NEURO CONNECTIONS Newsletter

January 2009

A joint newsletter from the ISNR
& the aapb Neurofeedback Division

NEUROGUIDE

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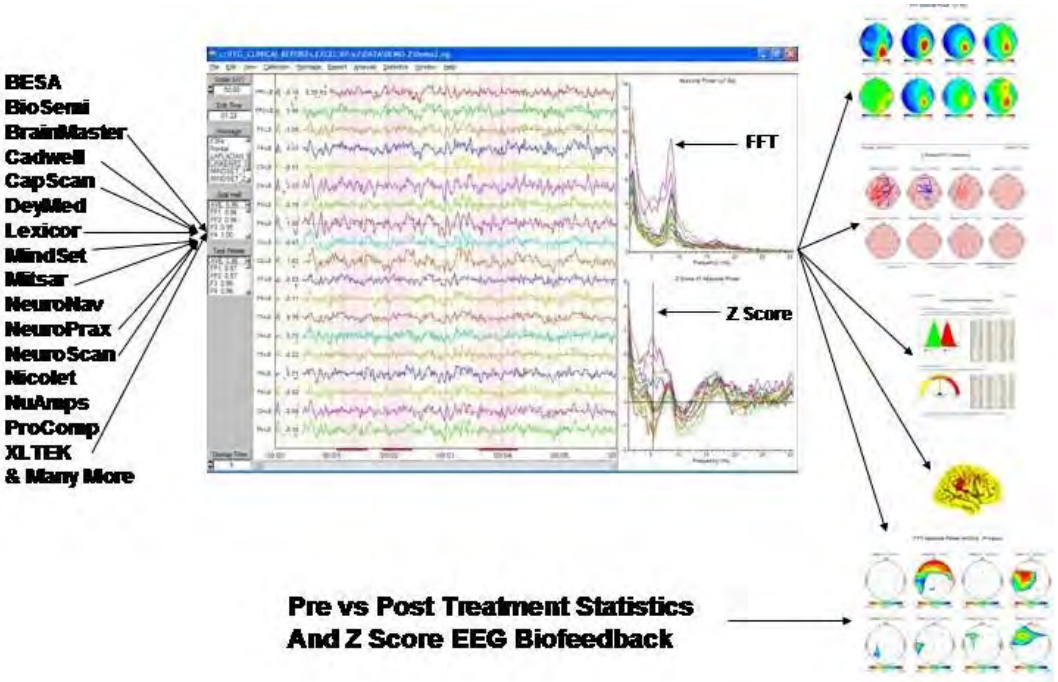

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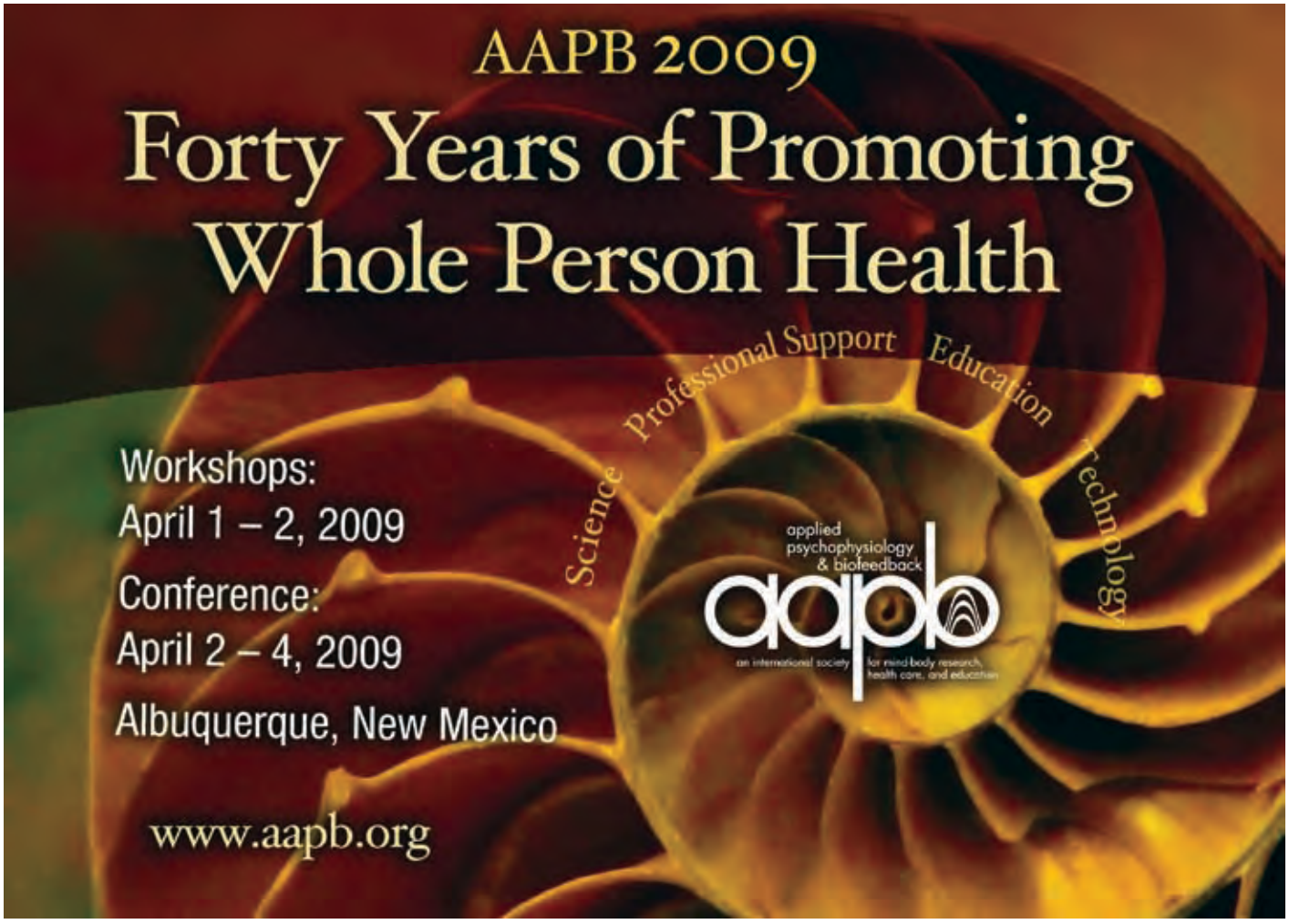

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Letter from ISNR President

György Buzsáki is one of our keynote speakers for our 2009 conference. I want to urge all of you to read his incredible book Rhythms of the Brain. Dr. Buzsáki gives us a comprehensive and unique picture of the way the brain creates our ability to be aware of time and space, taking the rhythmic reflexes that allow coordination and walking about as the underlying model for the development of perception and awareness. He's so comprehensive and enthusiastic about this integrating notion of synchronized oscillations that he starts his book with a Prelude—instead of the usual Preface! And he refers to the chapters as Cycles! The book has received the very highest praise from the top journals:

"In Rhythms of the Brain, György Buzsáki does a remarkable job of summarizing a vast body of literature on the topic... The book is a 'must read' for anyone interested in understanding the functioning of large and complex brain circuits." —*Nature*

"What makes this book so valuable is its range; Buzsáki has a worldly intellect, open to information from any discipline that provides insight, while insisting on a rigorous distinction between fact and baloney...Perhaps the greatest value of *Rhythms of the Brain* is that it provides a starting point for students and scientists who see the importance of this field and want to get a solid overview."—*Nature Neuroscience*

"Highly original exposition of a broad swath of modern neuroscience. Indeed, it brings together so many apparently

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Letter from AAPB Neurofeedback Division President

Current Status of QEEG in the Courtroom

Over the last decade, the medicolegal validity of QEEG (quantitative electroencephalography) as evidence for a closed head injury has become firmly established. Thatcher *et al*[1] successfully rebutted the assertion of Nuwer and the American Academy of Neurology, noting that there were factual misrepresentations and bias, whereas in reality QEEG is scientifically valid and reproducible, and does represent the gold standard for objective evidence of mild closed head injury. QEEG has greater than 96% sensitivity and 89% specificity, equivalent or better than the clinical standards for MRI, sonograms, blood analysis, and other common clinical diagnostic procedures. QEEG is used by the Department of Defense to determine whether Navy pilots will be permitted to resume flying after traumatic brain injury (TBI). The Department of Defense, the Veterans Administration, and the NIH consider QEEG to represent the standard of care for diagnosis of TBI. Organizations directly involved in TBI rehabilitation (the relevant community) include the American Medical EEG Association, the EEG and Clinical Neuroscience Society, the American Psychological Association, the International Society for Neurofeedback and Research, The Association for Applied Psychophysiology and Biofeedback, and the International Society for Brain Electromagnetic Topography. Three organizations (The American Board of EEG and Clinical Neurophysiology, the American Board of Certification in QEEG, and the American EEG Society offer board certification in QEEG. The Neurometrics® and Neuroguide® QEEG databases are approved by the FDA and have 510K clearance. The National Library of Medicine has hundreds of peer-reviewed papers on QEEG, all of which consider QEEG to be valid and reliable. Only 200 (out of 10,000) neurologists in the country use QEEGs. Neurologists therefore do *not* constitute the relevant community to determine QEEGs acceptance as reliable.[2] Individuals who are not certified by a QEEG board cannot serve as expert witnesses. The chief author of the AAN/ACNS report was unable to identify or recall under oath who the "others" were who told him that QEEG was predisposed to false positive abnormalities in normal subjects due to mild drowsiness or other problems. Reference to the anonymous "others" had to be omitted and or deleted from the trial. The author of the AAN article never responded to the rebuttal statements in the literature. The AAN supports the validity of QEEG in evaluating dementia, stroke, epilepsy, and intraoperative monitoring. It makes no sense to exclude TBI, for which the scientific evidence is much more compelling.

In many recent cases QEEG has been admitted as evidence of TBI.[2, 3] Monnett[4] has presented guidelines on working up and presenting a TBI case in court, which should aid attorneys representing these individuals to successfully litigate their cases. Thatcher *et al*[5] have reviewed the Frye

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ISNR Mission Statement

To promote excellence in clinical practice, educational applications, and research in applied neuroscience in order to better understand and enhance brain function. Our objectives are:

- Improve lives through neurofeedback and other brain regulation modalities
- Encourage understanding of brain physiology and its impact on behavior
- Promote scientific research and peer-reviewed publications
- Provide information resources for the public and professionals
- Develop clinical and ethical guidelines for the practice of applied neuroscience

AAPB Neurofeedback Division Mission Statement

To improve human welfare through the pursuit of its goals. The specific goals are:

- The encouragement and improvement of scientific research and clinical applications of EEG technology and neurofeedback.
- The promotion of high standards of professional practice, peer review, ethics, and education in neurofeedback.
- The promotion of neurofeedback and the dissemination of information to the public about neurofeedback.
- The division is organized for the purpose of carrying on educational and scientific objectives and is not to be operated for profit.

Letter from ISNR Co-Editor

Dear ISNR & AAPB members,

The winter is now in place with beautiful snowy scenes. One of the most magical rides is through Central Park on a snowy day, even in a car. Somehow one feels as though the stillness of the trees and footpaths has taken one to another planet. Our continuation of reporting on SCP and DC training is similar. There seems to be almost magical results and yet how this happens, what are the criteria for employing the techniques, how to evaluate the process and how to feel comfortable using the hardware/software is right in front of us. We, here at NeuroConnections, have pulled together authors who have the expertise to explain these types of training to us and to give us some ideas of the extent to which we can employ the training. This is a continuation of last months reporting on SCP and DC. Hopefully, you have found the articles useful and informative.

This issue has an article by Marc Saab on his use of SCP and Dave Siever discusses the hardware that he has developed to implement DC training. His hardware is compact and not so expensive with the usual reliability that he is known for. Tom Collura gives us a detailed explanation of the way SCP and DC training works and how to use it with the Atlantis. Daniel Keeser and Frank Padberg provides us with a study looking at the positive effects of DC training on depression, working memory, motor performance and other skills.

Finally, there are short write ups of several of the Small Group Discussions that were conducted at the ISNR conference. These have proven to be quite valuable over the last few years. Discussing a particular diagnosis or clinician issue such as how to evaluate equipment for neurofeedback with other clinicians and researchers is both fun and enjoyable. Besides, you are comfortably eating lunch and doing one of your favorite things... talking about your clients with clinicians and researchers and finding solutions! What more could one ask for.

Future issues of NeuroConnections will examine ways to work with PTSD and the veterans that need our work so much. Other

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Letter from AAPB Co-Editor

Welcome to the January 2009 issue of *NeuroConnections*. In the present issue we revisit the topic of DC and low frequency neurofeedback training, with a brilliant group of contributors, who tackle this interesting yet challenging topic from complimentary perspectives. Within the following pages readers will find a discussion of the physiological correlates of DC and slow cortical potentials in the EEG, a brief review the history of the pioneering work that has been done in the field, and discussions to help us to better understand both the opportunities and challenges awaiting those who may be considering moving into low frequency and slow cortical potential work clinically.

We are already planning our Spring issue, which will focus on the needs of returning military service members. We welcome those of you working with returning vets who might wish to share their experiences and outcomes in our forthcoming issue to contact us.

We also encourage you to mark your calendars for AAPB's 2009 Annual Conference. A number of presentations will be of particular interest to neurofeedback practitioners working with returning veterans, including, Steven N. Xenakis, MD, Brigadier General (Ret), U.S. Army Colonel Christopher Williams, MD, Defense Centers of Excellence for Psychological Health and Traumatic Brain Injury, and a featured symposia on neurofeedback applications with Blast Injury: TBI, PTSD, and Pain. Pre conference workshop dates are April 1st and 2nd, 2009, while the main conference will begin Thursday evening, April 2, and run through Saturday, April 4. Be sure to register online before March 2nd at www.aapb.org to receive your early bird discount. See you in Albuquerque!

Roger H. Riss, PsyD

Roger Riss, PhD
AAPB Co-Editor

Letter from ISNR ED

Letter from the ISNR Executive Director

ISNR continues to keep me busy. This year the Foundation and public relations issues are foremost along with standards for equipment and practice as spearheaded by President John Nash and President-elect Tom Collura. Many of you responded to the mention of the project in the email containing the minutes. Everyone is invited to participate in the process. We welcome your ideas and will keep you informed as the project unfolds. Feel free to contact any of us. I imagine we'll spend some time on this at our mid-year Board meeting in Houston.

The Foundation is building strongly. We're working on funding, an RFP for study investigators and establishing the non-profit status.

This year, we plan to represent the Biofeedback Neurofeedback Alliance at the APA conference in Toronto in August. This is our first attempt to convey our message to large groups of professionals who may seek education, certification and/or membership advantages within AAPB, ISNR and BCIA. If you are planning to present at APA or if you know of other venues in which our presence could benefit us, please let me know.

This issue, the second of two devoted to tDCS and SCP, has articles written by Marc Saab, Tom Collura, Dani Keeser and Frank Padberg, and Dave Siever. Each carries with it a unique approach. Between this and the last issue of NeuroConnections, one should have a fairly good grasp of the theoretical, practical and clinical aspects of tDCS and SCP.

The topic of the April issue of NeuroConnections will be Returning Vets. If you have something you'd like us to consider publishing, please contact me, Roger Riss or Merlyn Hurd.

Happy New Year,

Cynthia Kerson, PhD, BCIA-EEG
Executive Director, ISNR

ISNR President
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disparate strands, and levels on the reductionistic scale, that it deserves a must read score, especially for neuroscientists looking to get an up-to-date and challenging exposition of many of the big questions, even if they are not fundamentally interested in oscillations per se...If sharp wave ripples, associated with consummatory behavior in rodents, have the same connotations in humans, they too will likely occur in the readers' brain as a reward for the attention this book deserves."—*Neuron*

Dr. Buzsáki is a truly world-class neuroscientist; the fact that he's talking at our conference reflects the maturation of our field and its increasing recognition in scientific circles. This also highlights the need for us to strengthen our focus on being objective with our methods and our instrumentation as well as with our claims. As attention is turned to what we are doing clinically, the disaster of the first wave of neurofeedback in the 1960s and '70s must not be repeated. Dr. Buzsáki says, in talking about neurofeedback, "…the alpha feedback movement went underground in the late 1970s…" And that's the last most neuroscientists heard of neurofeedback until fairly recently.

I really hope you will read—and study—this book. It is NOT an easy read. It is very well-referenced and it is thick with facts, concepts and integrative ideas. I'm reading it now and I know it will take significant time. I also know it will help me integrate knowledge I already have and give me new knowledge, so gradually I will work through it. I hope you do too. T your time. Don't let this be just another pretty binder on your bookshelves after your eyes glaze over on the deeply technical details. Unglaze and go back at it! Do some beta uptraining and alpha/theta suppression while you read it if need be! Literature like this will give you more of the in-depth knowledge you need in order to think about what you are doing with neurofeedback, to converse intelligently with others in the health sciences and to assess and analyze the new claims and developments in neurofeedback.

John K. Nash, Ph.D., L.P., Fellow, BCIA-EEG
President, ISNR

AAPB President
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and Daubert Standards of Admissibility, with relevance to QEEG. They show how the peer reviewed science meets all of the Daubert standards of scientific knowledge. There are still some states that use the Frye standards, but the same evidence is effective in showing how QEEG meets them. It is important for the witness to review the reliability measures used in the specific case. If the subject has had neuropsychological testing, the results of the QEEG findings should be correlated. It may be useful to document the QEEG hypotheses of predictive validity and QEEG construct validity. Thatcher's paper[1]5 has an exhaustive bibliography on QEEG in the courtroom. The expert witness with expertise in QEEG now has the advantage in proving the existence and extent of closed head injury.

Jonathan Walker, MD

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ISNR Co-Editor
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themes include Autism and Asperger's and hopefully ways of conducting assessment with various types of tools being set forth. We are always open to suggestions of types of issues you would like to see explored so be sure to send an e-mail to the office and we will do our best to find the experts to write up their experiences for your consumption.
Hope you had a happy holiday and enjoy the beginning of a new year.

Merlyn Hurd PhD, BCIAC/EEG Fellow
ISNR Co Editor of NeuroConnections

Letter from AAPB ED

Engagement: The Spice of Life

It has been a good year for AAPB in many respects. Topping that list is that we experienced the highest percentage increase in membership in 2008 compared to any of the past five years. This is critically important to AAPB. Anytime we experience this type of growth, it affects other areas that impact the organization and biofeedback in a positive way. Some of the areas that this will impact, if past history holds true, is Annual Conference attendance, acquisition of AAPB-published books, and the opportunity for more volunteer engagement.

Volunteer engagement is the life blood of the organization! More than in recent years, the AAPB committees and task forces have been called into action. Here is a quick sample of our 2007-2008 committee and task force achievements:

- Early in the year, our special Nomenclature Task Force, chaired by Dr. Mark Schwartz and included representation from ISNR and BCIA along with AAPB, completed the arduous task of developing a joint definition of "biofeedback." This has been a significant achievement in providing consistent information to the media, the medical community, insurance carriers, and the general public.
- The Program Planning Committee, chaired by Dr. Howard Hall, has completed its job of preparing the 2009 conference. The theme this year is "AAPB 2009: 40 Years of Promoting Whole Person Health."
- The Education Committee, chaired by Dr. Gabriel Tan, has been responsible for the teleseminar series, the pre-conference workshops, an excellent Fall Workshop, and other considerations for future events.
- A new University Outreach Task Force has been formed, chaired by Dr. Constance Schneider, with the primary objective of expanding university curricu-

la to include biofeedback. Although this group is part of the Biofeedback/Neurofeedback Alliance, AAPB believes that this is a critical process in driving new graduates/practitioners into the field of biofeedback.

- A new History Task Force/initiative under the guidance of Drs. Carol Snyder and Francine Butler is developing a history that weaves together developments over the years that have shaped AAPB, the field of biofeedback, and the pioneers that have contributed to both.

Our volunteers are the essential ingredients in making things happen, the spice that brings new energy, new ideas, and new ways to think about our mission. In bringing their contributions, they create the programs and resources that are invaluable to our members and our field. As they become increasingly engaged in the overall leadership of AAPB, the more they share their involvement with other members, and the more we will continue to grow and thrive as a leader in the promotion of and development of biofeedback.

David L. Stumph, IOM, CAE
AAPB Executive Director

DC-EEG in Psychophysiology Applications—A Technical and Clinical Overview

Marc Saab, M.Eng, EEG Product Manager, Thought Technology Ltd.

