback: Laplaclan, Average Reference, Phase Reset, and Discriminant Functions

Robert Thatcher. PhD. Carl J. Biver, PhD. and Duane M. North. MS Applied Neuroscience. Inc. <rwlhatcher@yahoo.com >

Currently, there are no 19-channel Z-scorc biofeedback capabilities. One advantage of age-matched 19 or more channels of Z-scorc biofeedback is the real-time biofeedback of Laplacian and average reference Z scores as well as discriminant functions and phase reset. The purpose of this presentation is to show the methods and steps involved in overcoming technical and scientific challenges. One challenge was to minimize lime delays using a large array of channels. A second challenge was organizing the thousands of possible EEG features that arise from 19 channels or more. Adequate speed of processing and display is accomplished by the use of the real-time Hilbert transform implemented as Complex Demodulation. The selection and organization of Z-score biofeedback is accomplished using a symptom check list that generates hypotheses and links to specific surface scalp regions according to the scientific literature. Clinicians can veto the symptom check list links and create their own selections of EEG features. The ability 10 inhibit and reinforce specific EEG features at specific locations is accomplished by the use of the real-time Z-scores themselves as the goal is to reinforce movement of the EEG measures toward Z — 0. This allows lor simultaneous inhibition and reinforcement. Another method to minimize the large universe of possible EEG features is to link the Z scores derived from a quantitative EEG analysis to the patient symptom check list and further refine hypotheses that best match the patient's symptoms and complaints. The step-by-step mathematical details and computational details are presented and the results of 19-channeI Z-score EEG biofeedback on a selected group of patients are presented.

QEEG-Guided Neurofeedback for Remediation of Migraine Headaches

Jonathan Walker, MD Neurotherapy Center of Dallas <ad m i n@neuro thera pydallas.com >

Seventy-one patients with recurrent migraine headaches in a neurological practice were evaluated with a quantitative EEG (QEEG). Forty-six of them elected to do neurofeedback training to remediate their headaches. Each patient had five 30-min sessions of neurofeedback. Twenty-five of them (54%) experienced cessation of their headaches for a period of I year or longer. Another 18 patients experienced a 50% or greater reduction in headache frequency over the following year. Two patients (4%) experienced a reduction in frequency, but less than 50%. One patient did not improve. None experienced an increased frequency. In comparison. of the 25 patients who elected not to do neurofeedback, all continued to have frequent migraine headaches (greater than or equal to three per month). Seventeen (68%) maintained a similar frequency over 1 year's lime. Six experienced a reduction in frequency less than 50%, and 2 experienced a greater than 50% decrease in frequency.

The only abnormalities on QEEG that significantly correlated with recurrent migraine were excesses of high frequency beta (21 30 Hz). All sites with excessive high frequency beta were down-trained for five sessions each. The effective sites included P3(16). P4(13). FP2(8) PZ(7), CZ(7). FZ(6). FPK6). C3(6). F4(5). C4(5), T3(4), T4(3). F8(3), 01(2), F7(2), and OZ(l). The patient who did not improve had down-training of excessive 21-30 Hz at F8 and 01.

PANELS

Neurophysiology of Self: Constructs. Optimism, Gender Differences and Hyper- criticality

Rex Cannon, MA, Dehora Baldwin. PhD. Jessica Paskwietz, BA, Sarah Fischer. MS. Nancy Land, BA, Sempang't Jones. BA. Jecoiia White, BA, and Hannah Bowling, BA University of Tennessee <rcannon2@utk.edu>

Introduction

The self is a topic of considerable interest to researchers and psychologists alike. Current neuroimaging techniques have utilized self-recognition tasks to evaluate this phenomenon. It is unlikely that self-recognition alone constitutes fundamental components involved in the processing and evaluation of self. This study investigates ncurophysio- logical components involved in processing of self utilizing quantitative electroence-phalography (qEEG) and standardized low-resolution electromagnetic tomographv (sI.ORETA).

Methods

This study was conducted with 100 nonclinical university students. Four assessment instruments were completed while EEG was continuously recorded and item responses were marked within the EEG record. These were extrapolated and compared

for significance. We utilized the Self Perception and Experiential Schemata Assessment, the Brief Symptom Inventory (BSI-18), the Tennessee Self Concept Scale (TSCS). and the Life Orientation Test in addition to three photograph conditions. Participants were recorded while viewing an image of a hammer, a picture of a novel female lace, and a picture of self. Subjective reports were obtained for the image conditions and evaluated by three independent raters as positive of negative in content. Cortisol measures were obtained pre- and post-EEG sessions and correlated to assessments and sLORETA maps.

Results

Item analysis of the assessment responses indicated the female participants report more instances of sexual abuse and tend to rate self and self-in-experience more negatively on select scales than male participants. The participants show no differences in optimism, depression, or anxiety scales on the BSI. The TSCS shows live significant differences between genders. The sLORETA maps show each of these instruments involves different cortical regions in each frequency domain. The female participants rate the image of self more negatively than male participants at significant levels; this pattern of negativism toward self increases alpha/beta activity in the right insular cortex.

Conclusions

Female participants rale the image of self significantly more negative than male participants. This evaluative process involves regions in the right insular cortex and left parietal lobe. As a group, each of the constructs measured by the instruments appears to involve specific neural networks in specific frequency domains. Overall, female and male participants appear to proccss sclf-referential-information utilizing different neural mechanisms. Cortisol differences are perceptible to increase with the stimuli evoking the greater degree of negative emotion (internal stress inducing) mechanisms, with the evaluation of self and image of self creating the greatest negative processes.

Electroencephalograph in the Default Mode of Brain Function

Rex Cannon, MA. Joel Luhar, PhD. Robert Thatcher. PhD. and Deborah Baldwin. PhD
University of Tennessee <rcannon2@utk.edu>

Introduction

Recent research exploring cortical functional connectivity defines a default network (DNt) of brain function. The DNt is a set of dynamically coupled brain regions that are more active at rest than during cognitively demanding tasks. Structural cores are proposed to share associative properties of centrality such that they comprise connections between all major structural components. The posterior cingulatc and parietal regions are proposed to play an important role in this structural core, in association with medial frontal and temporal regions. The electroencephalographic activity in rhese components of the human default network has not been examined in detail. This study- aimed to examine frequency specific activity within and between 12 DNt regions of interest in both resting-statc and active tasks.

Methods

This study was conducted with 70 nonclinical participants 40 female and 30 male with a mean age of 20. The participants were recorded during eyes-closed (ECB) and eyes-opened (EOB) baselines and active task (AT) conditions (language and image processing). We estimated EEG source localization with standardized low resolution electromagnetic tomography (sLORETA) in 12 of the 13 regions of interest used by other default mode studies. We extrapolated current source density from each of the ROTs and the nearest neighboring voxel. We contrasted ECB with EOB and EOB with AT for each frequency domain in each ROI. We utilized partial and bivariate source functional connectivity procedures to examine the relationship between the ROIs in each frequency domain, flic participants also provided written reports of the mental processes and experiences during baseline recordings. There were coded by three independent raters for content.

Results

The ECB resting condition shows higher activity in delta and theta frequencies for all ROI. Contrarily, alpha 1. alpha 2. and beta show the effect in some but not all of the ROIs. Likewise, the active tasks show

differential effects for increased activity as compared to EOB for each ROI in each frequency domain. The inter-rater reliability for the subjective reports shows Cohen's Kappa of .83. Functional connectivity between regions is also influenced by specificity of task.