There has been increasing interest of late in very slow electroencephalographic (EEG) activity. While this sort of activity has been recorded and studied for many years, and used in biofeedback protocols in several applications, it is only recently gaining popularity as another tool with potential mainstream application to clinical neurofeedback. Whatever the tool, before embarking on a new clinical path, a general understanding of the existing research, as well as the technical and neuro-physiological basics is crucial to a successful experience. While there is no need to get overly carried away by the technical issues, a little knowledge can help avoid misunderstandings and common pitfalls, while hopefully leading to better clinical outcomes.

What is DC-EEG?

DC-EEG is a bit of a misnomer, as DC, or direct current, refers to a signal value that is not changing. It is commonly understood to be the baseline about which the oscillating EEG activity varies. Technically, the DC component is the average of the signal, and it happens to turn up as the first term of the Fourier series, or the first value in the frequency domain obtained using the fast Fourier transform (FFT). OK, enough math for now, all this means is that when a very slowly changing EEG signal is described, the term DC is adopted when referring to the signal as DC-EEG.

Most often, the term DC applied to the EEG signal is borrowed from the term DC used to characterize the amplifier being used in the recording. A true DC amplifier does not omit any low frequencies and the DC component of the signal is captured along with all the rest. In most applications, the DC component is selectively omitted from the signal acquisition (the motivations for this will be explained later), and the baseline of the recorded EEG is zero, i.e. the EEG signal oscillates about the zero line. In addition to the DC component, very low frequencies are also omitted, as the truncation can never be instantaneous. What is actually left out of the recording is a range of low frequencies starting at the DC point (0 Hz) and ending at the low cutoff frequency of the system (often around 1-2 Hz).

This brings only benefits as long as the signal of interest is within the frequency range that remains above the cutoff point. When this signal lives below the cutoff frequency, removal of the DC component and the range of frequencies slightly above it will also remove the required signal. This signal of interest, as it applies to the research discussed in this article, refers to EEG activity below 1 Hz, below 0.1 Hz, even below 0.01 Hz - in other words very slowly oscillating neurocortical activity.

Terminology tends to get tangled, but if semantics are respected and time and frequency are considered to be intimately related, it becomes clear that DC-EEG, low frequency EEG and slow cortical potentials (SCP) in fact all refer to the same thing. (Consider: a DC amplifier passes low frequencies, which can be described as slow activity, and cortical potentials are the source of surface EEG). In the field of neurofeedback to date, the different terms tend to describe the particular methodology, as low frequency training and self-regulation of slow cortical potentials may imply different training strategies applied to the same EEG signal.

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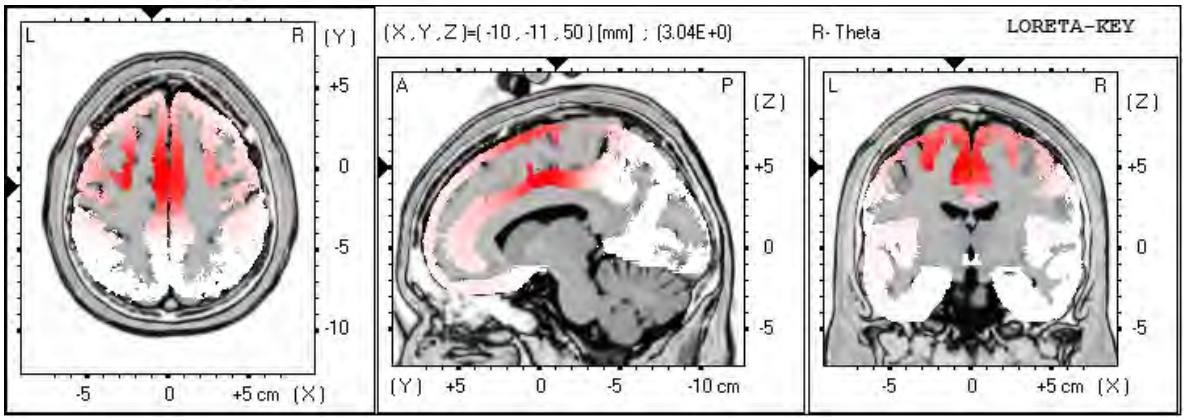

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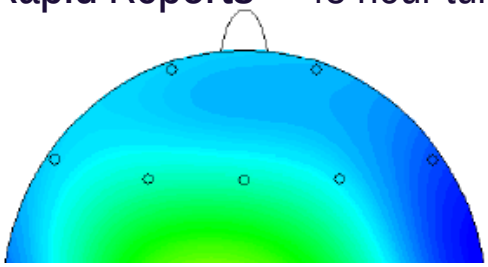

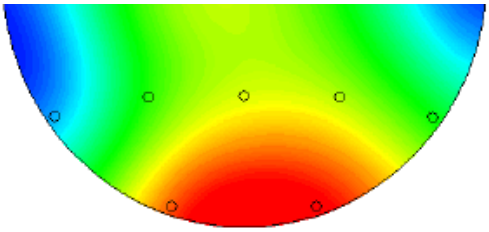

Database Comparison:

NxLink,
sLORETA,
NeuroGuide,
SKIL,
WINEEG,
Connectivity Analysis

Neurofeedback Panel:

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D. Corydon Hammond, Ph.D.
Jack Johnstone, Ph.D.
Joy Lunt, RN
Margaret MacDonald, M.D.
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DC-EEG in Psychophysiology Applications

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In the text that follows, when referring to the concept of recording EEG with a DC amplifier, the broad term DC-EEG will be used. When referring to the EEG itself, the terms low frequency EEG and slow cortical potentials will be used according to the context.

Why DC-EEG?

DC-EEG is considered to reflect the general state of neurons and to contribute to the explanation of the mechanisms of surface EEG (Speckmann and Elger, 2005). The origin is reported to be linked to several phenomena, at the same time neuronal, glial and non-neuronal in nature. The SCP is an indicator of relative whole brain state, as slow shifts tend to reflect general activation and inhibition.

Negative shifts of SCPs reflect widespread depolarization of apical dendrites of pyramidal neurons (Birbaumer et al, 1990) and decrease of thresholds for paroxysmal activity. Positive shifts of SCPs are thought to result from inhibitory sources. Dr.Ute Strehl states it this way: "Negative SCPs increase firing probabilities, whereas positive SCPs [inhibit] the respective cell assembly. These neurophysiological considerations suggest an important role for SCPs in the modulation of excitation thresholds of cortical pyramidal cells [the source of surface EEG]" (Langley, 2001). Hinterberger summarizes as follows (2004): "negativity represents the mobilization or readiness, positivity represents ongoing cognitive and neural performance or inhibition of neuronal activity."

The early work by Niels Birbaumer and his group at the University of Tubingen, in Tubingen, Germany, showed that control of these SCP shifts can be learned (Kubler et al, 1999; Birbaumer et al 2000; Kubler et al 2001, Wolpaw et al 2002) (Figure 1.). This was recently correlated to changes in fMRI data to further validate the previous findings (Birbaumer et al, 2003). Using biofeedback, patients were taught to control their SCPs to produce the positive and negative shifts required to select letters or words in a computer program. This was quite an inspiring undertaking with touching results, as one of the first successful messages typed using the device was a heartfelt thanks to Dr Birbaumer and his team (Geary, 2002).

Applied to epilepsy, it is believed that suppressing negative SCP shifts can help to limit the electrocortical activation of the brain and control the incidence of seizures (Kotchoubey et al., 2001; Rockstroh et al, 1993).

Contrarily, when applied to ADHD, negative shifts are encouraged in the hopes that the subjects can retain the skills required to reproduce the general activation and apply it when concentration is required (Strehl et al, 2006; Drechsler et al, 2007). Innovative ways to have children apply the method to their everyday life have been proposed as well. For example, they are given a card on which is displayed an image of the feedback they received while training, and are instructed to try to replicate the self-regulation while looking at the card. Results have been encouraging, and there is more significant validation work currently underway (Riss, 2008).

Researchers at the University of Kiel have applied this same technique to the assessment and treatment of migraine (Siniatchkin et al, 2000a; Siniatchkin et al, 2000b; Kropp et al, 2002) (Figure 2.). As seen in Figure 3, migraine sufferers exhibit increased amplitudes as well as reduced habituation of the Contingent Negative Variation, or CNV – a negative SCP shift in response to preparation (Andrasik

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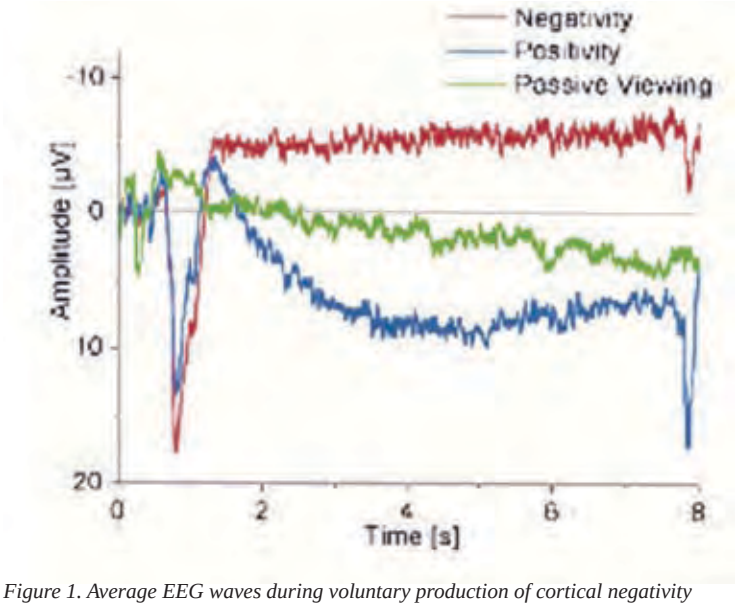

Figure 1. Average EEG waves during voluntary production of cortical negativity (red) and positivity (blue), with passive viewing (no SCP shift) shown in green. Taken from Birbaumer et al, 2003. Note: scale is positive DOWN.

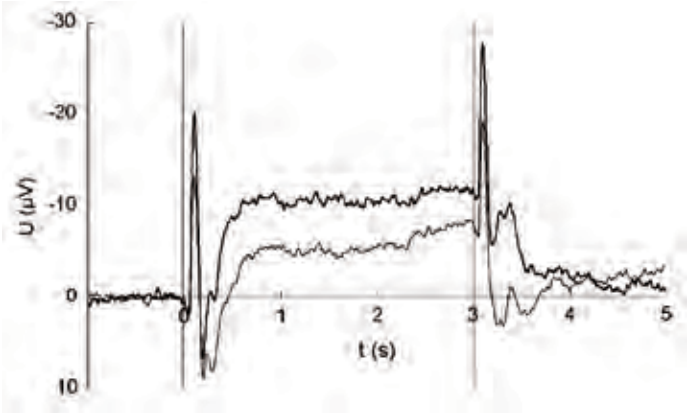

Figure 2. Average CNV during assessment of migraine disorder. Migraine patients appear to produce increased negative amplitudes in the pain-free interval (thick line) compared with healthy controls (thin line). Protocol and method of analysis are similar to the Tubingen approach shown in Figure 1. Taken from Kropp et al, 2002.

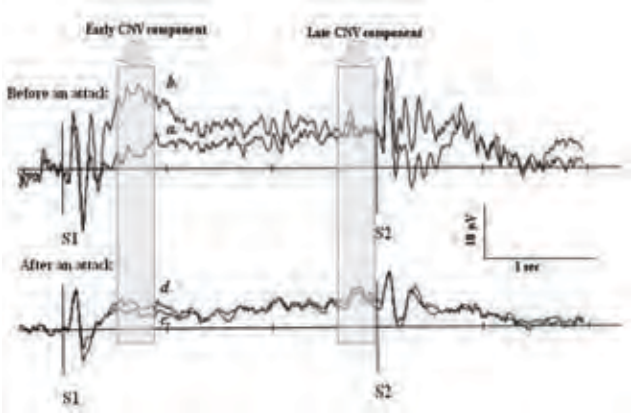

Figure 3. Average CNV in migraine patients, with focus on early and late CNV components. Traces .a and b. in top pane were recorded the day before an attack, traces c. and d. were recorded 2 days following. Traces a. and c. were measured during stress, traces b. and d. during rest. Trace b., during stress and before an attack, a clear increased negative CNV can be seen. Taken from Andrasik and Rime, 2007. Note: scale is positive DOWN.

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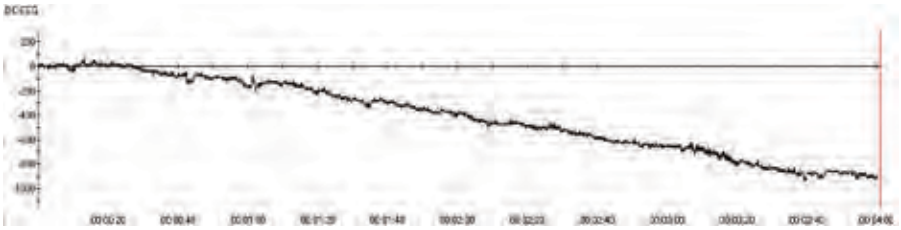

Figure 4. Raw, unfiltered DC-EEG captured with sintered silver/silver/chloride electrodes, shortly after placement. Note the floating baseline (downward in this case) and the very high drift rate of almost 1000 uV in 4 mins (approx. 250 uV / minute). While this drift does decline after some time has elapsed and electrode polarization has reached equilibrium, it is always present in DC-EEG.

and Rime, 2007). During training, subjects are taught to suppress negative SCP shifts to reduce frequency and intensity of migraine attacks. An adaptation of the Tubingen protocol is suggested as a standard for assessment and training of SCP applied specifically to migraine (Kropp, 2000).

Several other applications exist, including depression (Schneider et al, 2005a), substance abuse (Schneider et al, 2005c) and schizophrenia (Gruzelier et al, 1999; Schneider et al, 2005b), to name a few. A large list of abstracts has been compiled to serve as a recent review of literature regarding self-regulation of SCP (Langley, 2001).

Why is it not so straight forward?

As previously mentioned, the DC and low frequency range of the EEG signal are often selectively omitted from recordings simply because of the complexity involved with their inclusion. Several effects - physiological, mechanical, electrical, and chemical - exist to make the recording of EEG with a DC amplifier somewhat of a challenge. Historically, the best way to deal with this has been to filter out the low frequencies. To properly acquire and analyze DC-EEG, the issues involved must be well understood and carefully accounted for, as they have been in almost all of the literature on the topic, at least as experienced by the author of this article. That is not to say that a DC amplifier is not a wonderful tool, only that it comes with great responsibility. Or, more simply put: there is no free lunch!

DC drift

First things first, the DC value of the EEG, or the baseline about which the signal oscillates, actually changes over time. This effect is called DC drift. The rate of this drift is influenced by several factors, the most significant of which is electrode polarization. Electrode polarization is the electro-chemical effect that exists when a metallic electrode is placed in contact with an electrolyte (the conductive gel in this case) and the scalp. A chemical reaction begins during which ions are attracted to the surface of the electrode and charge begins to accumulate. This occurs at each electrode site in different quantities and at different rates, and this discrepancy in charge accumulation creates a voltage that is measured by the system (a.k.a the battery effect). To make a long story short, the system ends up measuring this additional voltage in parallel with the EEG.

As the polarization continues, this voltage changes and the baseline value of the EEG changes with it, as seen in Figure 4. The problem is twofold: firstly, the baseline will eventually drift beyond the range of the amplifier and only a flat line will register in the recording (although this is easily dealt with in modern DC amplifiers). Secondly, and more importantly, the rate of change is on the order of that of the slow cortical potentials being measured, and the 'battery effect' voltage that is produced can cloud the SCP. Simply put, it can be difficult to differentiate between DC drift and the SCP. (Electrode polarization eventually reaches equilibrium, and when it does the signal stabilizes somewhat, but this often requires several hours in the worst case, and in the best case far more time than is available in a clinical setting.)

The only way to completely remove this effect is to completely remove the low frequencies. When this is not an option, efforts to minimize the effect of DC drift should be made. Also, more important than equipment specifications or technical features, the experimental or clinical paradigm should be such that the effect of DC drift, and all other low frequency artifacts, is inherently ignored by the design of the protocol (more on this later).

To minimize the effect of DC drift, specific amplifier characteristics are required and special electrodes must be used. The amplifier requirements are not so stringent, and are met by most modern commercial DC systems. The special electrodes are made of sintered silver-silver chloride. The term sintered implies a specific manufacturing process, by which the chloride is added to the silver throughout the material and becomes part of the entire electrode, as opposed to comprising a thin sheet on the surface as with regular silver-silver chloride electrodes. A nice comparison of the low frequency performance of most commercially available electrodes was performed by Talgren et al (2005a), and the results are straight forward: only this type of electrode will do for low frequency recordings. It offers the lowest electrode polarization (and hence contribution to DC drift), the least low frequency noise and the best long-term stability. Several chloride-based conductive pastes are recommended as well (among these are name brands EC2, Ten20, and Electro-Gel).

The sintered Ag/AgCl electrodes themselves are somewhat delicate. They are absorbent and should not be left in contact with any substance for very long, lest they absorb foreign ions and then performance becomes degraded. They should be cleaned immediately after use and never left with any paste affixed that can dry and harden. Ideally they should be rinsed with distilled water and should be left to hang dry. It is also sometimes recommended that before use, soaking them in a saline solution for up to an hour can help reduce polarization and increase settling time once they are actually applied.

In addition to using these electrodes and pastes, careful preparation and placement techniques should be employed to ensure reliability, lower electrode impedance, and avoid artifacts related to the skin-electrode interface as much as possible.

Skin-electrode interface

Two important requirements for DC-EEG were described in context of DC drift (a stable system with good amplifier specifications, and high quality non-polarizing electrodes with a chloride-based conductive paste). The third important requirement for DC-EEG involves the skin-electrode interface, which is determined by how well the skin is prepared and the electrodes are applied.

Integrity of the skin-electrode interface is crucial to minimizing artifacts due to electrode movement and transdermal potentials (specifically galvanic skin response, or GSR). Tallgren (2005b, 2006) warns that the only way to avoid electrode movement artifacts is to fix the electrode with collodion (a pyroxilin-based surgical adhesive often used to fix surface EEG electrodes for long term recording) or other method (proprietary methods are described) and to ensure a constant amount of paste is always used. Bauer et al (1989) recommend that the electrode gel be properly evacuated using a vacuum pump to avoid air bubbles in the gel.

Tallgren (2005b, 2006) also warns that the only way to avoid GSR artifact, and to reliably record slow cortical potentials with a DC amplifier is to short circuit the skin, meaning it must be punctured. While this would seem extreme, it is repeatedly mentioned as a critical requirement in DC-EEG. Recent studies by Hennighausen et al (1993), Bauer et al (1989), Voipio et al (2003) and Tallgren (2005b) confirm previous studies by Picton and Hillyard (1972) and Cowen (1974) in which continuous, unpredictable DC drifts and often a profound contamination by GSR were measured when skin was left intact.

Other important effects

Eye movement is another significant source of artifact in DC-EEG recordings. Sometimes confused as ocular EMG, the signal produced by the eye is in fact electrical. The eye acts as an electrical dipole and produces a signal that is captured by the EEG amplifier. Eye blinks are well-known contaminants in neurofeedback, but eye movement and even eye position are important in DC-EEG as they contain considerable low frequency content. Eye position is in fact a DC signal itself, and it influences the baseline of the EEG signal; upward gazes will shift the baseline upwards, and downward gazes downwards. In addition to acting as an artifact, in SCP protocols eye movements can actually influence the feedback by mimicking the required positive and negative shifts in the SCP (voluntarily or otherwise).

Respiration causes another, lesser-known physiological artifact in DC-EEG. Voipio et al (2003) make a strong case for a non-neuronal generator of DC shifts, manifested as negative shifts linked to hyperventilation and positive shifts linked to hypoventilation, both directly caused by changes in partial pressure of carbon dioxide (PCO2) in the brain. Speckmann and Elger (2005) also present a clear positive shift during hypercapnia (increased CO2).

Finally, the influence of inter-subject variability which always helps to keep things interesting. According to Kotchoubey et al (2000), "subjects differ greatly in their ability to learn" and "independently of this, humans differ substantially in their overall tendency to produce positive or negative shifts, regardless of the task." That said, a quote from Hinterberger et al (2003) is interesting:

Success in self-regulation training depends not only on the correct selection of technical parameters, but also on the patient's psychological and physical state, motivation, social context, and the trainer-patient-relationship. Recent data demonstrated that self-regulation and communication skills of severely paralyzed patients could be predicted from the results of the initial training period: Patients who later acquired the self-regulation skill well enough to communicate (i.e., > 75% correct responses), had already showed a high performance (>80%) in the first 30 training sessions (about three training days [at 7-10 sessions per day, 4-8 minutes per session]) (Neumann and Birbaumer, 2003). Attentional capacities and motivational factors might be responsible for these performance differences between patients.

Siniatchkin et al (2000b) also confirm previous reports that children and adults can successfully learn self-regulation of SCP within 2 sessions.

What has been done?

It would appear nearly impossible to work with DC-EEG with all these sources of artifact and ambiguity. An obvious question arises: How has self-regulation training of SCP been achieved if simply measuring the signal is so complicated? Thankfully there has been significant innovative work that has shown solid results through practical methodology, with the a priori intention of influencing clinical practice to follow suit.

AC vs. DC

The suggestion has been made that DC-EEG is the only way to record slow potentials (Voipio et al, 2003; Tallgren 2006). Even more benefits are appreciated when no filters whatsoever are applied, and the more apt term full-band EEG, or fbEEG, is adopted (Vanhatalo et al, 2005). These are certainly valid arguments, and the authors make a strong theoretical case as applied to several areas of EEG analysis. For real-time neurofeedback however, DC-EEG is simply too impractical for use in a clinical setting. The authors agree, as mentioned above, that an absolute requirement, at the very least, is to puncture the skin. Co-author Pekka Tallgren, in his own comprehensive treatise on clinical DC-EEG (Tallgren, 2006), concludes after having tested several different methods to short circuit the skin, that there is no simple, quick, practical solution and that this remains a significant problem in the use of DC-EEG for clinical work.

In fact, most often DC amplifiers have not been used in the research of low

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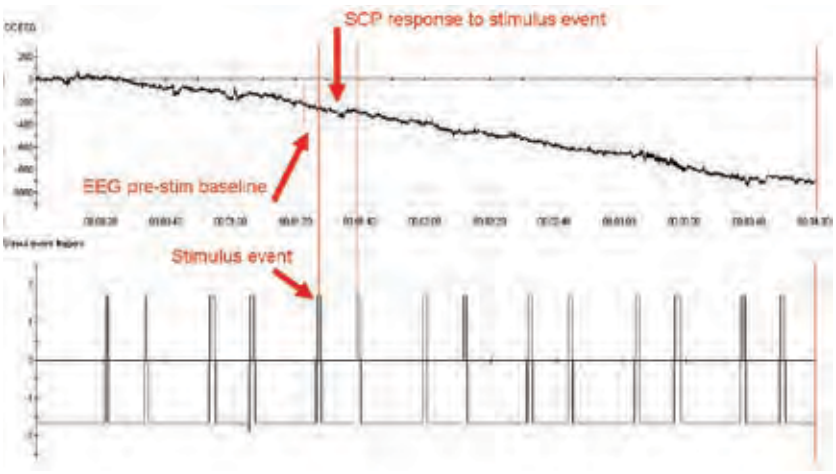

Figure 5. DC-EEG shown with timeline of stimuli event triggers (indicating when the stimuli were presented). The pre-stim baseline is defined as directly before the stimulus, and the response SCP is immediately after. Before averaging, the baseline is removed from the SCP response such that what is captured is the explicit change in slow EEG output in response to the self-regulation cue, as mentioned in Kotchoubey et al, 2000.

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frequency EEG because the complexity simply outweighs the benefits. All of the research quoted in this article, as well as that of many other studies, was mostly carried out using low frequency AC amplifiers (amplifiers that omit the DC component). Birbaumer's original Thought Translation Device (Birbaumer et al, 2003) and much of the work at Tubingen was implemented with a PSYLAB EEG8 amplifier from Contact Precision Instruments, which not surprisingly has a low frequency cutoff of 0.01 Hz.

That said, a DC amplifier can certainly be used, and would indeed record a theoretically pure SCP, but until more research is done and new discoveries are made, the DC-EEG issues outlined above cannot be ignored. The cost involved with using an AC amplifier is that a small portion of the SCP signal is lost. Also, the dynamics of the AC amplifier are such that recovery from movement artifacts require quite a long time. Thus, failing to identify these artifacts renders the recording useless, and avoiding or removing them becomes mandatory.

The benefit is a significant reduction in DC drift, although several of the same exogenous artifacts still exert influence albeit to a lesser degree. In essence, the extent of the trade-off depends on the cutoff of the AC amplifier. The lower it is, the more DC effects are included; the higher it is, the less pure SCP is recorded. The usual operating point is such that some low frequency effects are tolerated and an acceptable (although unknown) amount of SCP is filtered.

Standard Protocols based on the Tubingen Research

Electrode placement is at the vertex ('Cz' in the International 10-20 system) referenced to linked mastoids. To differentiate the SCP from DC drift and other low frequency artifacts, the mean SCP amplitude is computed relative to a trailing baseline and the clinical protocols are designed to isolate the positive and negative shifts from the background EEG. The general idea is that self-regulation via visual or auditory information is coordinated with an "effector," either motor (push button response) or non-motor (imagery and thinking) that explicitly elicits SCP output (Kotchoubey et al, 2000).

This is achieved using oddball paradigms and multi-trial averaging, such that repeated efforts to move the SCP in one direction or another are averaged separately. This ensures that what is trained and measured is in fact the self-induced shifts that are required as immediate responses to the stimuli pairs (target and non-target, for example; or positive and passive, negative and passive, or positive and negative). It also allows measurement of the respective SCPs, and hence the ability to quantify the progress of the self-regulation training by reporting an actual amplitude reading for a given session.

An important point is that amplitude of each SCP is measured relative to the section of EEG immediately prior to the generation of the shift (Figure 5.), such that the immediate change in amplitude of each trial is averaged during the period in which SCP shifts persist. This is the final pre-requisite that, when combined with the other protocol parameters, allows the differentiation of the SCP and DC drift and other low frequency artifacts.

To maximize learning, positive and negative shifts are randomly distributed. Trials also exist both with and without feedback. Feedback is given when the individual SCP shift produced is large enough to reach a threshold. The trials without feedback are called transfer trials as they are designed to transfer the ability to produce shifts in real life situations, when no feedback exists.

The number of sessions varies, but in general the strategy includes groups of sessions separated by periods of non-training. For example, one of Dr Strehl's ADHD protocols includes thirty 1-hour sessions, in three groups of ten, with each group lasting two weeks (five days per week) and separated by a 4-6 week break (Strehl et al, 2006).

To eliminate the influence of EOG and the CO2 effect

Eye movements should be discouraged as much as possible. The gaze of the subject

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Small Group Discussions from ISNR 2008

Generalization of NFT

Discussion Leader: Peder Fagerholm

This SGD occurred on Friday the 28th. Education as the underlying principle for NFT was discussed. Additionally, generalizing the learning was also considered. For example, one should be able to generalize sleep hygiene from the bedroom to the hotel room. Is this a conscious or unconscious process? It was noted that neurofeedback is a less-conscious process than biofeedback.

The concept of desensitization was discussed. Practitioners could suggest invoking the stressful event via visualization while training the client, then to couple the visualization while maintaining optimal brain function. One attendee suggested the analogy that neurofeedback is like a noise reduction switch on analog tape machines that removes extraneous noise.

Other points to consider when suggesting ways for clients generalize the training into their lives:

- People who cannot suppress MU have difficulty differentiating self from other.
- Schizophrenia is a structural as well as functional disorder which may be hard to address with neurofeedback.
- There is very little literature on paranoia.
- When working with AD/HD children, try allowing them to do their homework while getting feedback. Or ask them how long they can sit still.
- Posture affects process – have the client sit straight in the chair.
- The Thompson's speak about metacognition and create a trigger to bring about a change in focus. For example: every time you see a red dot, take a breath.
- Are these processes subconscious, automatic or habitual?
- Affirmations begin conscious and become subconscious over time.
- Think of neurofeedback as electronically-enhanced meditation.
- Introduce activities that reinforce neurofeedback training such as practicing handwriting or organizational tasks or puzzles.

Confounds to generalization include drugs, family dynamics, MU waves, peer group pressure, stress, nutrition, including soda, sweets and fast food, the choice of the generalizer by the clinician and an inability to stabilize the client.

Major Depression

Discussion Leader: Cory Hammond, PhD

For depression think genetic; then look for slow activity and note brain is trying to compensate, therefore, inhibit theta and slow alpha, and then beta goes down by itself.

OCD is usually FP1 and FP3 and usually look at left frontal area (F3) for excessive slow activity.

Question of whether someone with trauma would be different? The answer was, "Yes and use a QEEG to be sure of findings."

An article "First Do No Harm" by Lynda Kirk and Cory Hammond was recommended which is looking at adverse effects in neurotherapy when reinforcing too strongly theta, alpha and beta. Therefore, individualize for each client and focus on more significant issues first.

At end of first session have symptom rating form of about 8 symptoms including impulsivity; anger; depression and mental fogginess. Next session ask "Since you last saw me, how would you rate your depression; impulsivity; anger; depression and mental fogginess?"

Participants noted that Margaret Ayers primarily inhibited frequencies and only occasionally rewarded alpha.

Keep threshold on reward band really small so that you don't too strongly reward and cause adverse side effects.

David Burn's book "Feeling Good" was recommended to be given to patients and help them to use it.

Respiration training was recommended especially when anxiety is present.

Participants noted that hypnosis, placebos and systematic bias articles indicate that medication is overrated. Compared to placebos only severely depressed patients improved on antidepressants.

The participants noted Hamilton Depression Scale has been criticized.

In the frontal and parietal areas, if these are "stuck" use power training. Training coherence and amplitude usually resolves this condition. Participants noted clinicians need to be careful for adverse effects. Jonathan Walker says to train power first, then coherence, but for no more than 4-5 sessions between 2 sites for the coherence training. Treating coherence first may cause slower progress.

Barry Sterman noted that 26% showed reduction in seizure

rates but the EEG did not change because they were only looking at amplitude whereas the training may have been changing coherence or phase.

David Cantor has conducted AVS studies with depressed clients and this will be published soon.

Reinforcement sessions may be appropriate years later if symptoms return.

A subtype of OCD is noted at T5, 01, P3 with higher alpha.

The issue of bipolar depression was noted as being primarily at F7 and F8 and can be because of having too much beta. Bipolar depression is harder to treat because of many psychological reasons plus medication plus mania. As the patient gets better they may overdose if medication is not reduced. Suggestion was to make clients aware of the manic phase which is usually found in the right frontal and temporal areas. Depressed phase is usually in alpha.

Participants were advised to have informed consent/preparation form with underlining and in bold that they should not stop taking medication unless psychiatrist recommends such action.

Cory noted he is less inclined to use LENS when there is a lot of excess fast beta. For depression, Cory uses both LENS and traditional neurofeedback. He uses a QEEG to determine training. If primarily depression, he will use traditional neurofeedback, but if other issues are involved he may use LENS. If the depression is more genetic depression he will use site specific treatment, but otherwise he may use many different areas for treatment. It was noted that depression with PTSD usually has excess beta.

Neurofeedback for PTSD

Discussion Leader: John Carmichael, PhD

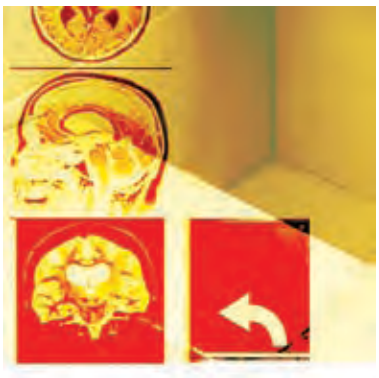
The Small Group Discussion on Neurofeedback for PTSD was held on Friday, August 28th. John Carmichael facilitated it and Dr. Patricia Jo Ryan was the scribe. Dr. Carmichael works mainly with police and military clients and believes that practitioners should be informed by research and vice versa. However, he found few existing studies using neurofeedback as a treatment modality. Most studies on PTSD were based on one event motor vehicle accidents. They are using cognitive behavioral therapy as the main treatment modality, which appeared to be ineffective with the police and military participants and there was a drop-out rate of 30% when exposure therapy was used as the main treatment modality. Dr. Carmichael reported that 50% of PTSD clients will have chronic depressive disorder and 40% of military clients wind up with obstructive sleep apnea. Among this group, comorbid features of panic disorder and other sleep problems are also common. The panic attacks often occur during night-time and are not related to delta brain wave activity.

The first study using neurofeedback was conducted by Eugene Peniston in the 1990s. He used a control and experimental group with 20 veterans. This group also had severe alcohol abuse problems. He used Alpha-theta training and found that all of the members of the control group had relapsed by the end of treatment. Additionally, he found that members of the experimental group showed a decrease in medication usage.

Dr. Carmichael reported on his treatment with police and military clients in a recent issue of NeuroConnections (July 2008). He found that 40% of the participants showed excess beta in the right posterior area of the brain. Thirty percent of the clients in his treatment group did not show remission. Treatment was based on qEEG results of the 30% of clients. There was remission of symptoms in all but one client who was unable to recover from the trauma. There may also be insufficient theta and the anterior cingulate may play a role in this, as the theta generator. Dr. Carmichael encouraged all providers to participate in the ISNR list serv to have access to the most current treatment information for this population.

Neurofeedback for Reading Disabilities

Discussion Leader: Dr. John Nash, PhD



The Small Group Discussion entitled Neurofeedback for Reading Disabilities was held on August 29th and was lead by Dr. Jonathan Walker. was the scribe for this discussion. There were 5 people present.

Dyslexia was discussed as one of the areas most easily remedied with NFT. The 3 types of dyslexia were discussed; which include dysphonetic, dyseidetic and combined. They are disabilities that include the inability to associate symbols with sounds, deficits in vision and memory, for example of letters and word shapes and a combined type, in which the person often cannot read or write (respectively). It was also pointed out that dyslexia can often be mistaken for ADD.

QEEG will show processing difficulties in amplitude and connectivity. It was stated that acquiring the EEG under a reading task may reveal the pathologies more readily than if the tasks were not related to the symptoms (such as eyes open and closed). If deficits which may include heightened slow wave activity lie at F8 and T6 this may indicate auditory issues. When the activity is normalized, the auditory processing improves. Pathologies at F7 /F8 do not seem to imply dyslexia. Training coherence up was suggested as it has been noted that good readers are often hypercoherent. A QEEG will also identify frontal high beta (possibly at Fz) which may cause or exacerbate anxiety and irritability due to the reading disorder. There may also be abnormalities in the Gamma range (32-60 Hz) with eyes closed and/or during a reading task.

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should be fixed and the subject should be instructed only to blink between trials (to avoid eye blinks being included in the trial averages).

In a slightly more advanced approach, EOG can be measured simultaneously and each or any combination of the following can be done: feedback can be interrupted when EOG activity exists, the EEG recording can be marked to indicate presence of EOG, and the EOG can be removed offline.

The Birbaumer group in most cases performs the subtraction online to ensure that feedback is not given for eye movements. This is implemented using a direction-independent method such that eye movement interrupts feedback but does contribute to it (by moving in the opposite direction, for example) (see Kotchoubey et al, 2000). Offline correction is also performed before analysis of the averages. This is a very useful technique that would seem to apply very well to general artifact removal in any type of biofeedback protocol. The online method does not necessarily have to be perfect, as long as processing times are fast and feedback is not influenced, and the associated offline method can require more processing power to remove artifacts accurately for the analysis of the data.

Respiration can also be measured to ensure that breathing remains calm and rhythmic (e.g. 4-6 breaths per minute). At the very least, breathing can be monitored visually without necessarily recording respiration, and the practicing clinician can respond to irregular breathing appropriately.

Conclusion

All of the technical and scientific challenges presented in this article are by no means meant to frighten or deter the reader from further exploring DC-EEG and self-regulation of SCPs. On the contrary; they are presented to inform so that as the new techniques are adopted, the likelihood of positive clinical outcomes is maximized. An analogous discussion could be about driving a car, in which the concepts of a gas pedal and brakes, a clutch and stick shift, a steering wheel, road conditions, traffic signs, pedestrians and speeding tickets may seem frightening and may even be strong deterrents. Most of us drive a car every day without considering these things to be overwhelming challenges, yet we are intimately aware of each and every one of them every time we get behind the wheel.

Clearly all the successful researchers who obtained results both experimentally and clinically with SCPs were well aware of these DC-EEG issues, and they managed, through this knowledge and with much creativity and determination, to achieve applicable results. As a clinician, thankfully you need not reinvent the wheel. That is the point of relying on research: you stand, so to speak, on the shoulders of giants. At the same time, clinical work is the loop that closes the circle, and research cannot truly progress without a venue for the applications it suggests. True progress is gained through collaboration, and only a consistent effort can continue to drive the field.

Thus far, the research and clinical work involving self-regulation of SCPs has been significant. Much published work exists showing strong results using essentially the same method in context of many different applications. Further validation work is currently in progress. More interestingly even, is that the techniques are in mainstream use in clinics in Germany and somewhat throughout Europe as well. It is exciting to wonder where this will lead, and if it may in fact help to further bridge the gap between neurofeedback and mainstream medical practice.

If you would like to know more about DC-EEG, SCP and assessment and training techniques using Thought Technology's new line of SCP equipment for the Infiniti platform (Figure 6.), please contact Marc Saab at marc@thoughttechnology.com.

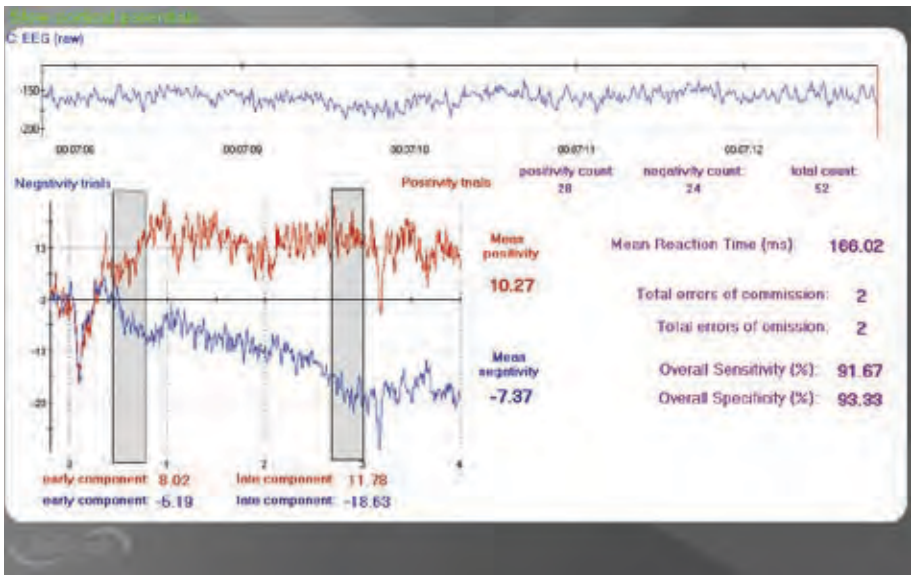

Figure 6. BioGraph Infiniti screen showing voluntary SCP production of positivity (red) and negativity (blue). Also displayed are mean values for early and late SCP components. Mean total SCP values are shown along the right. Reaction time statistics are also displayed here, and are optionally available in parallel with SCP measurements as they reflect attention and focus (low errors) and motor readiness (low mean reaction times). Note: scale is positive UP.

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Jonathan E. Walker, M.D.

- Board Certified Neurologist
- Board Certified Electroencephalographer
- President of the Neurofeedback Division of AAPB
- President of the American Board of QEEG Technology
- Pioneer in the field of neurotherapy research and treatment, he has used neurofeedback in his medical practice for over 20 years

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Dr. Walker stated that 12 weeks of NFT twice weekly at C3 often normalizes dyslexic children thus improving reading skills. However, it was noted that there is not enough evidence to show the best frequency, time and interval between sessions. It was noted that when training only once a week it appears the brain doesn't retain what it learned from the previous session. It may also be more efficacious to train under reading tasks, rather than without. This could include doing home work along with auditory feedback.

Rob Coben stated that when there are both coherence and amplitude abnormalities that training power (possibly in 21-30 Hz range) first may alleviate the coherence pathology.