Conclusions

Data are in agreement with other neuroi- maging techniques (fMRT/PET) investigating the default mode of brain function and further shows that the three-dimensional localization accuracy of LOR ETA EF.G is sufficient for the study of the DNt. In examining both within and between functional core regions there is a higher degree of activity in lower frequency bands during eyes closed; however, this pattern does not extend to all ROIs in the higher frequencies. We conclude that this difference represents functional connectivity relating to endogenous/ exogenous attention states as opposed to the simple concept of "resting" or "nonactivity." Further study of the functional relationships between EEG frequencies within and between the default core of the cortex may prove important to understanding the complex nature of functional integration.

Qualitative Observations of Four Traumatic Brain and Acquired Brain Injury Case Studies Using LENS: A Preliminary Report

Sara Hunt Harper, PhD. Mary St. Clair, MSIV, Kayle Sandberg-Lewis. MA. and Ann Marie Brown. LMHC Stress Management Center
<shhl35@gte.net>

Traumatic brain injuries (TBls) are a major public health problem resulting in more than 1.5 million injuries each year in the United States. They are caused by a blow- to the head or a penetrating injury occurring outside the body. The Centers for Disease Control and Prevention estimate that 5.3 million people in the United States have a TBI that causes them to need help with activities of daily living either long term or for life. An acquired brain injur}' is an event occurring within the body such as a stroke or sudden cardiac arrest (SCA).

The first case is a 72-year-old woman with an ABI due to Sudden Cardiac Arrest arriving at the hospital 10 minutes after event with no pulse or respirations. When first seen by therapist 4 months postevent, she was nonverbal, was nonresponsive to verbal cues, was in a wheelchair, had no swallow reflex, and was incontinent in bowel and bladder. After treatment, she is verbal, able to swallow, able to eat beans and cornbread. and can walk with support. A 5-min video documenting her progress is presented.

The second case is a 19-year-old man with an ABI due to inhaling Ritalin as well as alcohol intoxication resulting in problems of motor planning, expressive and receptive speech difficulties, flat affect, headaches, sleep, and riding in the car. He had dramatic reduction in symptoms after first session. After treatment, he was able to return to college and graduate in May 2009.

The third case is a 23-year-old man 3 years' post-TBI from motor vehicle crash resulting in skull erushed in two places and 3} months in a coma. Presenting symptoms were very significant balance issues preventing him from walking without a walker and nystagmus of right visual field. Nystagmus was almost eliminated after first LENS session. After the fifth session he was able to walk across the room without assistance. A video documenting these changes is presented.

The fourth case is a 61-year-old woman with multiple TBIs as well as ABI from environmental toxins with issues of migraine headaches, chronic pain, balance, inability to sleep, mental degeneration, and inability to work or maintain friends. After treatment, she had a part-time job, no longer needed medication to sleep, and had an increase in strength, stamina, arid balance.

All cases were evaluated with a LENS map and treated according to the site sort. The specific protocols and decision-making processes are discussed.

Adjunct Therapies to Neurofeedback: Significant Results Obtained by National and International Clinicians

Victoria Jhric. MD, PhD. Liviu Dragomir- escu, PhD. Lynda Kirk. MA. Steve Over cash, PhD, and Roxana Vasiliu. MD Neurofeedback & NeuroRehab Institute Inc.
<dribric@yahoo.com>

Dr. Roxana Vasiliu discusses that the use of adjunct therapies (pROSIII, Alpha-Stim, and LENS) associated with neurofeedback accelerated the recovery of a young adult with multiple addictions, depression, ADHD, and borderline personality. Lynda Kirk presents results obtained in her clinic combining pROSHI, AlphaStim, and multimodal BF that enhanced neurotherapy and speeded up the progress of many difficult clinical eases, including CVA (stroke), PTSD. and age-related cognitive decline. Dr. Stephen Overeash, who has been

working with traumatized (physically and emotionally, PTSD) policemen clients, compares the relaxation and antistrcss effects of the pROSHI versus the Alpha-Slim. He divided the clients into two groups of 10 and treated them for 8 to 12 weeks with Enhanced, by the adjunct devices, Biofeedback sessions. The results obtained were statistically analyzed and are discussed.

Dr. Joe Kamiya on Neurofeedback, Biofeedback, and First-Person Science

Joe Kamiya, PhD, and Thomas Collura. PhD
University of California <joekam@ix.netcom .com >

This presentation proposes a long-range program of research on the relationship of human subjective experience to its physiological and environmental concomitants. Subjective experience has been a long- debated topic, and attempts to rule it out of bounds of scientific inquiry have not been totally successful. The history of modern psychology started in the late 19th century as the study of consciousness, wilh trained introspection as the method of observation and the verbal reports of the results being the data.

Among the reasons for the failure of the approach was disagreement among different observers in the verbal reports of their introspections. presumably of the same object of observation. However, the process of introspection itself, apart from the reporting thereof, is the observing of events internal to the observer. Dreams, imager)', pains, hopes, thoughts, and feelings are still present. for all their privacy, waiting to be comprehended more adequately in a framework of all scientific knowledge. Because the activity being observed is private to the observer, we refer to this as first-person observation, and when reported verbally is commonly termed subjective report, and sometimes nonfalsifiable. This contrasts with the third-person reporting of observation of events external to the observer, where the reports of the observations can be publicly verified. Such reports are called objective, sometimes falsifiable.

Stoyva and 1 have pointed out that the temporal correlates of such private events with publicly observable events (both physiological processes of the observer himself as well as events of his external environment) are an important tool for consciousness studies. The logic is that when there is covariation over time between the occurrence of a private event (such as dreaming as indicated by verbal report upon being awakened and the presence of eye movements and EEG stage changes prior to the awakening), the convergence of the two observables provides increased confidence that dreaming did occur as suggested by the report.

That physiological events can thus be at least partial indicators of subjective experience underlies several avenues of research. One. exemplified by current work of Richard

Davidson and associates, shows that ihe magnetic resonance images of the brains of meditators is related to their activity of meditation. Thus the ancient human activity of deploying attention in specific ways as reported by the meditators is at least partially indexed by a physiological marker, thus making possible studies of the specific brain processes underlying the first-person experiences of these participants. Another approach is one 1 reported on in 1968 to train participants by operant discrimination procedures to identify moments, each time 1 rang a single ding of a bell, when occipital EEG alpha activity was dominant, versus moments when it was absent, by a simple dichotomous verbal response (A for alpha dominance, B for its absence). Successful discrimination was achieved by most participants. permitting inquiry of the participants as to the subjective differences between the two EEG states. Despite considerable individual differences in some of the verbal reports there was a tendency toward common verbal characterizations of the differences, suggesting that the subjective experiences themselves of most persons may have common correlates in brain activity.

To reduce the noise to be found in everyday language reports of subjective experience, it is proposed first that extensive discrimination training and feedback training be used on a selected variety of physiological measures, so as to increase the sensitivity of the individual to the "feel" of discriminating and/or controlling each of. say. 20 measures. Then, from each participant are obtained paired comparison ratings of the degree of subjective similarity (on a 5-point scale, say) of each measure to every other measure. This will result in a matrix to which principal components analysis can be done to specify the independent dimensions of the total subjective space associated with the measures. Thus, for example, the feel of EEG alpha at the central leads might be specified as occupying a specific spot in the derived multidimensional space. Verbal labels can be applied to the dimensions later, with the risk of introducing cultural biases in word usage. But to the extent that the maps derived from all participants are similar to each other.
there will be a basis for improved verbal agreements about the subjective qualities.

The method would significantly increase the precision of mapping the subjective judgments of physiological measures. Of course, the representativeness to real life of the measures selected for training will be crucial, and this will emerge only after very extensive multimeasure research in basic psychophy- siology of everyday life, particularly that involving interpersonal interactions.