Traumatic Brain Injury

Discussion Leader:
John Carmichael, PhD

So far there are four published studies that probably meet efficacy. Daniel Hoffman has two and Jonathan Walker has one.

Jonathan Walker used 32 subjects in a controlled study. No training for 10 weeks and used QEEG driven Neurofeedback. He looked at microcog, IVA, and behavioral check lists measures. Study was funded by ISNR. 10 weeks some received Neurofeedback and others did not. 20 sessions; reevaluation , then 20 more sessions.

Cases that were discussed were: Biker hit car and was in coma for 3 weeks. This is a clinician and he is working on regaining motor and language skills plus correcting sleep disorder. Using mainly SMR training. 2nd case was client was hit in head with a pipe. He was a former navy chief . Neurofeedback one year post injury . Training consists of inhibiting theta and using Alpha Stim at home. These cases caused participants to question whether training was to increase processing speed and or address theta and frontal and motor strip issues.

Suggestion was to set priorities with the patient and family for support will be needed.

Jonathan Walker noted that anger is usually associated with high amplitude beta and tends to correlate with QEEG data.

Some clinicians noted they use coherence training which seems to produce better results than just power training. Whereas power training may take 60 sessions, coherence can take ½ the number of sessions. Walker and Horvat noted in their work that first 5 sessions of coherence tends to normalize the issue. However, Jonathan noted that if coherence is done first patient developes more power abnormalities and vice versa so re-mappiing between training is essential.

Ryan Reitmeyer case was discussed. Case is on Youtube as Ryan Reitmeyer 2008. Also can obtain information at Reitmeyer.com; Doug@reitmeyer.com; Ryaninaustin.com. Case demonstrates need for strong advocation for patients with TBI.

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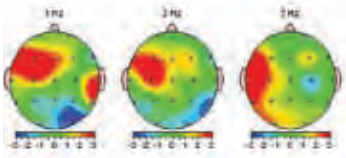

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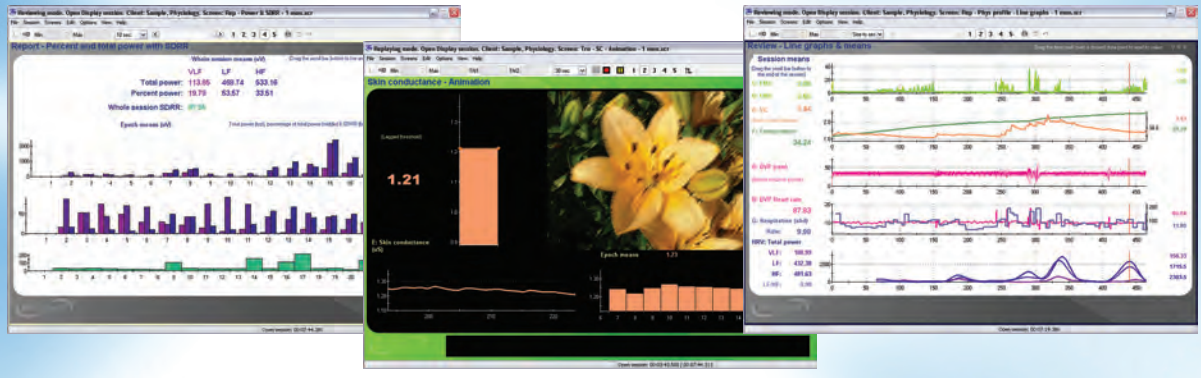

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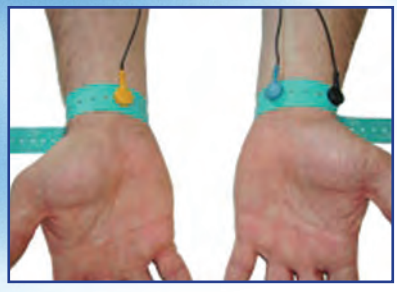

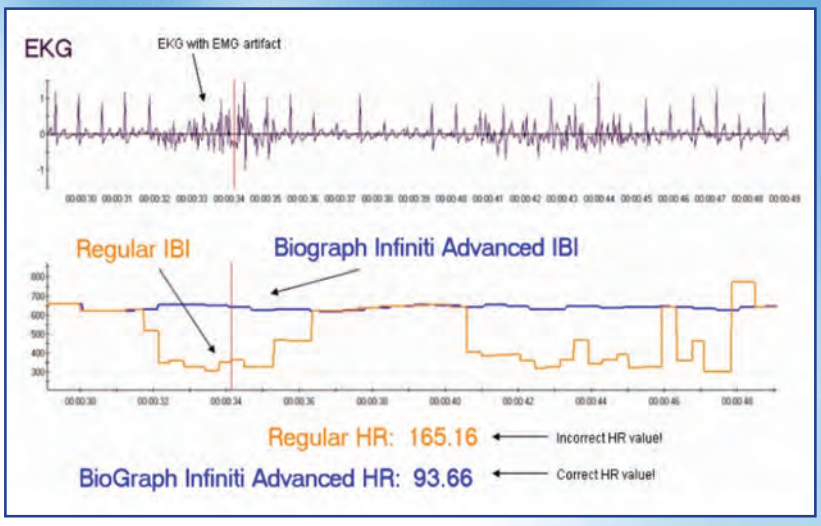

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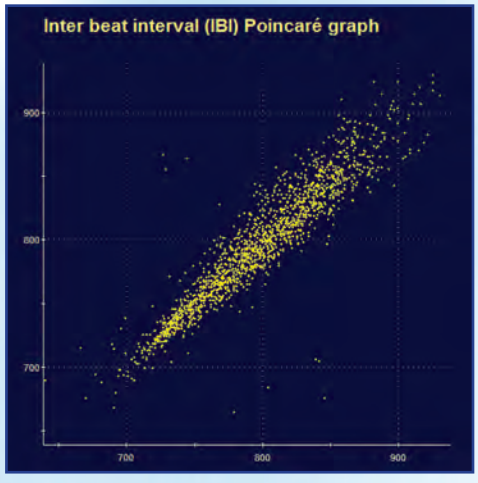

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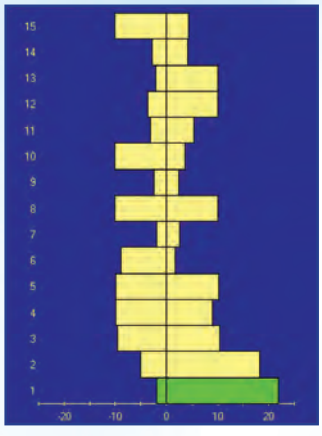

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Transcranial DC Stimulation

Dave Siever, CET

In 43 AD, Scribonius Largus, a physician of the Roman emperor Claudius, described a detailed account of the use of the (electric) torpedo fish to treat gout and headache. Since that time, a number of scientists experimented with electrical stimulation in hopes of treating various maladies as well as bringing people back from the dead. It was the invention of the battery that made DC stimulation or faradization, as it was termed at the time, possible. In 1755, French physician Charles Le Roy, wrapped wires around the head of a blind man in hopes of restoring his eyesight.

Duchenne de Bologne (Figure 1) became the first to systematically use electricity in the diagnosis and treatment of disease. He even brought a woman "back from the dead" after she was in a coma-state from carbonic oxide poisoning by using an early form of cardiac electro-shock.

In the USA in 1871, Beard and Rockwell published their book on the medical uses of electricity. They presented arguments for the use of galvanization (the term for DC stimulation at the time) for a variety of indications, as shown in Figure 2.

In the late 1700s to early 1800s, Giovanni Aldini (Galvani's nephew) reported experiments using galvanization to treat psychosis, depression and even revive the dead. He later went on a travelling road show demonstrating the use of electricity for bringing cadavers back to life. It is thought that this showmanship may have been the cause for damaging the reputation of electrical stimulation for the next 100 years. In the 1960s, animal experiments using weak DC stimulation on the exposed cortex showed that neuronal activity could be altered immediately, and that these changes would last for several hours. These studies marked the true beginnings of transcranial DC Stimulation (tDCS).

Most tDCS research has been done by Nitsche and his colleagues at the University of Gottingen in Germany. Other authors include: Fregni, Pascual-Leone and Boggio from Beth-Israel Deaconess Medical School (Harvard), plus Antal, Kincses, Hoffman, Kruse.

I have found roughly 75 studies and the list below shows the study focus and the number of studies done. To obtain .pdfs of 46 of these studies in a zip file, go to: www.mindalive.com/2_2.htm (products/CES-ta) and scroll down to "Research Articles on tDCS." To learn more about electrode placement locations, go to: www.skiltopo.com and select "Info about Brodmann Area Functions." The studies that I have found include the following categories:

Cognition (General)	2
Probabilistic Classification Learning	1
Treating Alcoholism	1
Working Memory (General)	2
With Parkinson's	2
Declarative Memory	2
Depression (F3 anode)	4
Motor Cortex	13
Stroke	4
Motor Imagery	1
Tactile Perception	1
Pain	1
Sensory	
Auditory (pitch-left temporal)	1
Somato-sensory	1
Visual Cortex	7
Tactile Perception	1
Physiology	4
NMDA Receptor	4
Pharmacology	2
Dopamine	1
Other	
Animal	2
Efficacy	2
Safety	3
NaCl concentration	1
Literature Reviews	3

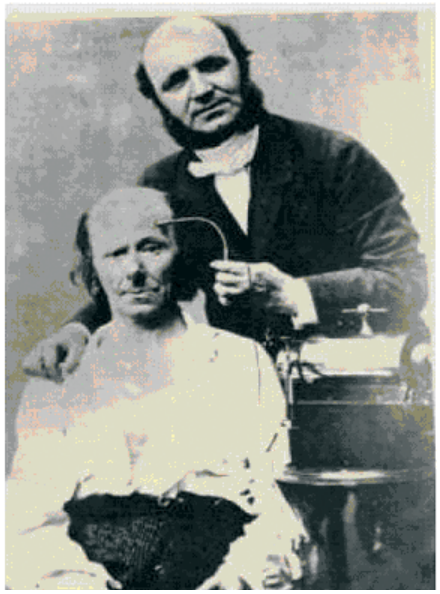

Figure 1.

Figure 12

Technical Aspects of tDCS:

The positive electrode is called the anode. Brain function under the electrode site is enhanced by roughly 20 to 40% when the current density (concentration of amperage under the electrode) exceeds 40 µa/cm2 (260 µa/inch2). The negative electrode is called the cathode and it reduces brain func-

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Transcranial DC Stimulation continued from page 21

tion under the electrode site by 10 to 30% at the fore-mentioned current density. Anodal stimulation is the most common form of tDCS as it enhances brain function.

The brain-stimulating electrode is called the active electrode, whereas the circuit-completing inactive electrode is called the reference electrode. In most of the studies, the reference has been placed over the contralateral orbit (above the left or right eye) to avoid negative effects from it. However, the studies never looked at the inhibiting effects that the reference electrode might have had on the prefrontal lobe. Some recent studies and in particular a study by Nitsche, et al., (2007) show that it is better to have a small stimulating electrode and large reference electrode. This way, the current density is high under the treatment electrode and weak under the reference electrode. This arrangement allows the reference electrode to be placed most anywhere over the scalp without it affecting brain function beneath it. Most studies have used stimulation at 1 ma of current through 7cm x 7cm (49 cm2) electrodes (There are 2.54 cm in one inch, therefore a 1" square electrode is 2.54 cm x 2.54 cm = 6.45 cm2). Fregni and his group at Harvard advocate using a shoulder for the reference placement. I also advocate using a shoulder placement except possibly for treating depression, where the active electrode (anode) is placed over the dorsolateral prefrontal cortex (F3 on the 10-20 electrode montage) and the cathode over F4.

Nitsche and Paulus found that a minimum current density of 17 µa/cm2 was needed to excite motor neurons. Studies involving other regions of the brain have suggested that 20 to 25 µa/cm2 are needed to excite neurons under the electrode. One depression study using anodal stimulation at F3 noted alleviated depression using 1 ma into a 35 cm2 electrode (28 µa/cm2). Iyer, et al., observed that when stimulating the left prefrontal cortex there was no effect on verbal fluency with a 1 ma current, but significant improvements at 2 ma (current density of 20 µa/cm2 vs 41 µa/cm2). Two depression studies by Boggio, et al., 2007; Boggio, et al., 2007) also used 2 ma.

It is important that the tDCS device is current controlled. What this means is that the device will adjust the voltage up and down as the resistance changes so that the current never changes. For instance, if the resistance of the skin is 10,000 ohms, then 10 volts will be needed to "push" 1 ma through. If for some reason, the connection becomes poor and jumps to 20,000 ohms, then the device should automatically increase the voltage to 20 volts in order to push the 1 ma current through the body.

We did some testing with a 9-volt battery supplying a 1 ¾" by 1 ¾" (4.5 x 4.5 cm) tap-water wet sponge anode at F3 and a 2"x 4" (5.1 x 5.1 cm) wet sponge cathode on the left arm and found that at the onset, the current flow was 0.3 ma (current density of 15 ua/cm2). By applying a mild pressure on the arm electrode, the current rose to 0.6 ma. When we increased the anode at F3 to 2"x 4", the current rose to 0.6 ma and 1.2 ma when pressure was applied to the shoulder electrode. The currents in

both situations are well below the necessary value of 40 ua / cm2, and therefore not effective. The variance was also 2 to 1. We then soaked the electrodes (1 ¾"x 1 ¾" and 2"x 4") in a 5% salt solution. The current was a whopping 3 ma, (current density of 150 ua/cm2) as confirmed by the ammeter and the stinging on my forehead. In this case, the current density was much too high. If the reference cathode was also used on the head instead of the shoulder, there would have been a significant inhibition effect around it.

tDCS Devices

There are presently only two stand-alone devices that produce tDCS. They are: the Eldith DC Stimulator by Neuro Conn, of Germany, which sells for €3000 (about $4,000US) and the CESta, by Mind Alive Inc., of Canada, which sells for $350US. Both units are current controlled and programmable. The CESta has the added benefits of providing cranio-electro stimulation and micro-electro therapy for muscle work. It also features randomization of the frequency stimulation and usage tracking for patient compliance. The CESta has been "tuned" with the electrodes provided so that at 1 ma stimulation, the active electrode delivers 50 µa/cm2, while the reference electrode produces 18 µa/cm2. This table shows the current density using various sizes at 1 and 2 ma currents.

25 cm2	5 x 5	@ 1 ma	=	40 µa/cm^2
25 cm2	5 x 5	@ 2 ma	=	80 µa/cm^2
36 cm2	6 x 6	@ 1 ma	=	27 µa/cm^2
49 cm2	10 x 10	@ 1 ma	=	20.4 µa/cm^2

Some Anecdotes

I have used tDCS with a middle-aged person who had developed some cognitive decline, lost confidence while driving and developed mild obsessive-compulsive disorder (OCD). He was ruminating a jingle over one hundred times an hour. Suspecting an over active cingulate, he was given cathodal stimulation between F3 and Fz (F1) with the reference on his right shoulder. His ruminations ended completely following the third treatment and he noted improvements in sharpness of mind despite the cathodal stimulation. He received 10 of the F1 (between F3 and FZ) cathodal/right shoulder anodal treatments, six anodal F3/cathodal left shoulder treatments and a few FP1 anodal/left shoulder cathodal treatments. At times, following F3 anodal/left shoulder cathodal stimulation, he experienced immense joy! One month following tDCS, he continued to feel sharp of mind. Although the occasional rumination occurs a few times per week, he easily stops it.

Depression, Brainwave Activity and Mood

It has been found that the left hemisphere activates (and therefore suppresses alpha electrical activity as seen on an EEG) with happy thoughts and the right hemisphere activates (suppresses alpha) with negative thoughts. Right brain strokes also spawn cheerful survivors while left brain strokes leave the survivor with depression (Rosenfeld, 1997). This supports the "happy-left" and "depressed-right" scenario. Other studies (Davidson, 1992; Coan & Allen, 2004) including my own observations have shown increased left frontal alpha concurrent with a negative outlook. As one could expect, people with unresolved trauma are plagued with negative thoughts, often waiting for something bad to happen to them. Therefore, what one thinks has a direct impact on the degree of depression. But this brings on the chicken and the egg –Does the alpha asymmetry bring on negative thoughts or do negative thoughts bring on alpha asymmetry?

Kang, et al 1991, ran a study where he monitored bilateral EEG at F3 and F4 (left and right dorsal-lateral prefrontal cortexes) in 20 female college students. The participants filled out a State-Trait Anxiety Index, a Derogatis Stress Profile and a Beck Depression Index. He then subtracted the left alpha EEG activity from the right alpha EEG activity. A positive result indicated that the participant had less alpha EEG (and more activation) in the left frontal lobe (a happy person). A negative result indicated that the participant had less alpha (and more activation) in the right frontal lobe (a pessimistic outlook). He also observed that the "happy" people had much improved natural killer-cell activity, associated with better immune function (as shown in Figure 3). This is, in my opinion, an unfortunate design flaw in the human nervous system. When a person has some stress or trauma to the point where the pessimistic right brain becomes dominant, then the person develops a negative physiological outlook, perceiving all of everything that is wrong/threatening within his/her environment, which in turn maintains right brain dominance. It is important therefore to boot-strap the left dorso-lateral prefrontal cortex simultaneously with talk-therapy in order to get the patient in a positive, receptive frame of mind that shows optimism and receptivity to the techniques employed by the therapist.

QEEG Assessed Case Study of Depression

Introduction

This is a case involving a 44-year-old woman of Chinese descent who had attempted suicide twice in the previous months and once back in 2006. She is diagnosed with bipolar disorder, and during her manic phase, she spends excessive amounts of money on herself and people she wants to impress. She is presently taking Epival (750 mg), Clonazepam (0.5 mg) and Seroquel (25 mg), although she randomly skips aspects of her medication in an attempt to try to prove to herself that she is better.

The client informed me that her father experienced a great deal of hardship as a youth in China. Upon moving to Canada as a young man, he experienced more hardship. He was robbed a few times as a small convenience store owner and mugged once

Continued on page 24

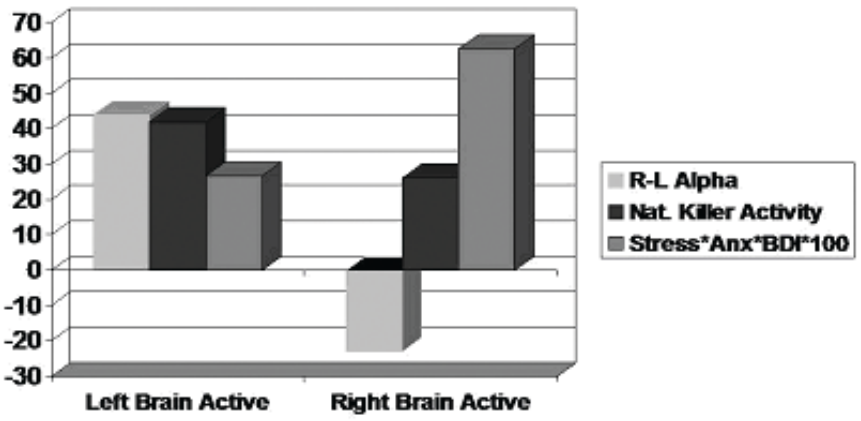

Figure 3

Transcranial DC Stimulation

continued from page 23

as a cab driver. According to my client, her father has never shown affection at all. Her mother, however, does show a moderate degree of affection. This lady is constantly in a victim/revenge cycle. She is "victimized" by "assbag" drivers who use their cell phones while driving, slow grocery clerks, bank tellers, her father, siblings, friends and so on. She is in a state of anger much of the time and exacts her revenge by saying aggressive and hurtful things to people or putting them down behind their backs, and intentionally cutting off drivers who have "pissed her off." She has no ownership of her feelings, which stems back to being an emotional "punching bag" for her father.

Procedure

We ran 10 tDCS sessions at 1 ma of current. The stimulus anode electrode (4.25 cm x 4.25 cm = 18 cm2) was placed over F3. During her first session, the reference cathode electrode (5.1 cm x 10.1 cm = 52 cm2) was placed over F4, but on her left shoulder for the remaining nine treatments. 19-channel QEEGs using the Mitsar EEG system (novatecheeg.com) were collected at pre-tDCS, 30 minutes following the first tDCS session and the day following her 10th treatment. QEEG data as shown on the SKIL database are shown below.