PowerPoint slides are used to illustrate the power of dimensional analysis of a matrix of subjective ratings of paired comparisons. As an example, a map of different food tastes is presented, dimensionalized along sweet, sour, bitter, and salty (which rather well account for all food tastes). It would show where, for example, apples, sweet pickles, raw cucumbers, and beef would likely appear as projections along the axes of the multidimensional space.

ERPs Endopenotvpes in Diagnosis and Therapy of Brain Disorders

Juri Kropotov. PhD, Andreas Mueller, PhD. and Jay Gunkelman. QEEGT Institute of the Human Brain <jd kropoto v@ya hoo .com >

During the last few years a new approach for assessment brain functions and dysfunctions was developed in our laboratory. This approach is based on two suggestions: (a) Information processing in the brain is char- acteri7ed by event related potentials (ERPs) recorded in humans during various cognitive tasks, and (b) the ERPs represent a sum of neuronal activities associated with different psychological operations. To separate these neuronal activities an Independent Component Analysis (ICA) was applied to a collection of ERPs recorded in a large group of healthy individuals who participated in five psychological tests, such as auditory tests; three stimulus tasks; two stimulus GO/ NOGO tasks; and mathematical, reading, and auditory tasks. Using the ICA method, a set of independent components was estimated for all task conditions. Each component was characterized by time dynamics and cortical topography and was associated with a certain psychological operation. Spatial filters were further built up on the basis of these topographies and provided the means for extraction the individual brain components associated with the specific psy- chological operations. Comparison with the data base thus consisted of computing *z* scores—standardized measures of deviation of individual ERPs components from the corresponding normative data.

This new approach was applied for discrimination a group of healthy participants (A' >1,000) from groups of patients with ADHD (>500 patients), dyslexia (A'=36). stroke with hemispatial neglect (A'= 20). The data were collected in different centers

in Switzerland (A. Mueller), Norway (S. Hollup & J. Brunner), England (T. Stcffcrt). and Russia (1. S. Nikeshina & E. A. Yakovenko). The results of discriminant function analysis of the data are presented in the paper. Briefly, the results show that each brain disorder is characterized by impairment of a specific independent component associated with a specific psychological operation.

In the final part, we present a practical application of the new approach for (a) constructing protocols of conventional EEG- based neurofeedback, for (b) constructing protocols of transcranial direct current stimulation, and (c) for constructing protocols of a newly developed method of ERPs based neurofeedback. In addition, (d) the results of pilot studies on ERP-based monitoring the effects of pharmacological treatment are presented.

Healing the Wounds of War and Violence: TBI and PTSD with Vets and Terror Survivors

H. Stephen Larsen. PhD. Len Ochs. PhD, Mary Lee Esty, PhD. and Siegfried Othmer, PhD
SUNY. Stone Mountain Center
<stcphcnlarscn@earthlink.net>

Neurofeedback possesses valuable and powerful tools for ameliorating the effects of the extreme kinds of trauma experienced by service men and women in war and by victims of terror. Dr. Stephen Larsen. who has treated many vets and accident and terror survivors, provides an overview of the field and its problems and pitfalls, including the self-protective and neuroprotective mechanisms involved in trauma; the issues of sensitivity, reactivity, and complex multiple traumas; and a look at neurology, psychodynamics, and possible mechanisms of healing.

Dr. Len Ochs discusses a Study of Brain Injured and post-traumatic stress disorder (PTSD) clients in which all participants (also patients) were treated with the LENS or its predecessors, and which correlates drops in the amplitudes of EEG with changes in subjective symptoms. This study is being prepared for presentation to the Armed Forces Centers for Excellence: Unites States Department of Defense.

Dr. Mary Lee Esty presents as follows: Six OEF/OIF male and female veterans with mixed TBI/PTSD symptom syndromes referred to the Neurotherapy Center of Washington were treated with Flcxyx Neurotherapy System for up to 25 sessions. Measures completed at pre- and immediately posttreatment included the Neurobehavioral Functioning Inventory' (Depression. Somatic, Attention/Memory, Communication. Aggression. and Motor scale scores) and PFSD Scale (Total as well as Re-experiencing, Avoidance. and Arousal subscale scores), and individual treatment session 0 to 10 ratings of current symptoms (fatigue, cognitive clouding, sleep, anxiety, depression, irritability/ anger) and activity levels. Statistically significant results are presented.

Dr. Siegfried Othmer discusses the compelling case of a Vietnam vet with PTSD of 40 years' duration. The vet was rescued by the Salvation Army in Los Angeles and brought to the Othmers for treatment. Three sessions produced a 50% symptom reduction, with a diminution of suicidally, night-mares, and binging. Further treatments consolidated these amazing early results and went on to achieve a 90% remission in 18 symptom areas. The vet also agreed to undergo q-EEG with Q-Metrx and SPECT imaging courtesy of the .Amen Clinic.

QEEG Guided Amplitude and Coherence Neurofeedback for Autistic Spectrum Disorders

Michael Linden, PhD, Robert Coben. PhD. and Jonathan Walker. MD ADD Treatment Centers
<drmike49@aol.com>

These symposia review EEG & QEEG patterns and subtypes of Autism and Asperger (Autistic Spectrum Disorder/ASD). including six subtypes of Autism and two subtypes of Aspergcrs. We discuss how to utilize EEG and QEEG amplitude and coherence patterns of ASD to guide protocol selection for more neurofeedback training. We present data, including pre-post QEEG's and CPT tests, showing the positive effects of neurofeedback with ASD students. Research studies of neurofeedback with ASD are reviewed.

Induced EEG Gamma Oscillations in Response to Drug- and Stress-Related Cues in Cocaine Addicts and Patients with Dual Diagnosis

Esuuo Sokhadze. PhD. Christopher Stewart. MD. Ayman El-Baz, PhD, Rajesh Ramaswamy, MD. Michael Uollifield, MD, Allan Tasman, MD
University of Louisville, KY <
tato.sokhadze@louisville.edu>

Introduction

The overall goal of this pilot project was to utilize single trial EEG variables and behavioral performance measures to examine cue reactivity to drug-related stimuli (three-stimuli oddball with pictorial stimuli) in a group of patients with substance (cocaine) use disorder (SUD), patients with cocaine addiction comorbid with PTSD (DUAL), and controls (C'NT). Our experiment was designed to examine behavioral and EEG measures of cue reactivity to pictorial drug- and trauma-associated stimuli, and to investigate how heightened orienting to these salient distracters will interfere with cognitive functions during performance on a visual thrcc-category oddball task. Dependent variables included EEG gamma oscillations (30 80 Hz), amplitude, and power density in response to nontarget categories of pictorial distracters containing both drug- and trauma-related cues. We expected that patient with SUD will express heightened reactivity of gamma only to drug-related cues, whereas the patients with dual diagnosis will show enhanced reactivity to both task- irrelevant drug and trauma cues and will pre-sent selective attention to these highly salient distracter signals, which will negatively affect processing of task-relevant stimuli.

Methods and Results

Twenty-three subjects (M age = 38.2 years) participated in this experiment: 8 participants in control group. 8 patients in DUAL group, and 7 patients in SUD group. PTSD diagnosis in drue abusing subjects was confirmed by Drs. Stewart and Hollifield using PSS-R questionnaire and clinical interview. Drug abuse was confirmed by Dr. Stewart's clinical evaluation and urine drug screening (DrugCheck4 NxStep) and saliva test. Cue category (neutral, trauma, drug) had main effect on reaction time (RT) (y? —.033), and accuracy of responses (/•'— 3.79, p = .045) without any significant Cue x Group (CNT. DUAL. SUD) interaction. However, RT to neutral and trauma cue was slower in addicts compared to controls (neutral: 592 msec vs. 502 msec, p .047: trauma: 642 msec vs. 529 msec, p .036), whereas no between group differences were found in RT to drug cues (532 msec vs. 570 msec).