Results

Shown in Figure 4, her baseline brain activity was 3.4 SD high with a definite alpha asymmetry with increased alpha in left frontal regions at FP1, F3 and F7. The high beta activity throughout is a typical side effect of taking anti-depressant medications. Her frontal alpha is slowed, which is typical of childhood cortisol damage, inhibiting her ability to reason and extinguish fears. This disinhibition is typical of over-reacting, racy-headedness and aggressiveness toward perceived daily stressors and hassles.

Thirty minutes following F3 anodal/F4 cathodal tDCS, the 9 Hz component of her slowed brainwave activity normalized, as shown in Figure 5. Immediate and profound increases in sharpness of mind have been my personal experience when I have used frontal tDCS. Her alpha asymmetry was still present, however her alpha was now reduced to 2.7 SD. Beta activity appears higher due to the tighter scaling of the this image. However, there was no change in beta magnitude.

Following 10 tDCS sessions (Figure 6), there were significant reductions in al-

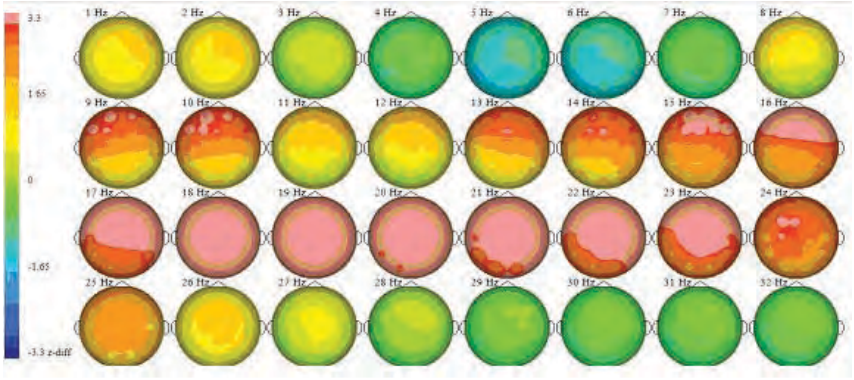

Figure 4. Baseline Brain Wave Activity.

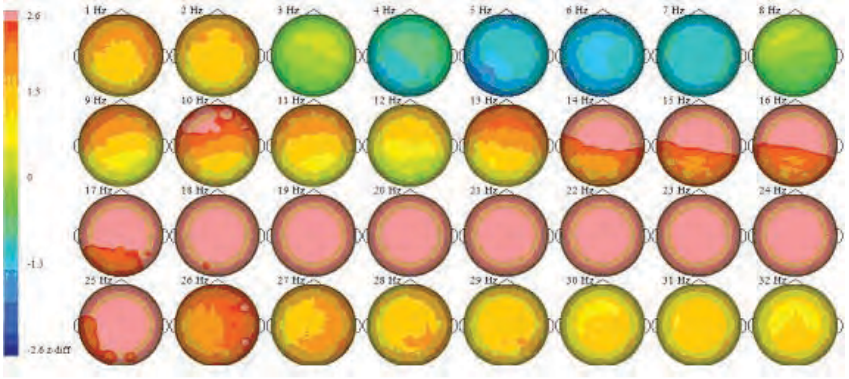

Figure 5. Brainwave Activity Post 1st tDCS Session

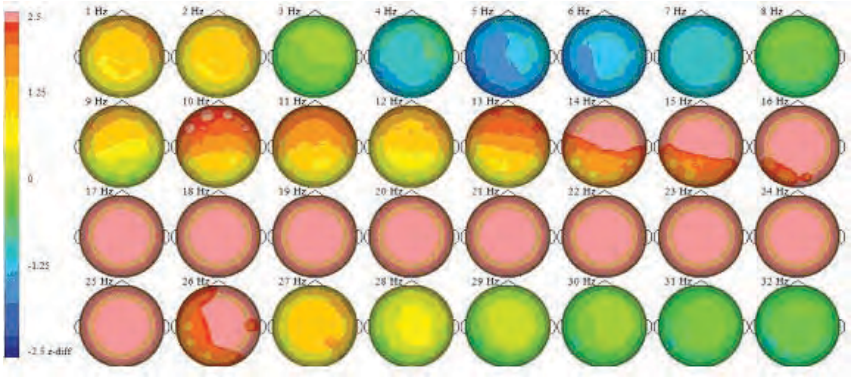

Figure 6. Brainwave Activity Post 10th tDCS Session

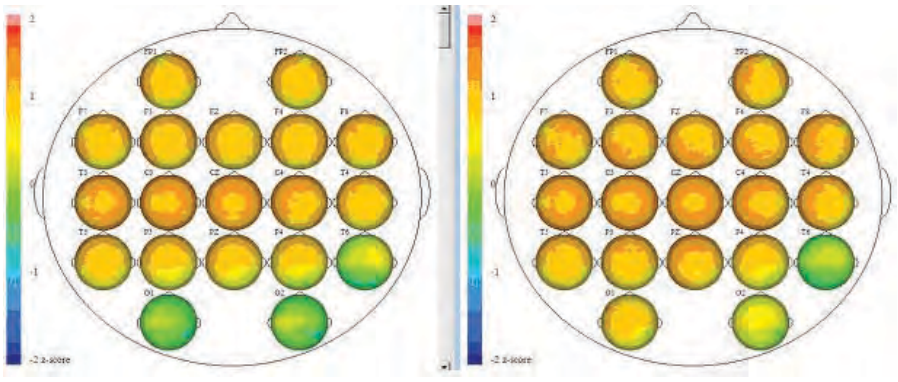

Figure 7. Pre-post Coherence Measures

pha asymmetry. Alpha activity continued to be 2.5 SD high. However this represents a significant improvement from the 3.3 SD high alpha activity at baseline.

Surprisingly, following 10 tDCS sessions, her comodulation measures were very close to normal as well as her phase measures, so they are not shown in this article. She showed some mild coherence abnormalities, but nothing clinical. However this could be the effects of the drugs she was taking. Her coherence, nonetheless improved, as shown in Figure 7 below.

Conclusion

Transcranial DC Stimulation is site specific and therefore can be used to up-modulate or down-modulate any region of the brain. Transcranial DC stimulation is also easy to use and doesn't require the constant attention of the therapist, thus allowing the therapist to engage in talk therapy and/or collect client information during the treatment. TDCS produces immediate and lasting sharpness and reasoning of mind. Unfortunately, very few tDCS studies consider the effects beyond a few hours. However, one depression study supports that there is a holding effect 30 days later, which personal experience confirms. Between the existing research and my personal experiences, I suspect that with appropriate training, tDCS will become a common clinical approach to neurotherapy.

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Listings of tDCS research and references to tDCS studies may be found at:

Full pdf files of 46 studies may be found at: www.mindalive.com/2_2.htm

Abstracts of 63 studies may be found at: www.eldith.de/support/studies/tdcs

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Transcranial Direct Current Stimulation

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Transcranial Direct Current Stimulation (tDCS) is already known for a long time as a non-invasive stimulation method that has again found increase attention during the last years on the base of more neurophysiological investigations. As the only stimulation procedure so far tDCS works on direct current applied on the head for 5 to 20 minutes and not as other stimulation methods with single stimuli (e.g. transcranial magnet stimulation - TMS). In animal-experimental investigations and neurophysiological experiments with people it could be shown that tDCS influences the spontaneous electric activity of neuron groups as well as the cortical excitability of neuron groups. Post-stimulation effects are longer lasting than for TMS. Clinical pilot studies up to now show promising findings in the treatment of neurological and psychiatric diseases. In the first pilot studies antidepressant effects of the method were also described.

Already 40 years ago it was described that the application of a weak direct current can leads to neuro-plastic changes in rats (Bindman et al., 1964). On anaesthetized rats it was possible to apply a weak direct current with intracerebral or epidural electrodes, leading to changes of the spontaneous activity and excitability in the cortex that continued about hours after the end of the stimulation (Bindman et al., 1964). Further studies showed that these effects depend on the local protein synthesis and were accompanied by intracellular changes of the cAMP-and calcium concentrations (Islam et al., 1995). The observed changes show resemblances in the scope of the so-called Long-Term Potentiation (LTP) and long-term depression from the neurophysiological basic research. With primates it could be shown, that approx. 50% of the applied current enters the cortex through the skull (Rush & Driscoll 1968) and these findings coud be replicated with humans (Dymond et al., 1975).

During the last 10 years tDCS has been intensely investigated in the area of clinical neurophysiology. In sequential studies it could be shown that tDCS causes polarity changes of the cortical excitability which can be observed during the stimulation and that continue after stimulation (Nitsche & Paulus 2000; Nitsche et al., 2003; Nitsche et al., 2007). Basically anodal tDCS increases cortical excitability, whereas cathodal stimulation decreases it (see Dave Siever's preceding article for more clarification on this concept - Ed). The strength of the effects depends on the duration of the stimulation and the applied current. With a current of 1 mA (electrode surface 35 cm2) at least 3 minutes of tDCS must be applied to cause persistent effects in the motor cortex. The lengthening of the stimulation duration or an increase of the stimulation strength leads to a lengthening of these post-stimulation effects in the motor cortex. Post-stimulation effects are maintained up to one hour after the end of the stimulation (Nitsche & Paulus, 2000; 2002; Nitsche et al. In 2003). We replicated these results recently (see Fig. 1).

In humans anodal stimulation of the primary motor cortex led to an improved performance in implicit learning of motor movement during the learning phase, while a stimulation of other areas (premotor and prefrontal cortex) remained without an effect (Nitsche et al in 2003).

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Transcranial Direct Current Stimulation

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In the area of implied semantic memory it was shown that frontal anodal tDCS improved performance while cathodal stimulation led to a deterioration in the learning achievement (Kincses et al., 2004). Repetitive bilateral anodal tDCS of the dorsolateral prefrontal cortex for more than 30 minutes led to an improvement of verbal memory achievements by application in certain sleeping phases (Marshall et al., 2004). Also a significant increase of the word fluency appeared after 20-minutes of anodal tDCS of the left dorsolateral prefrontal cortex (DLPFC), while with cathodal stimulation a light deterioration was found (Iyer et al., 2005). Fregni et al. found an improved performance in a task of the working memory (n-back paradigm) after anodal stimulation of the left dorsolateral prefrontal cortex (DLPFC) (Fregni et al., 2005).

Anodal transcranial direct current stimulation (tDCS) of the left DLPFC has been associated with working memory enhancement (Kincses et al., 2004; Marshall et al., 2004; Fregni et al., 2005; Marshall et al., 2005; Boggio et al., 2006; Ferrucci et al., 2008; Ohn et al., 2008) and improvement of mood. In depressed subjects promising pilot data was reported suggesting even a therapeutic action of prefrontal anodal tDCS (Fregni et al., 2006; Boggio et al., 2007; Boggio et al., 2008; Rigonatti et al., 2008).

However, all studies at the present level are pilot studies and the therapeutic effects remain unclear. Recently it was reported that repeated daily tDCS with 2mA for 20 minutes of the DLPFC caused clinically significant skin irritations under the electrodes in some patients (Palm et al. 2008, in press). Given these limitations, the clinical use of tDCS is not warranted at this stage and remains experimental.

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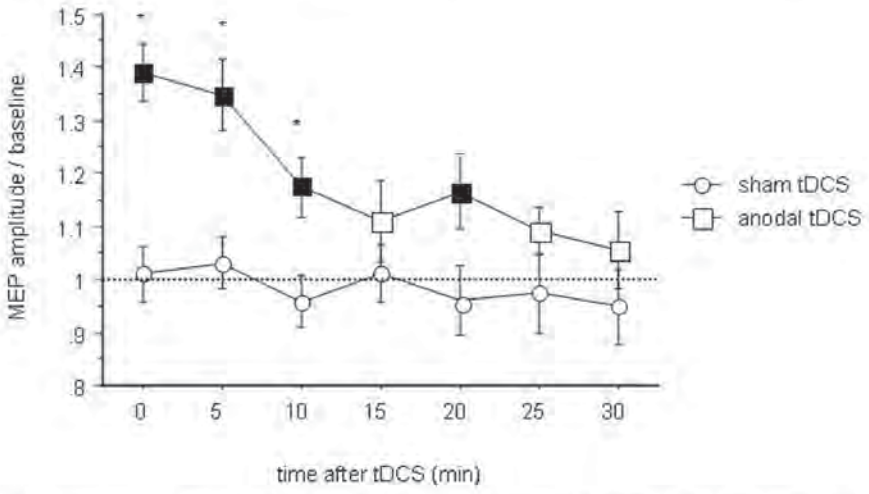
Fig. 1: In the anodal tDCS condition, the tDCS-induced excitability increase stayed significant until 10 min after DC stimulation, although borderline significance ($P = 0.049$) was also observed at 20min after DC stimulaiton. Sham tDCS didn't elicit any significant change of MEP amplitude as time evolved. The difference of excitability changes between anodal and sham tDCS is significant at the time bins of 0, 5, and 10 minutes after intervention ($p<0.05$).

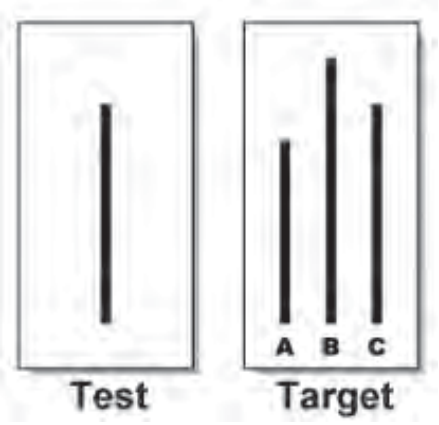


The stimulation was applied with the output of 1 mA over a period of 7 minutes at the motor cortex (M1). Transcranial magnetic stimulation (TMS)-elicited muscle-evoked potentials (MEPs) were recorded to measure excitability changes of the representational motor cortical area of the right abductor digiti minimi muscle (ADM).

MindFull

We Do What We're Told

David Kaiser, PhD



Imagine yourself sitting around a table with a bunch of fellow college students, participating in an experiment on visual perception. The experimenter, a man in a white lab coat, stands in front and asks everyone to judge which of the targets on a large cue card is of the same height as the test line.

Simple.

And it is simple, for a while. Each person speaks up and says aloud which line – A, B, or C -- is the same size as the test item. You are seated 7th or 8th from the start of the table so it's not unusual for a quick round of letters being called out, all the same, one after another, as your turn approaches. C, C, C, C, C, C, C… and you chime in with your answer, C! and a fellow or two after you complete the chorus, C, C, end of table. Not much difficulty here. Not anything that is perceptually perplexing.

The experimenter changes cards for each trial, but the task is always the same and the answer is quite obvious with each card change so you begin to wonder whether this is a big waste of time and how the man in the lab coat ever got tenure at this college. Trial after trial pass without incident, all of the group agreeing on which of the targets matches the test, and you begin to check your watch, hoping this will end soon. And that is when the true experiment begins.

On the 8th or 9th trial, the group now provides the wrong answer. The clear answer is C but now you hear B...B...B....B... B...B...B... one after another and suddenly it is your turn to speak. It is clear that B is so much taller than the test item and the answer ought to be C, but what should you say? Did the instructions change? Are you sitting at a weird angle to the card? What is going on?

What is going on is a classic psychology experiment from the 1950s, Solomon Asch's research on social conformity. In a series of studies his graduate students pretended to be subjects (as they were called back then instead of today's term of participants), and there was only one true subject. The confederates of the experiment, as they are called, answered correctly for the first few trials, then all together they switched to a wrong answer and the scientific question was, would the true subject – you, the unwitting soul -- conform to the group and answer incorrectly, or stay the course within yourself and answer what you knew was right. … B...B...B....B...B...B...B... now it's your turn to speak. Do you squirm in your seat? Peer closer at the card? Look to the man in the lab coat for quiet assistance? What is going on? Did you space out and miss something? Why is everyone giving the wrong answer, and what should you do?

With this simple setup Asch was able to study group dynamics and the process of conformity in a way no one had yet done. As it turned out, only 1 in 4 subjects held their ground throughout the entire rounds of cards. Most people caved -- and often, conforming to the group on nearly 40% of all trials. It was the 1950s and Rebel Without a Cause was still a year or two away from movie houses and conformity was an unquestioned aspect of our social fabric, so the results might be different if the experiment was repeated nowadays, but then again, maybe not. Asch studied how group behavior influenced individual behavior. This normative influence, as he called it, fear of appearing deviant, led to public conformity (behavior change) without private conformity (mental change). Debriefed subjects admitted that they went along with the group, even knowing the group had it wrong, because it was the easiest thing to do.

When a behavioral scientist is lucky enough to frame reality in such a way that everyone understands what he or she is studying and some see actual value in the pursuit, good scientists know to run the gamut, play all hands, permute all possible parts of the process. Good scientists do not stop at the first experiment but only after the 101st version. Asch ran dozens of variants of his Conformity experiment, everything available to him at the time.

He tested the effect of having an ally. A round begins and the group starts its familiar chorus of myopic responses… B...B... B...B…wrong answer… wrong answer… wrong answer…. but then something remarkable happens. The next student calls out C -- a miracle, the correct answer! But it is a fluke and group conformity is restored … B...B...B... and now it is your turn.

In this case, 9 out of 10 subjects broke from the group and gave the correct answer, freed of normative influence by a single voice of dissent. The ally effect is interesting but it conflates conformity-breaking with support (providing the answer you may later select). Asch recognized this so he ran a variant where a break in conformity was even more wrong-headed than the group's response. The group answers B….B…..B….B... until one lunatic chimes in A, the shortest line on the card, inches shorter than the test line, unbelievably myopic, and now it's your turn to speak.

Asch discovered that few needed support once conformity was broken. We don't need an ally as much as an example of dissent, even if we disagree with this dissent. People acted freely and answered correctly, against the group's response, 86% of the time in such cases.

Asch also studied the emotional toll of conformity. People were emotionally distressed when they conformed to easier decisions (agreeing that a 4" line was equal to a 6" line) and less distressed by harder ones (6.25" line said to equal to a 6" test item). But what I consider the most significant and largely unrecognized finding of his research was quantifying group size. How many people are a group? How many people must mill around together to constitute groupness? When do we put on our

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We Do What We're Told
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public face and take off our private face? When does a tete-a-tete become a crowd?

When a group consists of you and one other, and that person answers first and gives the wrong answer, only 1 in 25 of us cave, a 4 % conformity rate. Add another person to the mix and conformity rates more than triple to 14%. Then add a 3rd person and voila, you are now a group. The rate of conformity peaks and remains constant for groups ranging from 4 people to 14 people, the largest Asch studied. An amazing result, never discussed by any of the Psychology professors I had. A human group consists of 4.

Asch ignored one tricky variable which controls conformity more than group size or presence of allies. He did not manipulate the strength of relationships but kept it constant and at zero, examining how the behavior of strangers affect us. Had he used a group of three associates, three friends, or three lovers, or three children, three officers of the law, or three sisters, he'd have stumbled upon a more complicated calculus of interpersonal reality.

Other factors that he did study were awareness of group norms ("if you are not with us, you're against us," "we act as one"), and the effect of age and experience on conformity. Peer pressure in this experiment peaked in teenagers, was less in young children, and least of all in older adults. Women tended to conform more and men conformed less, but only when they thought they were being observed. Any gender difference evened out when perceived as unobserved.

Social conformity is most tested in the context of authority and it was a grad student of Asch, Stanley Milgram, who would go on to investigate obedience to authority in a series of classic experiments taught to every psychology undergrad. Sometimes these experiments are taught in ethics classes as examples of unethical research -- what we can no longer subject humans to on our university campuses. In Milgram's Experiment on Obedience, people off the street were asked to kill another human being. It was done elegantly and incrementally and as he discovered, it wasn't hard to convince strangers to kill, as long as you wore a lab coat during the request.

He gave his study of obedience a cover name—"The Effect of Punishment on Memory"—and subjects were asked to help him study the effect of punishment in learning. Individuals were assigned the role of "teacher" and it was their duty to apply an electrical shock to a "learner" whenever he gave the wrong answer to a simple memory test. Unbeknownst to the "teacher," the "learner" was a confederate.

So you walk into a room, followed by an overweight bespectacled middle-aged man, and you are greeted by an imposing man in a lab coat. He assigns you the role of teacher and to the other man "learner" and shows you an impressive device against the wall. This is the shocking box, which will be instrumental in studying the effect of punishment on memory. He explains the experiment: in the next room the learner is strapped to wires coming off this box and whenever he gives a wrong answer, you, the teacher, must press the button to deliver a brief but powerful shock. The hope is, with increased punishment there will be increased learning.