Along with behavioral and ERP measures (reported in Sokhadze et al., 2008) we analyzed single trial induced EEG gamma oscillations (30 80 Hz) for 30 trials in each of eight conditions (target-drug, nontarget drug, target-neutral, nontarget neutral, target-trauma, nontarget trauma cues) using Morlel Wavelet analysis at 14 EEG sites (frontal Fl, F2. F7. F8, AF3, AF4: central C3, C4: parietal P3, P4. P7, P8; and occipital 01, 02). SUD group showed higher gamma density in response to target drug cues at the frontal sites (AF3, p - M trend: F7. $p < .05$). At the lateral frontal site (F7) we found significant Stimulus (target, non- target) x Cue (drug, neutral, trauma) x Group (CNT, SUD) interaction effect, $F(1, 17) = 5.03$, $p = .02$, that can be described as a higher gamma density to nontarget drug cucs, a lower gamma response to both target and nontarget neutral stimuli, and a lower gamma density to nontarget traumatic stress cues in the addicted individuals as compared to controls. Patients in the DUAL group showed higher bilateral gamma density to nontarget trauma cues at the frontal and central sites (F7, F8. C3. C4) as compared to SUD-only and CNT groups (e.g., F7. />-.0l5: F8*. /x.Ol). Therefore, induced gamma demonstrated excessive response to both target and nontarget drug cues in SUD group, and overreactivity to nontarget traumatic stress cues in participants with dual diagnosis (SUD comorbid with PTSD).

Conclusions

Analysis of induced gamma oscillations in a cognitive task with drug- and stress-related visual cues showed between group differences in patients with substance use disorder and patients with dual diagnosis (substance abuse co-occurring with PTSD). We used these HEG markers of overreactivity to motivational^ salient stimuli as the outcome measures in a neurofeedback trial where patients with SUD and dual diagnosis were treated by neurotherapy based on neurofeedback training integrated with motivational interviewing. We discuss utility of early and late components of induced gamma activity to assess preattentive processing and explicit orienting to drug-related items in addicted patients.

Transcranial Magnetic Stimulation Study of Gamma Frequency Induction in Response to Illusory Figures in Patients with Autism Spectrum Disorders

Estate Sokhadze, PhD, Joshua Baruth, Ay man El-Baz, PhD, Rajesh Ramaswatny, MD, Lonnie Sears. PhD. Manuel Casanova, MD
University of Louisville, KY
<tato.sokhadze@Jouisville.edu>

Introduction

Neuropathologies! models of autism indicate an increased number of cortical minicolumns with less peripheral neuropil space in the dorsolateral prefrontal cortex (DLPFC). A lack of peripheral neuropil space in the cortical minicolumns of individuals with autism is associated with a reduction in gamma-aminobutyric acid (GABA)-mediatcd inhibitory intcrncuron activity, and the inhibitory intcrncuron activity of minicolumns is important for the fine tuning of cortical information processing. The generation of normal gamma oscillations directly depends on the integrity of the connections of GABAergic interncur- ons within cortical minicolumns, and individuals with ASD have been shown to exhibit significantly more EEG oscillations in the gamma range compared to controls. As a treatment modality, Transcranial Magnetic Stimulation applied at low-frequencies (<1 Hz) has been shown to increase inhibition of stimulated cortex. We investigated gamma frequency induction in individuals with ASD in response to Kanizsa illusory figures before and after six sessions of 0.5 Hz rTMS applied to the left DLPFC. in unimpaired individuals gamma activity is readily induced by Kanizsa illusory figures in neurocognitive tasks, and gamma induction is generally higher in response to target Kanizsa stimuli and attenuated to nontarget Kanizsa and non-Kanizsa stimuli. We expected the baseline (pre-rTMS) power (¿*V2) of induced gamma oscillations to be increased to nontarget and standard illusory figures at a majority of recording sites in individuals with ASD relative to controls. After six sessions of 0.5 hlz rTMS applied to the DLPFC we expected the power of gamma oscillations to standard and non-target stimuli to significantly decrease in individuals with ASD especially over the DLPFC.

Methods and Results

The study included 13 patients with ASD. all male, with a mean age of 17.2 ± 4.6 years. Eight of them were assigned to an active rTMS treatment group and 5 were assigned to a waiting-list group. An equal number of controls were rccruited, 8 male and 5 female with a mean age of 18.6 — 6.2. All participants had IQs in the normal range (Full Scale IQ > 80) and met *DSM-IV-TR* criteria for ASD. There were no statistically significant age or IQ differences between the two groups. rTMS was administered to the left DLPFC two times per week for 3 weeks at 0.5 Hz and 90% MT with a total of 150 pulses per day (10 trains with 15 stimuli per train). Motor threshold was determined before each session using EM G of the contralateral first dorsal interosseous hand muscle. The power (juV2) of induced gamma oscillations between 30 and 80 Hz from 0 to 800 msec poststimulus was recorded at frontal. central, parietal, and occipital EEG sites over both hemispheres and was analyzed using MATLAB wavelet analysis applications. The density (/<V2/Hz) of induced gamma oscillations and the density difference between gamma induced responses to nontarget and target Kanizsa stimuli were also analyzed. The ERP results were reported in our recent preliminary study.

There were baseline (pre-rTMS) group gamma differences as individuals with autism showed increased levels of gamma induction to non-target and standard stimuli relative to controls at 8 of 12 recording sites: left frontal (Fl. F7). left and right parietal (PI. P2, P7, P8), and occipital (Ol. 02) EEG channels. A Stimulus x Group (control. autism) interaction indicated highly significant gamma power increases to non- targets in the autism group relative to controls at all recording sites (/? < .001). Also, the gamma power of autistic individuals to nontarget stimuli was similar to controls at parietal sites while significantly higher at frontal sites (p < .05), and group differences in gamma oscillation power to nontarget and target Kanizsa stimuli were better expressed over lateral frontal (F7, F8) and parietal (P7, P8) recording sites. After rTMS treatment individuals with ASD predominately showed reductions in induced gamma activity to nontarget and standard stimuli at frontal and parietal sites ipsilateral to the stimulation site. The power of gamma oscillations to standard and nontarget stimuli significantly decreased at the following sites: left lateral frontal (F7, nontarget from 326 to 100 *fiV2. F*= 5.00. p = .044), left central (C3. standard from 69 to 20 /<V2. F=7.80. p = *.0\5:* nontarget from 97 to 29 *(i\2.* F= 5.43, /> = .037), left medial parietal (PL standard from 111 to 47 /iV2, /-'=6.69. ¿> = .023), left parietal (P3, standard from 119 to 36 /¿V2. *F*= 16.15. p = .001: nontarget from 156 to 42 ,« V2. F-10.31, p = .007), and right lateral parietal (P8. noniareet from 395 to 111 /A'2. /'=6.12, p = .028) EEG sites. The autistic participants in the waiting-list group (N = 5) did not show any changes in induction of gamma activity.

Conclusions

Individuals with ASD show significant gamma power increases to nontarget and standard stimuli at a majority of recording sites relative to controls, and group differences in gamma oscillation power to nontarget and target Kanizsa stimuli were better expressed over lateral frontal and parietal recording sites. Repetitive low-frequency transcranial magnetic stimulation administered to the left DLPFC reduced induced gamma activity to nontarget and standard stimuli at frontal and parietal sites ipsilateral to the stimulation site. Low-frequency repetitive transcranial magnetic stimulation tends to increase cortical inhibition and reduce induced high-frequency EEG activity to standard and nontarget stimuli in individuals with ASD. TMS may restore a balance in the ratio between cortical excitation and inhibition and improve sensory stimulus discrimination in patients with ASD.

Neurofeedback: The Past. Present, and Future

Nancy White. PhD
Enhancement Institute, Houston, Texas
<nancy@enhancementinstitute.com>

Joe Kamiya. PhD. and Juri Kropotov, PhD Institute of the Human Brain *Abstract by Leslie Sherlin, PhD*

As any previous ISNR attendee will tell you, much of the learning experience occurs in the hallways and around dinner tables with experienced providers. In my early career and still today 1 find catching conversation with the brightest minds of our field to be the most satisfying and educational experiences and the one that I always remember most from the conferences. If you're lucky enough to find an empty seat at a table with one of our elder pioneers or an up-and-coming innovator you should take advantage of this opportunity to just capture the stories of their experience. In the meantime. I have invited and created a special panel that has quickly become an ISNR favorite for bringing this same idea into a room for all to enjoy.

Our first special panel took place in 2008 with contributions from Tom Budzynski. Joel Lubar, and Barry Slerman. It was truly one of the most entertaining and educational events of the conference as we all came together to share experiences and speculate about our common future. The panel participants arc given a very loose goal of making a 30-min presentation each sharing their perspective of neurofeedback's past, present, and future. It ranged from a photo slide show of other pioneers and colleagues highlighting landmark achievements, presentation of data, and studies, to simple story telling about our field and accomplishments.

Our special panel presenters have unique histories in the field of neurofeedback, and each has changed our history and guided our future through their work.

POSTERS

The pRoshi: An Investigation Into Its Applications as a Stand-Alone Tool for Relaxation and Its Use in Combination With Selective Music

Elsa Baehr, PhD. Corey Feinberg, BA, and Brett Rustin, BA Ncuro-Quest. Inc.
<e_baehr@hotmail.com>

The pRoshi was developed by Chuck Davis as a stand-alone unit that would function in a similar way to the original computer-linked Roslii. The viability of the pRoshi as a clinical tool is assessed in different conditions, the pRoshi alone and the pRoshi in combination with a musical CD. The musical CD is also assessed as a stand-alone treatment. EEG data for each condition were measured in terms of amplitude ratios and *Z* scores for each individual. Data for 30 participants, 10 in each condition, were then subjected to statistical comparisons.

A Study of Breathing, Heart Rate Variability Amplitude, and Blood Pressure

Stephen Elliott. BS. and Dee Edmonson, RN
Coherence LLC < steve.elliott@cohercnce.com>

This poster presents results of a study- examining the absolute relationship between heart rate variability amplitude and blood pressure. Clients participated in 8 to 12min of resonant breathing with HRV biofeedback. At the end of this period, their blood pressure was assessed and correlated with their average HRV amplitude for the period.

Gender Differences in EEG Source Localization During Processing of an Unfamiliar Face

Sarah Kathleen Fischer. MS, Demeka Robinson, BA, Ashley Williams-Bond. BA, Jessica Combs. BA. Kelli Cox, BA. Jasmin Bennet, BA. Rex Cannon, MA, and Dehor a Baldwin, PhD
University of Tennessee
<sfischel@utk.edu>

This study investigated neurophysiologi- cal activity during the processing of a face unfamiliar to the subject, utilizing standardized low-resolution electromagnetic tomography (sLORETA) to map sources of the EEG recorded at the scalp. We obtained 100 university students (60 female) with a mean age of 21. EEG data were recorded for4min while participants viewed an image of an unknown female face. We performed EF.G source localization using sLORETA and compared the image condition to baseline using all voxel-by-voxel *t* tests. Significant voxels of difference were mapped onto a Montreal Neurological Institute (MNI) atlas containing 6,329 5 mm voxels. Subjective reports were obtained from each participant after the EEG procedures. These were rated by three independent raters for positive, neutral, or negative content. The sLORETA comparisons between female and male participants show less activity in delta and theta frequencies in left BA 7 and mid-line cuneus for female participants. However, female students show increased activity, as compared to male students, in right BA 7 in the alpha frequency and in right BA 8 in low beta power. The subjective reports of the experience of viewing the image of the unfamiliar face was neutral to positive in content and shows no differences between groups. The subjective reports indicate that male and female participants rate the unfamiliar face in similar fashion in a neutral or positive description. This consistency, however, appears to involve different cortical mechanisms. First, as compared to male students, female students showed less activation in the left precuneus and mid-line cuneus in the slower frequency domains, in addition, female students showed increased activity in alpha and low beta power in the right frontal and right precuneus, with less higher beta activity in the right somatosensory cortex. The difference in EEG activity may reflect the heightened evaluative state of female participants as a result of socialization.

P300-Based Protocol (With Acoustic Stimuli) for Assessing Memory Deficit, Malingering, and Deception in Clinical and Forensic Settings

Elena Labkovsky. PhD, and J. Peter Rosen/eld. PhD Northwestern University
<clcnalabkovsky@yahoo.com>

It has been previously shown that event-related potential (ERP) methodology can be effectively used for assessing memory deficit/intactness and feigning/ deception. All previous P300-based recognition and memory assessment protocols utilized video stimuli. In the present study we test a novel audio version (words) of ERP (P300)-based protocol for detecting memory deficit, malingering, and deception.

Methods

Participants were 26 individuals (14 male and 12 female) recruited through advertisements at Northwestern University campus. EEG was recorded from Fz. Cz, and Pz while participants were listening to the audio stimuli via headphones. A modified audio (words) version of the oddball protocol was implemented. The protocol included three types of stimuli: (a) A "Probe" (Pr—a relevant to the participant (his or her Last Name), (b) "Irrelevant" (Ir—a last name, *not* relevant to the participant), and (c) a "Target" (Tr, an item with "assigned signifi- cance"). There were seven different stimuli (last names) in the protocol: five Irrelevant names, one Probe, and one Target. Each of the names was repeated 30 times in a test run. Participants responded to all Irrelevants and the Probe with a LEFT button on a two-button response box. They were instructed to press a RIGHT button when they heard a "Target" name.

Resulrs

Two groups were tested: an experimental (E) group where one of seven repeatedly presented stimuli was a participant's last name (Probe), and a control (C) group where all the stimuli were irrelevant to participants. Bootstrapped-based hit rates in the E group were 100%, based on Probe versus five Irrelevants combined, and 78% for Probe versus maximum Irrelevant. In the C group there was one (of 12) false positive (8.3%), based on Probe versus five Irrelevants combined as well as Probe versus maximum Irrelevant. A 2 x 2 (Group x Stimulus Type) mixed analysis of variance was performed to examine the effects of Group (E vs. C) on P300 amplitude (Probe and Irrelevants). There was main effect of group (/?<.001). We also found significant effect of stimulus type (/><.001), and a significant interaction of Group x Stimulus Type *(p* < .001).

Conclusions

The study confirmed that P300 component can effectively serve as an indicator of audio recognition

(as well as feigning and deception) in ERP-based protocol: P300 amplitude significantly increases when presented audio information is recognized (even when a person denies it) compared to unrecognized stimuli.