It is all a ruse, but you do not know this. They plan to study you, not the "learner." There is no punishment, only obedience being studied.

The shock box is an elaborate theatrical prop, with 30 lights and 30 switches labeled from "15 volts (mild)," to moderate shock, to severe shock, all the way out to "450 volts (XXX)." With each wrong answer, you flip the next switch, increasing the voltage. The middle aged man – the "learner"—is strapped to wires in an adjoining room, you are seated in front of the box and asked to read off a series of words; here is an example: "Remember the word: bird. Now of the following list, house, toy, bird, fly—what word did I ask you to remember?" The learner in the next room provides the correct answer through a loud speaker and you continue on without incident, paralleling Asch's initial trials. Nothing sinister or out of sorts yet. But the tension in the room grows steadily as here and there the middle-aged man misspeaks and calls out the wrong response and you are reminded by the lab coat to click the toggle to shock the man. It is all very impressive —you click a switch, a buzzer sounds, and a jolt is delivered to the man in the next room.

What you do not know is that everything, except your behavior, has been scripted. The actor in the next room is playing a part. He's no longer even strapped to any wires, but you do not see this. Instead you hear him stoically accept jolt after jolt with each wrong answer, until finally he hits some point in the script where cries out, "Ow! The pain." That is the first indication that you are causing him harm. You had just flipped the switch for 120 volts. At 150 volts he demands for the experiment to end. It doesn't, unless you have the courage to stand up and end it. It's all up to you. At 180 volts the actor/learner screams "no more pain! no more pain!" and this continues for each jolt until 300 volts are reached. Now you can stand up at any point during this process and tell the lab coat to shove it all and storm out of the room. Milgram is hoping you do this. In fact he is expecting you to quit at any moment and that moment when you quit is the only measurement taken from this entire arrangement. But in case you do not leave the room at 120 volts, or 210 volts, or 280 volts, he has more plot points in this story. At 300 volts the learner pounds the wall. At 330 volts he lets out a final cry and collapses, giving an appearance for all the world that he has been shocked unconscious. He is mum from this time forward and when you hear no response from the next room, you are reminded by the lab coat that no response counts as a wrong answer and to continue to increase the voltages until 450 volts are reached.

Prior to running the experiment, Milgram asked psychiatrists and students to predict the most voltage anyone would give the learner in this situation. Starting from the beginning, when would you as a teacher balk and ignore the authority of the experimenter. The general consensus was that nearly everyone would stop around 150 volts and only perhaps 1 in a 1000 might enjoy torturing another human being and go all the way to the maximum (450 volts).

Milgram ran his obedience experiment at Yale University with mostly unemployed men, and instead of most men quitting at 150 volts as predicted, he discovered that 2 out of 3 went to the max. Everyone, including Milgram, failed to judge the power of the situation, the power of authority to make us act in ways we might not imagine.

When the results were published, people couldn't believe that 2 in 3 people were so gullible, so controllable, as to possibly kill a stranger at the bequest of another stranger (at least outside of warfare). Critics argued that this finding was absurd and tainted by a number of coercive elements in its design including setting (Yale University) and awareness of a worthy goal (pursuit of science). Others mentioned how volunteering self-coerced subjects or how money ($4) drove the outcome. Women, some offered, would not act so incautiously.

So Milgram repeated the experiment in a crummy office building in downtown New Haven, tested women instead of men,

wore jeans instead of lab coats, and even had the experimenter slip out of the room for coffee. In each variant of the study he ran a new set of 40 subjects and here is the percent of how many went to the maximum and shocked the learner all the way up to 450 volts.

Experimenter absent = 23%

Teacher must hold shock paddles against learner's arm = 30%

Downtown office building = 48%

Women subjects = 65%

Subject reads test items only; a confederate controls shock box = 93%

The last version of the experiment had the highest compliance, the most obedience. Thirty-seven out of 40 (93%) can conscience being a cog for the powers of darkness as long as the devil doesn't make us pull the actual trigger.

He ran about 20 versions and the lowest compliance occurred when authority broke down from within. Two experimenters were used in this version and after so many volts, they begin to bicker about going forward. This killed compliance to nearly nil. (The 2nd lowest compliance rate after the divided-authority variant was for when the learner in the next room demanded to be shocked! Shock me! Shock me! One in 20 subjects still complied.)

Milgram determined that obedience varied as a function of an authority's legitimacy but a subject's personality, gender, age, or education had little effect. Clothes made a difference (lab coats trumped blue jeans in terms of compliance), as did distance from the victim (touching compared to same room or a different room), degree of supervision (absent, present, remindful authority figure), presence of others who modeled obedience, and lack of dissent in group tasks.

Here is transcript from Milgram of a 50 year old unemployed male subject. After delivering 180-volts, he pivots around in chair and addresses experimenter:

Subject (agitated): I can't stand it I'm not going to kill that man in there. You hear him hollering?

Experimenter: As I told you before, the shocks may be painful, but . . .

S: But he's hollering. He can't stand it. What's going to happen to him?

E: The experiment requires that you continue…

S: I refuse to take the responsibility. He's in there hollering

E: It's absolutely essential that you continue….

S: All right. (He continues experiment. Learner is "shocked.")

Learner (screaming): Let me out of here! You have no right to keep me here! Let me out of here, my hearts bothering me, let me out!

S: You see he's hollering. Hear that?

E: The experiment requires . . .

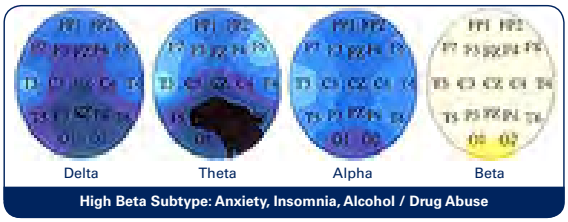
S: I know it does sir, but I mean—he doesn't

Continued on page 31

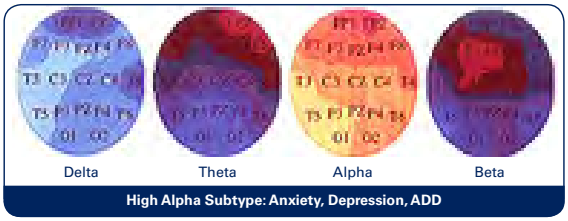
SCOTTSDALE NEUROFEEDBACK INSTITUTE

QEEG mapping service

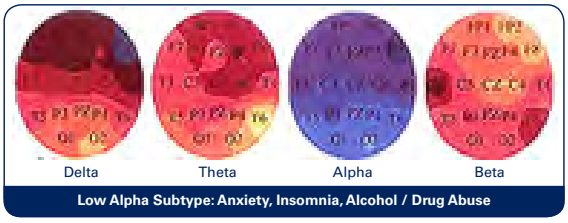
QEEG / TOPOGRAPHIC BRAIN MAPS:
Generalized Anxiety Disorder Subtypes



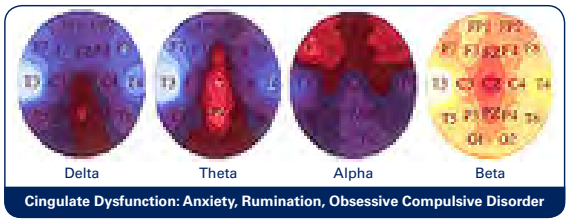
High Beta Subtype: Anxiety, Insomnia, Alcohol / Drug Abuse



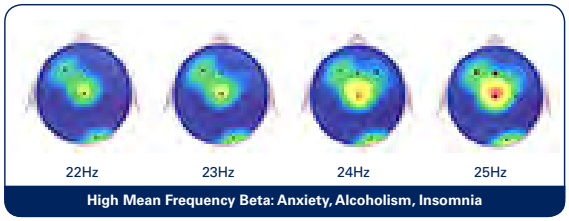
High Alpha Subtype: Anxiety, Depression, ADD



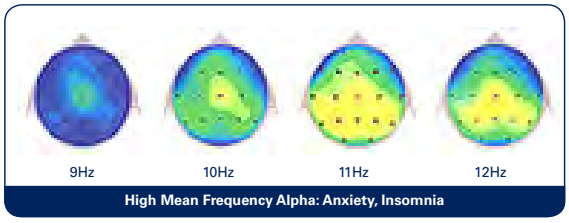
Low Alpha Subtype: Anxiety, Insomnia, Alcohol / Drug Abuse



Cingulate Dysfunction: Anxiety, Rumination, Obsessive Compulsive Disorder



High Mean Frequency Beta: Anxiety, Alcoholism, Insomnia



High Mean Frequency Alpha: Anxiety, Insomnia

AVAILABLE SERVICES

Full Package: #'s 1-7: minimum recommended for Neurotherapy *Includes electronic copy. Priority mail is $20 extra.*	**$225.00**
Full Package: #'s 1-6: Without report (1-5 only) *Includes electronic copy. Priority mail is $20 extra. If one database used the minimum is $75.00*	**$195.00**
01) NX Link - NYU/E. Roy John Normative Database (Eyes Closed) *A) NX Link Discriminant Analyses: ADD, LD, Depression, Memory/Dementia, Substance Abuse, Head Injury, Schizophrenia/Thought Disorders*	$70.00
02) EureKa3! - Nova Tech EEG LORETA Analysis System and Adult Normative *Database - Eyes Closed*	$70.00
03) Neuroguide - R. Thatcher Normative Database *A) Eyes Closed Linked Ears Z-scores // Eyes Closed LaPlacian Z-Scores* *B) Eyes Open Linked Ears Z-Scores // Eyes Open LaPlacian Z-Scores*	$70.00/each
04) Neurorep - W. Hudspeth QEEG Analysis System *A) Eyes Closed - Weighted Average, Z-scores, Magnitude, % Power, LaPlacian, Average Spectrum, coherence, connectivity* *B) Eyes Open - Weighted Average, Z-scores, Magnitude, % Power, LaPlacian, Average Spectrum, coherence, connectivity*	$70.00/each
05) Thatcher TBI Discriminant Analysis and Severity Index	$70.00
06) Thatcher Learning Disabilities Discriminant Analysis and Severity Index	$70.00
07) Clinical Correlations and Neurotherapy Recommendations by Bob Gurnee	$70.00

total value: $630

08) Conventional Medical EEG - Read by Neurologist	**$125.00**
09) EureKa3! – Nova Tech EEG LORETA Analysis - Eyes Open-Non Database	**$70.00**
10) Neurorep - W. Hudspeth QEEG Analysis System: Task *Weighted Average, Z-scores, Magnitude, % Power, LaPlacian, Average Spectrum*	**$70.00**
11) Supervision and Training Hourly Rate	**$100.00**
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14) Overnight Shipping & Handling (Price varies with carrier, destination, & package weight)	**$Varies**

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MSW, BCIA:EEG, QEEG Diplomate, Director

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Established 1982

We Do What We're Told
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know what he's getting in for. He's up to 195 volts!

(Experiment continues, 210 volts, 225 volts, 240 volts, 255 volts, 270 volts, all the way to 360 volts. There are no more responses by learner in the next room. The room has gone quiet. At 375 volts the subject stands up.)

S: I think something's happened to that fellow in there. I don't get no answer. He was hollering at less voltage. Can't you check in and see if he's all right, please?

E: Not once we've started. Please continue, Teacher.

S (sits down, sighs deeply): "Cool day, shade, water, paint." Answer please. Are you all right in there? Are you all right,

E: Please continue, Teacher. Continue, please.

S: You accept all responsibility?

E: The responsibility is mine. Please go on.

Subject obeys and reads each test item rapidly, quickly getting to the end, 450 volts.

S: That's that.

E: Continue using the 450 switch for each wrong answer.

S: But I don't get anything!

E: Please continue....

We are taught to obey authority from an early age. We are social creatures and conformity and obedience are required for our survival. Neurons are also taught to obey. They are social creatures like us, the most social of cells, but when neural authority breaks down, we have disease, forgetfulness, and disorder. In EEG rhythm training we often train towards normalcy in terms of rhythm incidence, partly because we know so little about brain function and assume group norms are reasonably good for any individual. Normalcy is a start, and as we advance in our understanding of brain synchrony, we'll know better when to seek rhythmic conformity, or when rhythmic conformity is the primary complaint.

ISNR Foundation

Research Foundation Brochure

We are in process of putting together a brochure for the Research Foundation. This is a work in process. The text that follows is what we have to date and any ideas you have would be most appreciated. Please e-mail them to trude003@tc.umn.edu

Feel free to share this with your friends and patients/clients and especially anyone you think would be interested in helping us achieve our goals. This brochure is intended for the general public.

Foundation Donor Packet:

What is ISNR?

The International Society for Neurofeedback and Research was founded in 1992 "to promote excellence in clinical practice, educational applications, and research in applied neuroscience in order to better understand and enhance brain function." The Society is composed of nearly a thousand practitioners and academicians who are interested in affecting human behavior in health and disease by influencing brain physiology, principally by brain wave biofeedback. The society has fostered research directly through its own funding (the ISNR Research Committee), has published a peer reviewed scientific journal (the Journal of Neurotherapy) and has held annual scientific meetings. Details about the Society, its meetings, its directly sponsored research, and its journal can be found at the Society's web site http://www.isnr.org.

What is the ISNR Research Foundation?

With the emphasis on research and development of neurotherapy - through four years of direct sponsorship of research projects and through twelve volumes of the Journal of Neurotherapy and through seventeen annual scientific meetings, the Society is embarking on a new phase of research emphasis. Through the Research Foundation – a separately established and governed 501 3(c) corporation, ISNR seeks to channel funding from individuals and foundations to qualified academic researchers to conduct well designed large-scale studies that will determine efficacy of neurofeedback. To this end the research foundation will engage in a number of strategies. One will be to dialog with academics and departments interested in neurofeedback to foster research capabilities and interest and graduate studies. A key part of this process is to identify researchers and institutions capable of performing large-scale studies. Another will be to collaborate with researchers and research supporting institutions to establish criteria for definitive studies, and determine – for instance – what conditions are suitable for sham controls, and which study designs are optimal for conditions studied. A third will be ongoing support and monitoring of research funded through the Foundation, with strict performance, ethical and accountability standards. Finally, the Foundation will inform the general public and health care providers about advances in knowledge, quality, credibility and availability of neurofeedback services.

To finance these strategies the Foundation will pursue funding from interests that share the objective of improved and accessible patient care for the disorders that appear to benefit the most from neurofeedback and other neurotherapy interventions. Identifying and contacting and dialoging with these interests will be ongoing.

What is Neurofeedback?

Neurofeedback is a type of biofeedback in which the trainee receives information about specific kinds of brain electrical activity from specific sites in the brain and learns to change that activity. The interface of sensors, processors and computer algorithms makes possible the display of brain electrical activity in such a way as the trainee sees displays that represent the EEG events of interest, and the trainee can then learn to increase or decrease parameters that are being measured and displayed. Neurofeedback is one therapeutic tool that may be useful in treating brain disorders that are associated with changes in brain electrical patterns (EEG) that deviate from normal. Such changes have been observed, for instance, in ADHD and generally consist of frontal brain EEG changes of excess slower frequency

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ISNR Foundation
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and decreased faster frequencies. A commonly employed protocol in this case is to train the excess slow frequencies down and the deficient fast frequencies up. However there are many other ways in which EEG can be trained for many other conditions. It is possible to train connectivity between brain sites by increasing EEG coherence. It is also possible to train electrical activity in deeper structures in the brain. There is a substantial literature on the use of neurotherapy in attention disorders, addictive disorders, anxiety disorders, brain trauma, posttraumatic stress, autism, epilepsy, affective disorders and as an adjunct to psychotherapies. The web site http:/isnr.org contains an extensive bibliography for this literature.

While Neurofeedback can be used as a stand-alone method, it is commonly used in conjunction with psychological treatment modalities including cognitive behavioral therapy, motivational interviewing, twelve step programs, and family therapy. Neurofeedback has also been used in combination with pharmacotherapy, with decreased or discontinued medication use a possible outcome. EEG Neurofeedback also has been investigated as an adjunct to other types of biofeedback for brain function such as fMRI feedback and infra red (temperature/blood flow) feedback. The use of neurofeedback in combination with transcranial magnetic and electrical stimulation has also been studied.

Neurofeedback can be used to enhance normal performance and has been used for athletic performance enhancement, and cognition enhancement. An interesting application of the auto regulation of brain electrical activity has been in the area of brain computer interface. These applications have been used for communication and mobility assistance in disabilities and the development of prosthetics.

Why More Research is Vital

Practitioners of neurofeedback know how potent this therapy can be in a wide variety of disorders. Many times our patients/clients have been inadequately treated with other therapies and adding neurotherapy to their treatment regimes makes a huge clinical difference. Yet neurofeedback remains a therapeutic option available to the few – most often those who have become convinced of neurofeedback's effectiveness through word of mouth and who have the ability and motivation to self-pay. Because neurofeedback lacks large randomized and controlled studies that can demonstrate its efficacy and specificity, it is not widely accepted as a mainstream therapy and is not recognized by third party payers. As a result hundreds of thousands of people with afflictions including autism related disorders, post concussive disorders, attention deficits disorders, substance use disorders and other disorders known to respond to neurofeedback can not avail themselves of this therapy. These include children with ADHD and Asperger's syndrome, returning veterans with brain injuries and PTSD, and a growing incarcerated population of persons with substance abuse. The societal impact of more treatment options for these and other conditions is obvious. The objective of the Foundation is improved quality of and accessibility to neurofeedback through sound science. The Foundation believes that it is possible scientifically to further assess the efficacy of non-medication, brain physiology based treatments. To do this requires substantial funding. While some public funding is available through governmental agencies such as the National Institutes of Health, competition for these funds requires substantial data and experience from other studies. The Foundation intends to facilitate these other studies, enlisting the best of academia in this pursuit.

Why We Need Help Now

The Foundation is just starting – beginning its first year and has a vision (above) that will refine through dialog and collaboration and insight as it evolves. The focus of this first year is to initiate and guide a long-term process that will yield advances in quality and accessibility of care for those who suffer from brain dysfunctions such as autism, attention deficits, brain injuries, addictive disorders, affective disorders and others amenable to neurofeedback. The economy is stressed at many levels, and foundations and academic institutions and other endowment holding organizations are forced to reorganize and reallocate increasingly scarce resources. Nevertheless, the Foundation believes that now is the time to begin its quest of long-term development in support of improved care.

Appendix

ISNR-Sponsored Research

In 2004 ISNR established a research committee to raise funding and invite proposals from researchers in clinical and academic practice for research projects that would advance knowledge in the field of neurotherapy. Because of the limited resources, projects considered were necessarily limited in scope and likely to demonstrate the feasibility of new technology and/or gather pilot data. In every case of award the contributions of equipment, salaries, clinical services and other in kind contributions exceeded the amount of the award by a factor of at least twice the award. A number of proposals were submitted and evaluated during the life of the committee from 2004 to 2007 and the following awards were made.

2004

1. $20,000 awarded to Mario Beauregard, PhD (Principal Investigator) and Johanne Levesque, PhD (Co-Investigator) of the Department of Psychology at the University of Montreal for their project "Effect of Neurofeedback Training on the Neural Substrate of Executive Deficits in ADHD Children." In this study standard instruments assess the effectiveness of neurofeedback therapy (NFT) on attentional performance and fMRI assesses the effect of NFT on activation of the anterior cingulate cortex and other areas of interest while the participants perform attentional tasks. This study is the first attempt at delineating functional neuroplasticity associated with NFT and increases our knowledge and understanding of the neurobiological effects of NFT on the neural substrate of executive deficits in ADHD children. This is the first study to use an imaging measure of brain physiology other than EEG to assess the outcome of NFT. Funding from the ISNR research fund was used for research salary, participant reimbursement and the cost of doing fMRI's.

Study completed and published as:

Beauregard, M., & Levesque, J. (2006) Functional magnetic resonance imaging investigation of the effects of neurofeedback training on the neural bases of selective attention and response inhibition in children with attention-deficit/hyperactivity disorder. Applied Psychophysiology & Biofeedback, 31(1):3-20.

Levesque, J., Beauregard, M., & Mensour B. (2006) Effect of neurofeedback training on the neural substrates of selective attention in children with attention-deficit/hyperactivity disorder: a func-

tional magnetic resonance imaging study. Neuroscience Letters. 394(3), 216-221.