Recovery of Vision with NeuroRehabilitation in Children with Cortical Visual Impairment

Denise Malkowicz, MD. and Diana Martinez. MD
Institutes for the Achievement of Human Potential
<denisemmd2@aol.com>

Introduction

Cortical Visual Impairment (CVI) is bilateral visual impairment due to brain injury in posterior visual pathways without significant anterior pathway (eye, retina, or optic nerve impairment), therefore the light reflex is intact. CVI is an increasing common cause of blindness in children. CVI is often caused by perinatal or postnatal anoxia or trauma. CVI due to gray matter and white matter involvement, the presence of seizures, or anoxic etiology has a very poor prognosis for recovery of vision.

Methods

Twenty-one consecutive cases from the Institutes for Achievement of Human Potential, a neurorehabilitation center met the criteria for CVI. MR I or CT documented brain injury in visual areas. Informed consent was obtained. No one had better than crude outline perception. All 21 had extensive gray and white matter injury to visual areas: 20 also had seizures. Children ranged in age from I to 10 years. Neurorehabilitation with visual stimulation was based on the neurodevelop- mental acquisition of vision. At the lowest level, light/dark stimulation was given multiple times daily until light perception was intact. Next progressively complex visual stimulation consisted of black-and-white 12-in squares followed by high contrast outline then with increasing details as vision improved. Then similar but unlike visual symbols were followed by identification of symbols and letters and in some reading.

Results

At the start of the program all children had light reflex and some had crude contrast perception. Success on the program was considered to occur if the child could distinguish complex symbols or read. Of the 21 children, 20 (95%) achieved visual recovery in an average of 6.9 months with visual neurorehabilitation: the range was 5 to 13 months.

Conclusions

Studies of CVI in children rarely show- recovery of useful vision; however, visual neurorehabilitation programs were not used. In our study, the 21 children that met criteria were multiply handicapped and had extensive white and gray matter injury. Twenty also had seizures. This represents the most severe population and would bias this study against recover)'. However, in all cases, useful vision was recovered. This implies considerable neuroplasticity in the visual system. Success in our study appears to be due to the neurodevclopmental approach to visual stimulation based on the participant's initial level, increasing in complexity until recovery. This model may be useful in other neu roreha bil tat i on sett i ngs.

Intensive Neurotherapy Facilitates Recovery From Severe Brain Injury and Seizures

Denise Malkowicz, MD, Diana Martinez, MD, Jorge Leon Morales, MD, M. Barry Sternum, PhD. and David Kaiser, PhD Institutes for the Achievement of Human Potential
<den isemmd2@aol .com >

Introduction

Patients with severe brain injury and refractory seizures often have poor recovery, intensive neurotherapy reinforcing sensory motor rhythm (SMR) may promote neuroplasticity in thalamocortical circuits, significantly improving outcome.

Methods

A 29-year-old man had a severe traumatic brain injury after a motor vehicle accident 10 years ago. He had spastic quadriparesis, un- coordinalion. dysphasia, aphasia, and sleep disruption and refractory secondary generalized seizures with postictal impairment lasting up to 10 days. All previous therapies tailed to improve his condition. Twenty-four-channel EEG recordings (NcuroNavigator) were analyzed using SKIL software. It showed excessive diffuse delta and thela (-12 *z* score) compared to healthy adults, with little

SMR or alpha activity. Daily neurotherapy aimed to progressively reinforce SMR in central regions and 8.6 to 10.6 Hz activity in other brain regions. Therapy sessions continued to increase in length and complexity as he improved. He underwent three 30-days periods of neurotherapy with the same protocols, separated by 5 months each.

Results

After the first session his sleep integration increased from 2 to 8hr per night. Seizures decreased in frequency, intensity and duration without postictal impairment. Speech, swallowing, coordination, and motor control in trunk and extremities improved by at least 50% significantly increasing his abilities. Posttraining QEEG showed more normalized delta and thêta (-1-2 *z* score), and SMR and alpha activity were present. Despite slopping neurotherapy for 5 months he continued to improve in all areas including seizure control, allowing him to be independent in his daily life. His posttraining QEEG revealed more SMR and alpha activity.

Conclusions

Intensive neurotherapy facilitated recovery from brain injury and seizures 10 years after injury and despite failure of other therapies. Neurophysiologies! and clinical changes were robust, durable, and self-regenerating. We believe that this intensive neurotherapy protocol normalized thalamocortical circuits by- facilitating Long Term Potentiation (LLP). LTP increases neural protein synthesis, growth, and remodeling.

Examination of Cranial Electrotherapy Stimulation on Alpha-Amylase Levels. Cortisol Levels, and State-Trait Anxiety Scores in the Chronically Mentally III

Julie Strentzsch, MS. and Randall Lyle, Phi) St. Mary's University <j st ren tzsch@sa tx. rr.com >

This randomized, double-blind, placebo-controlled study was designed to measure the efficacy of Cranial Electrotherapy Stimulation (CES) in a population that is most susceptible to problems related to anxiety, the chronically mentally ill. Changes in anxiety levels were identilied using pre- and posttest measures of alpha-amylase, Cortisol, and the State-Trait Anxiety Questionnaire. Participants were randomly assigned to one of three treatment groups: active CES. sham CES. and no treatment. This experimental design was implemented to address potential placebo effects.

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PROCEEDINGS OF THE 2009 SABA CONFERENCE

Abstracts of Conference Presentations at the 2009 Society for the Advancement of Brain Analysis (SABA) 8th Annual Conference, Marineland, Saint Augustine, Florida

The 8th annual conference for the Society for the Advancement of Brain Analysis (SABA) was held in Marineland, Saint Augustine, Florida, May 1 to 5, 2009, and was sponsored by the Whitney Laboratory

for Marine Bioscience, University of Florida. SABA is a daughter group of ISNR, a nonprofit membership organization of educators, researchers, and clinicians that is focused on psychological electroencephalography (EEG) with the purpose of integrating knowledge of brain structure and function in the practice of neurothcrapy and psychological evaluation. SABA actively supports research in EEG technology, methodology, and interpretation in the context of EEG rhythm operant conditioning (neurofeedback) and neuromodulation, and this year's conference focused on both structural and functional neuroplasticiiy.

David A. Kaiser. PhD
Editor

Real-Time fMRl Feedback Training

Mario Beauregard, PhD

It has now become possible to image the functioning of the human brain in real time using functional MR I (rtfMRI) and thereby to have access simultaneously to both sides of the mind/brain, that is, subjective experience and objective quantitative measurements of brain activity. RtfMRi methods are reviewed, as well as recent rtfMRi studies showing learned control over localized brain activity involved in various functions (e.g., sensory and motor processing, pain and emotion regulation). The potential thcraj^eutic applications of this new neuroimaging approach are also discussed.

Can Models of Homeostatic Plasticity Explain Nervous System Functional Stability?

Dirk Bueher, PhD

A neuron's identity and function is determined by its morphology, the densities and spatial distribution of its specific types of receptors and ion channels, and its synaptic connections within the network. These features are all subject to dynamic regulation and must be matched to the functional requirements in the face of changing environmental and behavioral demands, both during growth and development, and in adult life. Homeostatic mechanisms are needed to ensure that dynamic changes occur only within certain boundaries that keep neuron and network activity in a functional range. We are only beginning to understand how nervous systems strike a balance between altering individual neurons and synapses in the name of plasticity while maintaining long-term stability in neuronal system function. Our research focuses on the question of how stability of network function is achieved through regulation of neuronal properties, including morphology. synaptic, and intrinsic membrane properties.

What Can a Lazy Fish Teach Us About Synaptogcucsis?

Kimberley Epley, PhD

Our goal has been to elucidate the basic principles of synapse function and development using zebrafish as a model system. We use mutant fish lines that show abnormal behavior. These fish have defects in the way neural excitation is translated into movement. Because zebrafish develop rapidly inside transparent eggs, we can analyze their neural function before they die. In addition, the transparency of the embryo itself enables optical studies, tracing individual proteins marked by genetic methods through devel-opment in vivo. We take advantage of these merits that the zebrafish system provides to pursue the following projects. Current projects in the lab center around two locomotor)' mutants we found to have defects in two key molecules of the neuromuscular synapse. One lacks acetylcholine receptors (AChR) in the muscle. As a result, the fish cannot mount a movement when the motor neuron releases ACh. The other mutant has a dysfunctional rapsyn. Rapsyn is a postsynaptic protein that brings AChRs together. In this fish, AChRs do not make clusters at the synapse and are diffusely distributed over the muscle cell surface. From the AChR-less mutant, we found that AChRs, which were thought to be passive players in synapse formation, play an active role, directing rapsyn molecules to the synapse. In the rapsyn mutant fish, we found that not only do AChRs fail to form clusters at the synapse, but their functions are also altered. That is, when motor neurons fire at a high frequency, the amplitude of AChR current remains constant in wild type, whereas in rapsyn-mutant fish the response shows a marked attenuation with repeated firing of motor neurons.

Brain Laterality. Brain States and ADHD

Sigi Hale. PhD

The left and right cerebral hemispheres differ with respect to gross and functional anatomy (i.e., white-fiber systems and associated network

properties) as well as microanatomy (i.e., cytoarchitecture). Moreover, it is well established that each hemisphere makes unique contributions to cognitive function: the left hemisphere (LFI) linguistically encodes sensory information and the right hemisphere (RH) uses a more configural coding scheme. In other words we are endowed with a bimodal representation of our sensory world, and these representations compete for neural resources and lend themselves to distinct types of cognitive operations. Hence, adaptive functioning requires that we dynamically regulate their relative contributions during different operations.

We focus on the role of imbalanced utilization or integration of unihemispheric specialized information processing in ADHD. Several of our studies using converging measures of behavioral laterality, fMRI. and EEC have revealed mounting evidence that adults with ADHD demonstrate increased RH contribution during early stages of sensory information processing and that this is associated with compromised LH linguistic abilities and abnormal interhemispheric interaction. Moreover, we have found evidence that this is likely a brain-state associated phenomenon rather than reflecting inherent capacity. We suspect that increased RH relative to LH contribution during early stages of sensory processing is generally associated with ADHD symptoms and that what distinguishes ADHD-pathology from a more typical expression of such traits is a matter of the frequency, duration, and/or adaptive expression of a RH biased mode of processing.

Toward this understanding we have recently found evidence of increased rightward alpha asymmetry in frontal and parietal regions of adults with ADHD during an eyes closed condition and during the Conner's Continuous Performance Task (CPT). Moreover, we have found robust rightward high beta asymmetry in parietal regions of adults with ADHD also during the CPT.

instrumental Conditioning of Human Sensorimotor Rhythm (12-15 Hz) and Its Impact on Sleep as well as Declarative Memory Performance

Kerstin Hoedlmoser, PhD,
Wolfgang K/unesch, and
Manuel Schahus

The present study sought to clarify the effects of instrumental conditioning of sensorimotor rhythm (SMR; 12-15 Hz) in humans on sleep parameters during a 90-min midday nap as well as on declarative memory. Twenty-seven participants were randomly assigned to either 10 sessions SMR-conditioning or randomized-frequency- conditioning. Before and after this instrumental conditioning period, participants had to attend the sleep laboratory to take a 90-min nap and to perform a declarative memory task before and after sleep.

The three major findings are (a) the experimental design was successful in conditioning an increase in relative 12-15 Hz amplitude within 10 sessions (d = 0.7), (b) the increased SMR activity is also expressed during subsequent sleep by eliciting positive changes in various sleep parameters (sleep spindle number [¿=0.6], total sleep period [¿=0.7]. sleep onset latency [¿=0.7]), and (c) this increased relative 12-15 Hz amplitude is associated with enhancement in declarative memory performance (¿=0.9).

Results thus indicated that SMR frequency constantly increased over the 10 training sessions (in the SMR group only) and that this "shaping of one's own brain activity" also facilitated the expression of 12-15 Hz oscillations during subsequent sleep. Most interesting, these electrophysiological changes were accompanied by profound positive sleep as well as memory performance.

The Periodicity Table: Introduction to Bimodulution and Entropy

David A. Kaiser, PhD

The Periodicity Table organizes spectral properties on number of signals, frequencies, and phase relationships (Kaiser, 2008). Of recent interest are the measures of bimodula- tion (Pearson product moment correlation of two frequencies at the same electrode site) and spectral entropy. Spectral entropy is a relative incidence measure from information sciences, which may be conceived as a measure of signal disorder or constituent variability. High spectra! entropy occurs when activity is spread across most of the spectrum, and low spectral entropy is when activity is localized to a handful of frequencies, as seen in sleep and coma states. Nuncs. Almeida, and Sleigh (2004) likened entropy to freedom of choice in that "conscious cortex is free to move among a huge number of available microstates" when entropy is high. Entropy indexes the number of possible microstate rearrangements, which can produce same macrostate. EEG rhythm training is discussed in terms of entropy training, increasing or reducing the possible accessible microstates as indicated by specific EEG rhythms. The value of these coefficients and related measures were discussed in terms of normative EEG assessment.

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Decision Making in Neurofeedback Protocol Selection

David A. Kaiser, PhD, and
Penijean Rutter, MA

Normalivc HEG analysis can provide dozens or even hundreds of statistical abnormalities for any individual given the large number of EEG sites, frequencies, and spectral coefficients examined by state-of-the-art techniques. General rules for prioritizing EEG findings are direly needed as we tailor our protocols to address specific behavioral or mental impairments. Two models for interpreting normative EEG are presented based on clinical practice and theoretical considerations. In the first model, the brain is conceived in terms of maturation, where functional and structural brain disorders reflect regression toward primitive brain behavior, that is. ontogenetic as well as phylogenetic immaturity. r.EG indicators of immaturity include excessive delta, diminished connectivity, lack of functional differentiation in prefrontal cortex, reduced hemispheric specialization, and lack of coordination between anterior and posterior brain regions. In the second model, rhe brain is conceived as a reward- seeking machine in which all mental processes work to maximize reward within a limited resource system. Such resource allotment necessitates a hydraulic relationship between brain areas or systems. Whenever resources arc allocation to one brain area or system they must be taken from another. With this in mind brain activity is organized along a number of dimensions including inhibition (output gating), meaning attribution (input gating), and recruitment. Disturbances in connectivity and evidence of hyper- recruitment or "resource hijacking" are viewed as likely candidates for EEG training.

Can Theories of Circuit Modification with Sensory Motor Rhythm Feedback Explain Our Remarkable Effects with Epilepsy?

Denise Malkowicz. AID, and
Diana Martinez. MD

Epilepsy is a disorder of recurrent seizures, paroxysmal abnormal electrical discharges arising from cortical neurons under the influence of thalamo-cortical circuits. Treatments with drugs and surgery have limited success, often with risk of serious side effects. Intensive SMR EEG feedback brain modification training appears to promote neuroplasticity with desirable EEG changes, long-term potentiation (LTP). and reorganization of thalamo-cortical circuits, thereby altering neuronal networks and facilitating remediation from epilepsy. The present report reviews evidence for such an outcome in a patient with seizures secondary to brain injury.