2. $2,000 awarded to Marco F. Congedo, PhD of the IRISA (Institute for Research in Informatics and Random Systems), Rennes, France in support of his study, "A 3-D Real-Time Virtual Brain Navigation Environment for Immersive EEG Biofeedback." This study is a further step in the development of more powerful neurofeedback paradigms through the creation of a true 3-dimensional real-time brain navigation system. Such a system should be able to record EEG from 19 to 64 locations and represent the 3-D brain activity as a virtual environment as close as possible to the actual human brain. It is being done within the SIAMES team (Computer Generated Images, Animation, Modeling and Simulation) located in the Institute for Research on Informatics and Random System (IRISA), Rennes, France. SIAMES (http://www.inria.fr/recherche/equipes/siames.en.html) is a team of more then 20 engineers and computer science experts affiliated with two French National Institutes of Research (INRIA and CNRS) and with the University of Rennes. According to Dr. Congedo, "possible applications of the technique include the treatment of epileptic foci, the treatment of specific brain regions damaged as a consequence of traumatic brain injury, and in general of any specific cortical electrical activity. The system can be used for research in Neurofeedback, Brain-Computer Interaction, and general electrophysiological research. The system will disclose a whole new universe of applications and will probably represent the most powerful and immersive real-time virtual representation of electrical brain activity to date." The outcomes of this study will be in the public domain. Funding from iSNR research fund provided for electrocaps and other supplies. The bulk of the funding for this complex project came from the French government.

Study is ongoing and published as:

Arrouët C., Congedo M., Marvie J-E., Lamarche F., Lècuyer A., & Arnaldi B. (2005), Open-ViBE: a 3D Platform for Real-Time Neuroscience, Journal of Neurotherapy, 9(1), 3-25.

2005

1. $20,000 was awarded to Mario Beauregard, PhD, Jean-Paul Soucy, MSc, MD, and Johanne Levesque, PhD for their proposed study entitled, "Effect of Neurofeedback Training on Dopamine Neurotransmission in AD/HD Children: A Single Photon Emission Computed Tomography (SPECT) Study." The study was to be done at Departement de Psychologie, University de Montreal, Canada. Dr. Beauregard's study to ascertain if the same changes occur in dopamine transmission in neurofeedback treatment that occur in medication (methylphenidate) treatment was withdrawn due to the inability of the investigators to obtain Canadian approval for the radioisotope ligand necessary for the study. The funding for this study was rolled over to a subsequent 2007 award to this group as detailed below under 2007.

2. $5,000 was awarded to Rex Cannon M.A. and Joel Lubar Ph.D. of the University of Tennessee for a study to determine the efficacy of low resolution brain electromagnetic tomography (LORETA) neurofeedback training (LNFB) of 14-18 Hz activity in a three-voxel cluster of the left dorsolateral prefrontal cortex (DLPFC} .Of particular interest to neurofeedback clinicians is the possibility of using LNFB effectively in sub-cortical and limbic regions. This advance in neurofeedback allows a trainee to focus on electrical activity in deep brain structures.

Study completed and published as:

Cannon, R., Lubar, J., Gerke, A., Thornton, K., Hutchens, T.A., & McCammon V. (2005) EEG Spectral-Power and Coherence: LORETA Neurofeedback Training in the Anterior Cingulate Gyrus. Journal of Neurotherapy, 10 (1) 5-31.

Cannon, R., Congedo,, M., Lubar, J., & Hutchens, T. (2009) Differentiating a Network of Executive Attention: LORETA Neurofeedback in Anterior Cingulate and Dorsolateral Prefrontal Cortices. International Journal of Neuroscience, 119(1):1 - 39.

Cannon, R., Lubar, J., Sokhadze, E., & Baldwin, D. (2008) LORETA Neurofeedback for addiction and the possible neurophysiology of psychological processes influenced: A Case Study and region of interest (ROI) analysis of LNFB in right anterior cingulate cortex (ACC). Journal of Neurotherapy, 2008, v.12/ 4. (in press)

2006

1. Joe Horvat, PhD and Jonathan Walker, MD received a $20,000 per year award for a two year multi-site study of traumatic brain injury (TBI) and EEG biofeedback. This study, still in progress, relies on substantial donations of equipment by Thought Technology. The study aims to estimate the efficacy of neurofeedback (NFB) to ameliorate neurocognitive symptoms in patients with traumatic brain injury. The primary outcome is total symptom score, measured on the neuropsychological symptom survey, the Iva, a patient constructed Primary Concern Scale and the Microcog. The authors hypothesize that patients assigned to NFB will exhibit significantly lower symptom scores as compared to patients receiving only standard care groups. The study will also examine changes in QEEG maps of patients treated with NFB for traumatic brain injury. This study has been delayed due to the untimely death of the PI, Joe Horvat.

2. Graduate Student, Andrew Hill of the UCLA, Psychology Department was awarded a $5,000 grant for his proposal "EEG Biofeedback Training of Lateralized Networks of Attention: What Actually Happens During EEGBF?" Proposal supervision was to be by Dr. Eran Zaidel, PhD and Dr. Jack Johnstone, PhD. The proposed research aims to vigorously assess EEG Biofeedback techniques in clinical use by combining assessment of ERP and spectral EEG with a new behavioral test of lateralized attention. This is especially important as clinical EEGBF practices differ widely regarding choice of left, right, and interhemispheric training. This study was unable to be completed due to several conflicts, and the funding was returned.

2007

1. A $1,000 award for a Pilot Project to Ascertain Utility of the Tower of London Test (TOL) to Assess Outcomes of Neurofeedback in Clients with Asperger's Syndrome. Bojana Knezevic (PI), Lynda Thompson, and Michael Thompson. This project assesses the utility of the Tower of London (TOL), an individually administered neuropsychological instrument designed to assess higher-order problem solving – specifically executive planning (EP) abilities – in children and adults. The goal of the current study is to investigate the effects of neurofeedback and training in metacognitive strategies on EP in children with Aspergers Syndrome (AS) as tested by TOL. In addition, these changes are expected to correlate with improvements in AS clients noted in the previous research on IVA, TOVA, and questionnaire

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ISNR Foundation
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data. Preliminary results show that AS individuals seem to improve their planning and problem solving performance, approach to the task, problem solving speed, response to failure and frustration ability, and flexibility in altering problem-solving efforts. Currently, 30 consecutive AS clients have been tested and 14 comparison group participants in order to obtain pre-NFB data. Post-NFB data has been obtained on 14 AS clients.. Current trends of decreased symptomatology on questionnaire data and performance improvements on IVA and TOVA are expected to reach significance once the sample size increases.

2. A $12,000 grant for Neurofeedback and Motivation Enhancement Therapy Based Bio-Behavioral Treatment in Psychoactive Substance Use Disorder (PSUD) awarded to Estate (Tato) M. Sokhadze, Ph.D., University of Louisville. Cocaine addicts are very difficult-to-treat having features of low motivation to change and reluctance to enter inpatient treatment. Motivational Interviewing (MI) (referred also as Motivation Enhancement Therapy [MET]) is designed to increase the compliance and probability of treatment entry and abstinence. Due to its brevity, MI is best suited to enhance compliance and facilitate treatment engagement. This project proposes that a combined application of neurofeedback and motivational interviewing techniques will be an effective intervention for cocaine addiction. It also studies the application of cognitive ERP and qEEG for post-treatment assessment. The overall goal of this project is to utilize electrocortical (dense-array ERP, qEEG) variables and measures of behavioral performance on mental tasks (reaction time, accuracy) to explore cognitive functions in patients with cocaine dependence diagnosis and compare recovery of these functions during brief biobehavioral intervention in an outpatient population. This research also proposes to characterize changes in cortical functioning associated with success rate of three arms for cocaine addiction treatment (MET, NFB, combined MET + NFB).

In this study most of the subjects successfully learned to increase sensorimotor rhythm (SMR), but were less successful in simultaneous SMR increase and Theta decrease blocks. Increase of the SMR during successful neurofeedback sessions was accompanied by a general arousal increase as indexed by the parallel increase of beta band power, as well as a significant increase of the skin conductance level and skin temperature decrease. Subjects who completed course of combined neurofeedback and MI intervention showed improvement on behavioral and ERP measures of their executive functions (e.g., conflict detection, error monitoring, cortical inhibition, etc.) and showed decreased reactivity to drug-related cues. Among the clinical outcome measures the most significant was decrease of depression scores (Beck Depression Inventory) and PTSD symptoms (PSS-SR). The drug screens did not show decrease in cocaine use, however the number of positive tests for marijuana use decreased significantly. Motivational interviewing was useful in maintaining a high level of retention in this study. The results of this pilot study support that a combination of motivational interviewing with neurofeedback is a promising approach to biobehavioral intervention for addictive disorders, and specifically for treatment of cocaine addiction in outpatient populations.

This study resulted in several papers:

Sokhadze, E., Stewart, C., & Hollifield, M. (2007) Integrating cognitive neuroscience methods with neurofeedback therapy in treatment of substance use disorder comorbid with PTSD. Journal of Neurotherapy, 11(2), 13-44.

Sokhadze, T.M., Cannon, R., & Trudeau, D.L. (2008) EEG biofeedback as a treatment for substance use disorders: Review, rating of efficacy and recommendations for future research, Applied Psychophysiology & Biofeedback , 33 (1), 1-28.

Sokhadze, E., Stewart, M., Hollifield, M., El-Baz, A., & Tasman, A. (2008) Attentional bias to drug- and stress-related pictorial cues in cocaine addiction comorbid with PTSD. Journal of Neurotherapy, V 12, N 4 (in press)

Sokhadze, E., Stewart, C., Hollifield, M., & Tasman, A. (2008) Event-related potential study of executive dysfunctions in a speeded reaction task in cocaine addiction Journal of Neurotherapy, v. 12, N 4. (in press)

And also several pending grant applications:

NIH-NIDA, R21-DA027157 : (PI) Executive dysfunctions and emotional abnormalities in cocaine addiction. Submitted on 10/19/2008. 2 years, $275,000, pending review.

NIH-NIMH, R01-MH083697-01: (PI) Integrated behavioral treatment and cognitive assessment of adolescents with dual diagnosis, Submitted on 11/06/2007, 5 years, $1,200,000 (pending resubmission).

Grants in preparation (January-February 2009 cycle): NIDA, R01, (PI) Behavioral therapy integrated with neurofeedback in treatment of adolescent drug abusers with comorbid ADHD.

3) A $20,000 award for Effects of Neurofeedback Training on Spatiotemporal Patterns of Response Inhibition in AD/HD Children: A Magnetoencephalography Study to Mario Beauregard and Johanne LeVesque, University of Montreal.

This study cross correlates outcome of neurofeedback training on performance tests, QEEG and magnetoencephalography (MEG.) Like previous studies by Dr. Beauregard which employed PET scanning and MRI correlates of QEEG and performance changes, this study offers to strengthen ADHD neurotherapy validation using an image technology other than QEEG to display neurophysiologic evidence of remediation of performance deficits. Eight subjects have been enrolled. The recruitment process is relatively slow given the stringent nature of the inclusion/exclusion criteria.

Research Foundation Contributions since October 2008

Brodmann booklet sales: $100

Delta Level:

Carol Lee-Hilewick
Doreen McMahon
Michael Sitar
Morry Edwards

SMR level

Cynthia Kerson

A very special thank you to:

Richard E. Davis and Genie Bodenhamer-Davis for their contribution of $3,000

Student Fund:

Cynthia Kerson $50
Michael Sitar $25

Practicing with Multichannel EEG, DC, and Slow Cortical Potentials

Thomas Collura, PhD

In the Atlantis series of EEG devices, BrainMaster has implemented hardware and software capable of recording and training DC (Direct Current) and SCP (Slow Cortical Potentials). This provides the ability to record the DC or "standing" offset potential of the EEG channels down to zero Hz, and to train using the DC information, and/or using SCP. The Atlantis hardware includes 2 or 4 high-quality DC-sensitive EEG amplifiers, and all EEG recordings have always been taken internally with DC coupling. However, until recently, the PC software has only had access to the "conventional" EEG information. The new software (and firmware) now makes it possible for the PC to have access to the DC EEG data, and to use it for research in DC/SCP EEG monitoring and training. In addition to providing DC measurements down to zero Hz, this capability also provides extended bandwidth for standard protocol-based EEG training (0.01 – 120.0 Hz), and simultaneous SCP data.

The DC potential is the actual "standing" or "zero hertz" component of the EEG. Unlike the other components which all have a defined frequency range (e.g. 8.0-10.0 Hz for alpha), DC potentials are recorded with a low-frequency cutoff of 0.00000 Hz. That is, if the sensor is "sitting" at a steady offset of, say, 150 microvolts, then that signal can be recorded and trained. This capability allows the system to monitor the slow, graded changes in the brain potential, which has traditionally been very costly and difficult to achieve. The SCP potential is defined as the DC offset, but with a very slow adaptive baseline correction factor, that eliminates the need to "zero" the amplifiers. Rockstroh et. al. (1989) provide a very complete and thorough review of applications of DC and SCP signals in research and in clinical practice. The recent article in NeuroConnections by Hartsuiker and Anderson (2008) also provides important background and practical data.

The Atlantis (2 and 4-channel) and Discovery (24-channel) EEG encoders employ DC amplifiers that provide measurable signals all the way down to 0.000 Hz. Combined with the 24-bit digitizers, the devices are capable of resolving EEG signals with an accuracy of less than 0.02 microvolts, and a dynamic range of 200 millivolts. The entire signal is digitized, then processed into two signals, the first being an EEG channel with a working bandwidth of 0.100 to 100 Hz, and a DC channel with a working bandwidth from 0.000 up to more than 5 Hz. While the EEG channel is filtered using conventional frequency bands, e.g. 0.1 to 2.0 Hz, etc., the DC data is managed by using a "damping factor" that applies a time-constant to the data. There is a direct inverse relationship between frequency and time-constant. For example, a time-constant of 8 seconds corresponds to a cutoff frequency of 0.16 Hz. The low-frequency cutoff of the DC channel is always 0.000 Hz, so it is typically some nonzero number, e.g. "175.0 microvolts," so would typically "be off the graph". By subtracting off a damped baseline, it is possible to create the SCP data, which have an average value of zero, hence always return to the center of the graph.

The DC signal contains all forms of offset voltage including metal-to-electrolyte junctions, skin potential, and other offsets. In and of itself, it is of limited use because it includes so many sources of voltage, and it is very difficult to achieve stable recordings. High quality DC sensors made of silver chloride must be used, and the physical connection must be very robust. More useful is the Slow Cortical Potential which is derived by removing the nearly constant standing offset, and allowing only the slow changes to be measured. In order to do this, the bandwidth of the SCP is typically taken with a "time constant" of about 10 seconds, which corresponds to a low frequency cutoff of about 0.05 Hz, and a high frequency cutoff of a few Hz. Most practical EEG training is done with the SCP potential. The raw DC offset is, however, particularly useful for monitoring and assessing the quality of the sensor contacts. It is thus useful for detecting poor or intermittent sensor connections, and is a useful sensor quality monitor.

The DC and SCP potentials are generated by several physiological mechanisms. One of these is the slow graded post-synaptic potentials of giant pyramidal cells in the cerebral cortex. However, these potentials typically do not extend down in frequency much below 0.5 Hz, and are primarily "oscillatory" signals. The predominant source of the slowest cortical potentials is the population of glial cells which support and regulate the neurons, as part of the global brain system. Glial brain cells have been found to be closely related to overall brain activation, and are also connected with brain stability. There are almost 10 times as many glial cells as neurons, and they are known to be related to general cortical arousal, intention, and are also very relevant to epilepsy and other abnormal processes. The training of slow cortical potentials has been pioneered primarily in Germany, by a group at Tubingen headed by Dr. Neils Birbaumer. This group has published results with brain-controlled interfaces (BCI), as well as working with epilepsy and ADD/ADHD using biofeedback training of slow cortical potentials.

DC/SCP training is generally done in a monopolar fashion. In this way, the system is monitoring the shifting of the brain potential levels relative to a standard reference. This makes it possible to specifically train the potential up or down, depending on the protocol. Unlike with regular EEG rhythms, the polarity of the training is important, as it dictates whether the brain potentials will be trained in an activating, or in a de-activating fashion. This is the approach used by the Tubingen group, and is the most precise and accurate form of DC or SCP EEG. With the use of the BrainMaster's Event Wizard, specifically directional DC and SCP protocols can be designed with 1, 2, or 4 channels. The entire DC signal, with 0.0000 Hz as the low end, can be recorded using this approach.

It is also very likely that recent use of very low frequencies in bihemispheric training is in fact working with slow cortical potentials. In this work, if, for example, T3 and T4 are used, the trainee is learning the effects of increasing the difference between the sensors, at low frequencies, hence

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Some Speculative/Theroretical/Elucidation Considerations

If glial cells outnumber pyramidal cells by 10 X and they control general cortical arousal, intention, and epilepsy mechanisms; they can hardly be regarded as functionally silent supporting connective tissue as medical students were taught long ago. In fact current studies suggest they may play an integral role in all brain activity. Do glial cells act en masse to condition the whole brain or could they act regionally, hemispherically, or locally? Could their influence affect cortical pyramidal cells only or could it affect relationships between the cortex and subcortical entities like the amygdala, medial bundle, reticular activating system, or caudate nuclei? Could glial cell cortical excitability-settings affect "conventional" EEG feedback training between 1 and 30 Hz? Those, and a host of other questions, await elucidation and the Atlantis (and soon the Discovery) hardware/software systems can play a role in that elucidation. Is it time to train the entire measurable spectrum of brain activity? Is it time to consider dynamic brain function as a mélange of the known, and yet unknown, local micro functions as well as global interactive activity?

Let's take depression as an example entity we might use to begin answering some questions posed above. Depression is the most common of all human afflictions; it pervades all human cultures; and it is easily diagnosed with an interview lasting just a few minutes; the Beck Depression Inventory; or other more extensive measures. It causes significant, possibly huge, economic effects that affect all societies worldwide. Expensive psychotherapy may help and drugs are used widely to combat it but neither approach leads to reliable, long-lasting, or side-effect-free results. Effective neurotherapy will attract favorable attention to our field of endeavor and governments as well as insurance companies will be willing to consider a neurotherapy alternative to very expensive, lifelong drug and psychiatric therapy, both with their expensively treated ripple side effects.

Further, let's take advantage of some very special technical aspects inherent in the ratio and interval scaling made possible by using full spectrum data available with combined elegant DC amplification for 0-1 Hz data and z-score data for measuring 1-40 Hz spectral brain activity in local, regional, or hemispheric brain spaces. Those information-rich measurements will enable us to test well-conceived hypotheses relevant to dynamic brain functioning, including cortical-subcortical relationships, with small enough sample sizes to make clinical studies conducted by clinically involved practitioners possible, scientifically rigorous, and convincing to super-critical criticism as well as our most important audience, our clients.

Then, let's apply a head-to-head clinical study design currently under consideration by the ISNR Clinical Studies Subcommittee as an appropriate research tool. This approach will use clinical skills and experience of seasoned and new neurotherapists working under scientifically rigorous protocols to test well-conceived hypotheses will indeed provide answers to many of the above-mentioned questions as well as other, elegantly-imagined questions put forward by experienced neurotherapists as well as serious neurotherapy critics. Because these proposed trials will be financially lean and have considerable economic importance, they will likely attract private funding.

By first comparing SCP-only training results head-to-head with conventional EEG feedback z-score training results, or any other conventional EEG training results, we can, for example, discern whether SCP-only training has an advantage over conventional EEG feedback, or amplitude EEG feedback training, or LENS training. Then, we can conduct further head-to-head trials to determine various combinations and exclusions that fair better over others. With each interative step in the comparisons we will get closer to an optimal clinical approach to depression. Further, because the trials will be conducted in real clinical settings in diverse geographic and sociologically different populations by diversely capable clinicians, any significant differences revealed will likely be robust in real neurotherapy settings. Isn't that the goal of all research?

For details regarding anything above please contact the authors. To join this clinical trial effort, go to: http://spreadsheets.google.com/ccc?key=pD1i6LBZw6tXMpVgV9dt-Ng&hl=e

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EEG, DC, Slow Cortical Potentials

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is working with basic brain activation processes. One advantage of the Atlantis system is that it permits the exact recording of the precise offset between each channel and the reference, thus providing more information than a single difference channel. It is still possible to train differences, or sums, or other derived values, based on the DC and SCP data recorded for each channel.