After traumatic brain injury the individual had a 10-year history of severe refractory epilepsy with prolonged postictal stales. He had failed multiple therapies. Initial QEEG showed diffuse delta and theta (1 12 *z* score) and no 12 15 Hz sensorimotor cortex SMR. He underwent three spaced periods of intensive SMR EEG feedback training at C3 C4, with 5-month spans separating each of these periods. SMR EEC) feedback resulted in seizure control within the first 3 weeks. He continued to improve in all areas of neurological function, including seizure control during the 5-month period between neurotherapy sessions. Posttraining QEEG showed normalization of della and theta. increased SMR. and increased alpha and beta.

SMR feedback is associated with regulation of thalamo-cortical circuits and facilitates neuroplasticity through LTP. increasing neuronal protein synthesis, growth, arid remodeling. This process continues to be robust, durable, and self-regenerating with clinical improvement seen between sessions. Previous studies by Sterman et al. showed that SMR EEG feedback can reinforce and normalize thalamo-cortical circuiis and result in LTP. In his animal studies. SMR training resulted in increased seizure thresholds when cats were exposed to epileptogenic compounds. Other studies in humans have shown improvement in seizure control with neurotherapy. Our participant is remarkable for the rapid and durable control of his refractory seizures with our intensive SMR EEG feedback

protocol. It is concluded thai intensive SMR EEG feedback training and consequent modification of thalamo-cortical and sensorimotor circuits through LTP remodeling seems to explain this remarkable effect on neuroplasticity and recovery from refractory epilepsy.

Genomic liases of Neuronal Identity and Plasticity

Leonid Moroz. PhD

Our laboratory works to characterize basic mechanisms underlying the design of nervous systems and evolution of neuronal signaling mechanisms. The major questions are (a) why are individual neurons so different from each other, (b) how do they maintain such precise connections between each other, (c) how does this fixed wiring result in such enormous neuronal plasticity, and (d) how docs this contribute to learning and memory mechanisms? By taking advantage of relatively simpler nervous systems of invertebrate animals as models, we combine neurosciencc. genomics, bioinformatics, evolutionary theory, zoology, molecular biology, microanalytical chemistry, and nanoscience to understand how neurons operate, remember, and learn. As part of the N1H Center of Excellence in Genomic Sciences, our first project investigates the genomic basis of neuronal identity and plasticity. Because of the tremendous difficulties in mapping single cells and processes in the mammalian brain, we study the giant neurons of the sea slug Aplysia californica, a well-established model organism for cellular neuroscience. Our objective is to investigate nearly all messenger RNA (mRNA) involved in simple feeding and defensive networks.

A Nonpharmacological Alternative for the Treatment of Insomnia: Instrumental Conditioning of Brain Oscillations

Manuel Schahus. PhD,
Kers rin Hoedlmoser. and
Wolfgang Klimesch

Electroencephalographic recordings over the sensorimotor cortex show a very distinctive oscillatory pattern in a frequency range between 12-15 Hz termed sensorimotor rhythm (SMR). SMR appears to be dominant during quiet but alert wakefulness and synchronizes by the inhibition of motor behavior. This frequency range is also known to be abundant during light nonrapid eye movement sleep and is overlapping with the sleep spindle band. Given our recent findings in a healthy population (Moedlmoser et al.. 2008) where we showed improved sleep quality and cognitive performance, we were encouraged to extend this approach to humans suffering from primary insomnia by again comparing instrumental conditioning (IC) of the SMR frequency band with a placebo control.

Twelve participants with primary insomnia (11 women: M = 29.3, SD = 10.6) attended the sleep laboratory 19 times (four nights. 10 x SMR-IC, 5 x placebo-lC). A counterbalanced. within-subjects design was used. Results confirmed the increase of 12-15 Hz activity over the course of the 10 SMR-IC training sessions (/;<.03) but not over the course of the placebo-lC training sessions. Of interest, the increased SMR activity was associated with the enhancement of subjective sleep quality measured by the Pittsburgh Sleep Quality Index (;><.0I). Furthermore, sleep onset latency was reduced after SMR-IC (p = .056) but not after placebo-IC. Therefore, we could show that people suffering from primary insomnia could benefit from SMR-©Onditioning as indicated by improved measures of subjective and objective sleep quality.

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The SMR Story

M. Barry Stermun. PhD

This overview provides an updated review and integration of the neurophysiologieal rationale, implications for synaptic plasticity and learning, and basic and clinical methods and findings pertaining to brain modification training (BMT). formerly known as neurofeedback. It is based on documented findings, rational theory, and the research and clinical experience of the author. While considering general issues of physiology, learning principles, and methodology, it focuses on the uniqueness of the sensorimotor rhythm (SMR) training, arguably the best established clinical application of EEG operant conditioning (BMT). The basic research literature provides ample data to support a very detailed model of the neural generation of SMR as well as the most likely candidate mechanism underlying its efficacy in clinical treatment. Further, although more controlled clinical trials would be desirable, a respectable literature supports the clinical utility of this alternative treatment for epilepsy. However, the skilled practice of clinical neurofeedback requires a solid understanding of the neurophysiology underlying EEG oscillation, operant learning princi-ples, and mechanisms, as well as an in-depth appreciation of the ins and outs of the various hardware/software equipment options open to the practitioner. It is suggested thai the best clinical

practice includes the systematic mapping of quantitative multielectrode EEG measures against a normative database before and after treatment to guide the choice of treatment strategy and document progress toward EEG normalization. We conclude that the research literature reviewed in this article justifies the assertion that neurofeedback treatment of epilepsy/ seizure disorders constitutes a well-founded and viable alternative to anticonvulsant pharmacotherapy.

Mapping Brain Networks with Mutual Information Analysis
Jason R. Soss, MD

Current emerging theories of brain function envision a model of cognitive function defined by coherent interactions of anatomically distant neuronal populations. This model is supported by many studies showing that, brain activity, including consciousness and epilepsy, are correlated with firing rate synchronization across multiple neuronal assemblies. This neuronal activity is reflected in the EEG signal as the frequency component. Through measurements of the EEG signal at different regions, the functional network can be elucidated by determining the degree of synchronous firing patterns between regions. Using mathematical techniques of mutual information analysis, we can propose the strength of interactions between regions and track these changes during tasks or events to determine what brain regions are responsible. Application of this technique has be used to determine the epileptic network for surgical treatment, evaluating participants' awareness for performance needs (i.e.. airline pilots, truck drivers), studying the necessary brain functions for consciousness, and for brain/machine interfacing.

Biofeedback and Neurofeedback: Science or F iction?
Lynda Thompson, PhD

This talk shares information that was presented at a National Institutes of Health (NIH) symposium on Mind Body Medicine on May 7, 2009. The three areas discussed are Meditation. Biofeedback, and Tai Chi, and the goal is to bring the researchers at NIH up to speed with respect to biofeedback. The presentation underscores the fact that the practice of biofeedback developed from research findings and continues to be based on the careful application of learning procedures, especially operant conditioning techniques. There is a brief overview of the history of the field, dating back to the 1969 founding of the Biofeedback Research Society (forerunner of the AAPB). Clinical applications of biofeedback for various conditions are mentioned, with discussion of level of efficacy that has been established through research published in peer-reviewed journals. With respect to heart rate variability training, for example, there is established efficacy concerning asthma and hypertension with two or more large sample size, randomized, controlled trials for both of those conditions. The main emphasis is on neurofeedback training with particular mention of applications to seizure disorders and ADHD, which are the best validated applications. (The latest research from Europe—a German randomized controlled study establishing neurofeedback efficacy in ADHD and a Dutch meta-analysis of ADHD studies should help them realize that lack of American funding for biofeedback research has meant waiting for Europeans to validate a madc-in-the-USA intervention.) in line with the symposium's emphasis on health promotion through mind-body medicine, the data presentation concludes with a case study that highlights the combined approach of biofeedback and neurofeedback for effective stress management.