This DC/SCP capability can also be used to provide extended EEG frequency range in connection with bihemispheric protocols, to provide training that rewards any shift in the slow potentials, whether up or down. In these applications, both the active and the reference sensor are placed on active sites (e.g. T3 and T4), and the difference between them is used as the training signal. When a wide-band EEG channel is used as for uptraining ("go"), then any shift in the potential will cause a training reward. Training down ("stop") in this context will train the potential to stay constant, and not to change. The most direct method to do such training is to use a standard EEG channel for the feedback, and use the BrainMaster built-in protocol processing software. This provides training using conventional protocol-based approaches, with a working bandwidth range of 0.01 to 120 Hz.

The firmware upgrade provides a number of significant improvements, including several types of DC and SCP related features. When used in "Full Atlantis" mode, the EEG signals normally recorded for standard EEG training will extend from the range of 0.01 to 120.0 Hz. The software and hardware filters can be used to limit this as desired. It becomes possible, in "Full Atlantis" mode, to design protocols that operate down to 0.01 Hz, and provide useful training data.

In addition to extending the range of the standard 2 or 4 channels of EEG, this upgrade provides the ability, via the "Event Wizard," to access the DC and SCP data directly. This facilitates a variety of protocol approaches including automatic baseline correction, directional training, and complex protocols involving all 4 channels. Protocols can combine conventional EEG training including alpha synchrony, peak-performance protocols, z-score training, or LENS training, with the use of DC or Slow Cortical Potential data.

The Atlantis system does not require any additional hardware modules or spe-

cial cables in order to record these potentials. It is, as is customary, important to use silver chloride sensors, in order to achieve a valid and stable DC recording. This is because only silver chloride provides a "reversible" ionic interface with the skin and electrolyte, allowing DC signals to pass. Other sensor materials such as gold, silver, and tin, are all "capacitive" and will block DC signals due to the ion layer they build up with the electrolyte (paste or gel).

Many types of silver chloride sensors are generally available, including disposable stick-on EKG sensors and low-cost disposable or re-usable plastic retainers with embedded silver chloride disks, generally held on with a headband or measuring cap. Any of these are usable with the Atlantis equipment. With the use of proper sensors, DC and SCP data are immediately available, without having to resort to using EEG channels for "special" connectors or interface devices to access DC/SCP data. This allows users to learn about DC potentials as they are doing their customary work using any other EEG protocols. This avoids the need to "jump in" to DC work, but rather, it is possible to add DC/SCP monitoring and training without abandoning existing capabilities or familiar procedures. Each EEG channel thus provides both the standard EEG data, as well as the DC/SCP information, on each channel. In addition, in the "Full Atlantis" mode, the EEG channel bandwidth is extended to a range of from 0.1 to 100 Hz, facilitating wide-band EEG work, in addition to the use of DC and SCP data.

There is recent interest in "pushing" the capabilities of EEG systems to operate at low frequencies. Even a conventional EEG system with a low cutoff frequency of 0.5 Hz, has a finite gain at low frequencies. A signal with energy at 0.01 Hz, for instance, may be attenuated by 100 times or more by the EEG amplifier, yet still be measurable. For example, a 100 microvolt shift, when reduced by a factor of 100, still produces a 1 microvolt signal, at the input of a conventional EEG amplifier. However, it is preferable to employ EEG amplifiers that are designed to accurately record these slow potentials, and record them reliably, with valid quantitative results.

This DC/SCP capability operates simultaneously with the existing Atlantis capabilities, as shown in Figure 1. Therefore, in addition to the DC/SCP data, the complete EEG signal, with all of its component bands and protocol processing, are still operational. The built-in continuous impedance measurement is also operational. The new firmware additionally provides access to all of the impedance data

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Figure 1 – Four-channel training display using ultralow Delta band (top traces), as well as DC and SCP data (bottom panels). The four DC/SCP channels 1, 2, 3, and 4 are recognizable as blue, yellow, green, and red, respectively. The Event Wizard text panel (bottom left) shows the DC and SCP values, while the Event Trend display (bottom right) shows the 4 components in real time, along with the reward indicator.

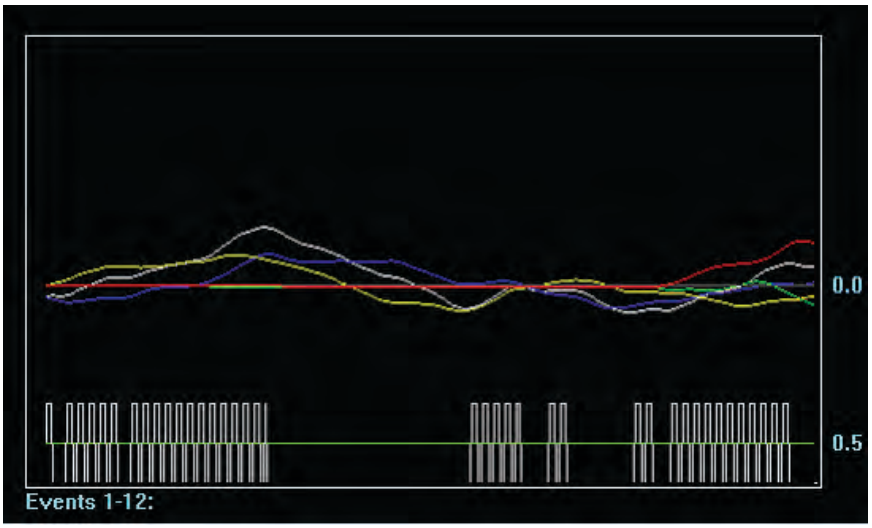

Figure 2. Detail of SCP training screen and reward method. SCP signals for F3, F4, P3, and P4 are shown in blue, yellow, green, and red respectively. Total SCP signal is in white. Rewards are earned when the total SCP potential is rising (bottom indicator).

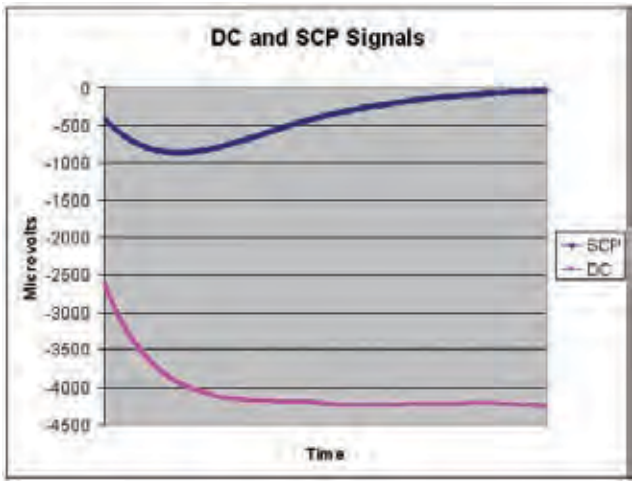

Figure 3. Comparison of SCP and DC signals for a 60-second epoch. The SCP signal (in blue) tends to stay near the baseline (zero value), while the DC signal stays at its full value, which exceeds -4000 microvolts. The SCP signal reflects the negative deflection of the DC signal (in pink), and returns to baseline after the DC signal has stabilized.

from within the PC software. This provides the sensor impedances for all leads, both active and reference on the PC display, and accessible via the Event Wizard. It is therefore possible to record DC/SCP potentials, conventional wideband EEG, and sensor impedances simultaneously, and monitor and train on any or all of these variables in real time. No other system to our knowledge provides simultaneous EEG, DC and SCP, and impedance monitoring on all channels at all times, moreover without additional hardware required.

The DC offsets of all channels are displayed in the status line above each of the raw EEG waveforms at all times, when the Full Atlantis mode is in use. This means that no special protocols or setups are required in order to view the DC data. All 8 frequency bands are also continuously monitored, and can be used for assessment and training, including live Z-Scores. In addition, the DC and SCP data are also available via the Event Wizard, regardless of the other training protocols or displays in use. Figure 2 shows 4 channels of SCP data displayed and trained using the Event Wizard. This approach makes it possible to incorporate DC and SCP work seamlessly into existing designs, without having to resort to special designs in order to access the data. All games, animations, DVD, CD, and other training screens may be controlled by DC/SCP signals. The combination of using standard leads and inputs, and having continual access to DC data, means that DC and SCP work can be incorporated at any time into any BrainMaster training protocols, so long as silver chloride sensors are in use.

With the 4-channel cable available with the Atlantis 4x4, it is possible to connect all 4 EEG channels with only 7 lead wires and a single cable to the user, eliminating confusion and excessive cables. It is hoped that this new capability will help to spread the use of DC and slow cortical potentials, by providing an economical, reliable, and accurate means of recording and training multiple channels, while retaining existing EEG capabilities.

The standard DC/SCP protocols provide a simple and well-defined use of lead wires to record 1, 2, or 4 channels. The standard use of color for 4 channels is the familiar blue / yellow / green / red color scheme, used to distinguish typical channel placements of, for example, F3/ F4/ P3/P4, or C3/C4/T3/T4. Using a standard placement, the 4-channel data are recognizable, as shown in the Figure 1. This design also provides a training feedback variable that is active when the combined shifts of all 4 channels is net positive (signals rising).

Both objectively and subjectively, DC and SCP potentials are a thing apart from conventional EEG rhythms. Figure 3 shows the relationship between SCP and DC signals, for a typical shift occurring over a period of 1 minute. Figure 4 shows an SCP signal simultaneous with the magnitude of a theta wave. An SCP signal does not resemble the magnitude of an alpha or SMR wave that waxes and wanes continually. When using conventional EEG magnitudes, the trainee must learn to let go and allow the feedback to lead the brain into a state that is often difficult to articulate. Some experienced peripheral biofeedback practitioners struggle when confronted with the apparent uncontrollability and relentless waxing and waning of EEG magnitudes. Slow cortical potentials, on the other hand, have a different "flavor." When using SCP signals, there appears to be more of a tendency for there to be essentially no response at all, until the brain decides to do something interesting. Monitoring 4 channels allows the simultaneous observation of all 4 brain quadrants.

When demonstrating 4-channel SCP monitoring and training, trainees may report that after a few minutes, they become aware of something to do with intention and the relationship to the environment, which shows up in SCP signal deflections. For example, when an interesting discussion begins, one or more of the traces may rise for many seconds, reflecting the change in regional brain activation. By observing the location and direction of the shift, it is possible to observe brain responses in real time that are not possible using conventional EEG rhythms. When using a standard F3/F4/P3/P4 montage, the responses may reflect regional hemispheric function, roughly corresponding to the following:

F3: Approach, engagement, interest

F4: Withdrawal, apprehension, disinterest

P3: Language processing, integration with self, logical reasoning and memory

P4: Image processing, integration with environment, spatial reasoning and memory

It is possible to observe correlations and relationships between DC and conventional EEG data using 1, 2, or 4 channels with the Atlantis, or up to 24 channels with the Discovery. It is also possible to simultaneously record, monitor, and train all 8 EEG components in the normal fashion, while DC/SCP data are also recorded and trained. Peripheral measures such as nIR and pIR HEG, Temperature, and HRV can also be monitored continually along with DC, SCP, and EEG signals. No special setup files are necessary for DC or SCP signals to be available for monitoring or training. In addition, live Z-Scores can also be monitored during DC and SCP training by specifying an age and eyes condition for the session, and enabling the Z-Score panel. Continuous impedance monitoring is also enabled when using the Full Atlantis mode.

Figure 5, for example, shows F3 and F4 SCP data over a period of 5 minutes. It is apparent that, at times, the entire frontal cortex is shifting in a similar fashion, demonstrating hemispheric co-ordination of activation patterns. At other times, however, they clearly behave separately, revealing differential hemispheric activity. Figure 6, similarly shows F3 and P3, demonstrating intra-hemispheric slow cortical potentials and their relationship.

DC and SCP potentials provide a valuable window into the brain and mind, and one that has historically been difficult and costly to obtain. With new technology, it is now possible to record and train DC and SCP brain signals in any clinical or research environment.

For further details and links regarding research and the use of DC and Slow cortical potentials, see the BrainMaster Technologies, Inc. Knowledge Base: http://www.brainm.com/kb/entry/302 /

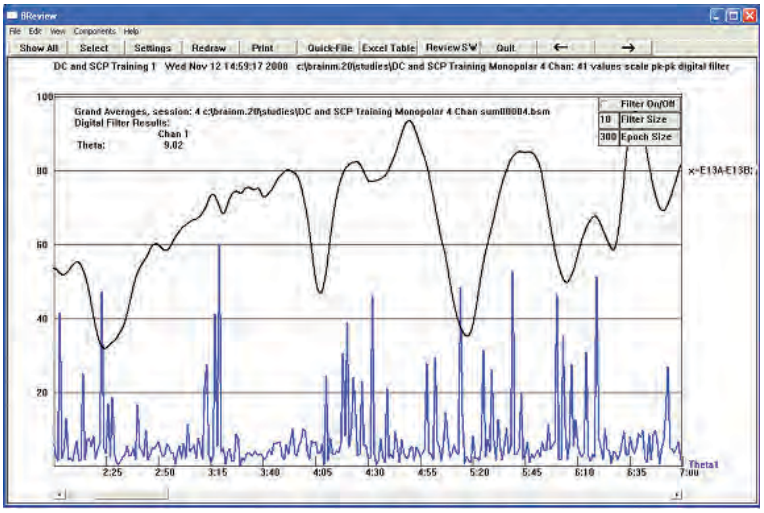

Figure 4. Simultaneous slow-cortical potential (SCP) (black), and filtered magnitude of theta wave (blue) for a 5-minute training epoch. Note that the SCP signals exhibit a characteristically different type of response, when compared to conventional magnitude-based training variables.

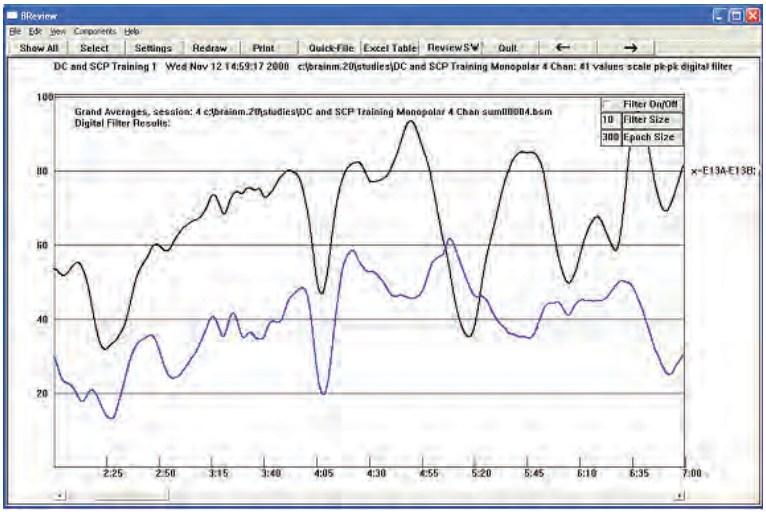

Figure 5. Comparison of F3 (black) and F4 (dark blue) SCP signals. The signals have periods of agreement, and also periods during which they are divergent, and even out of phase.

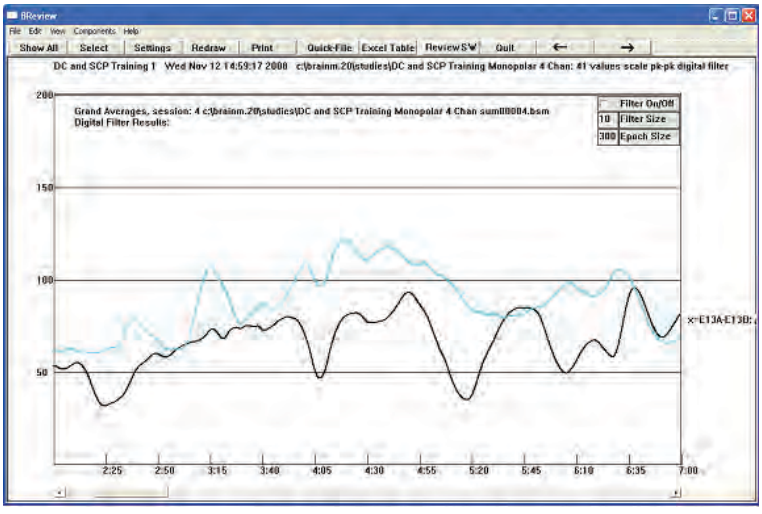

Figure 6. Comparison of F3 (black) and P3 (light blue) SCP signals.

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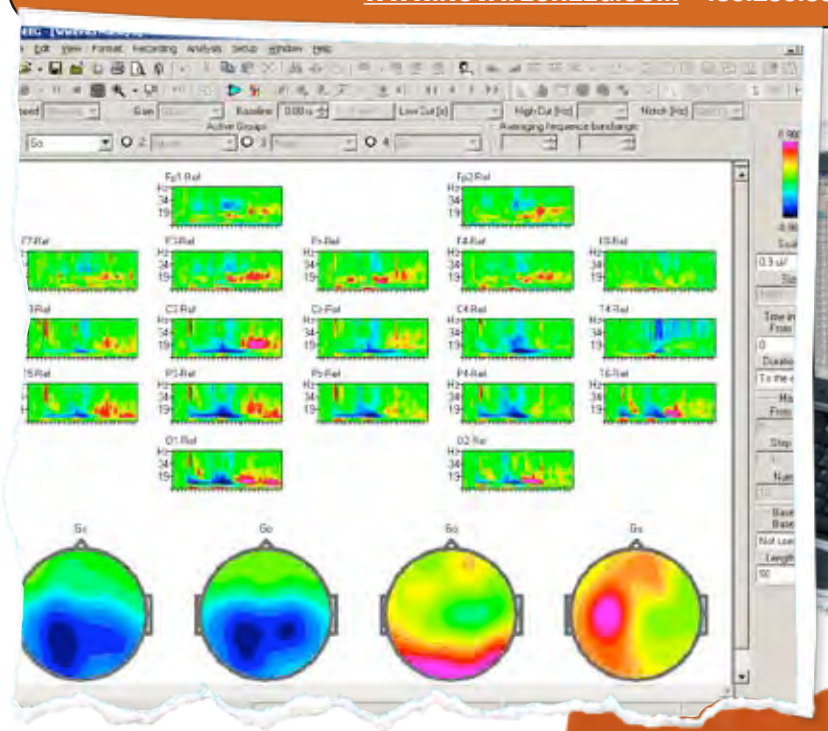

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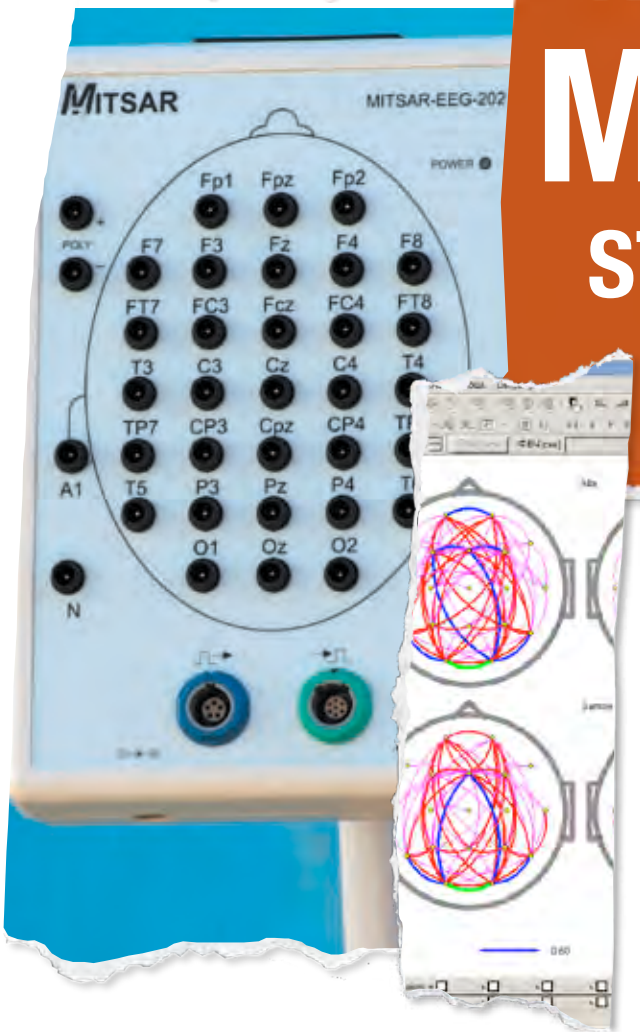

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