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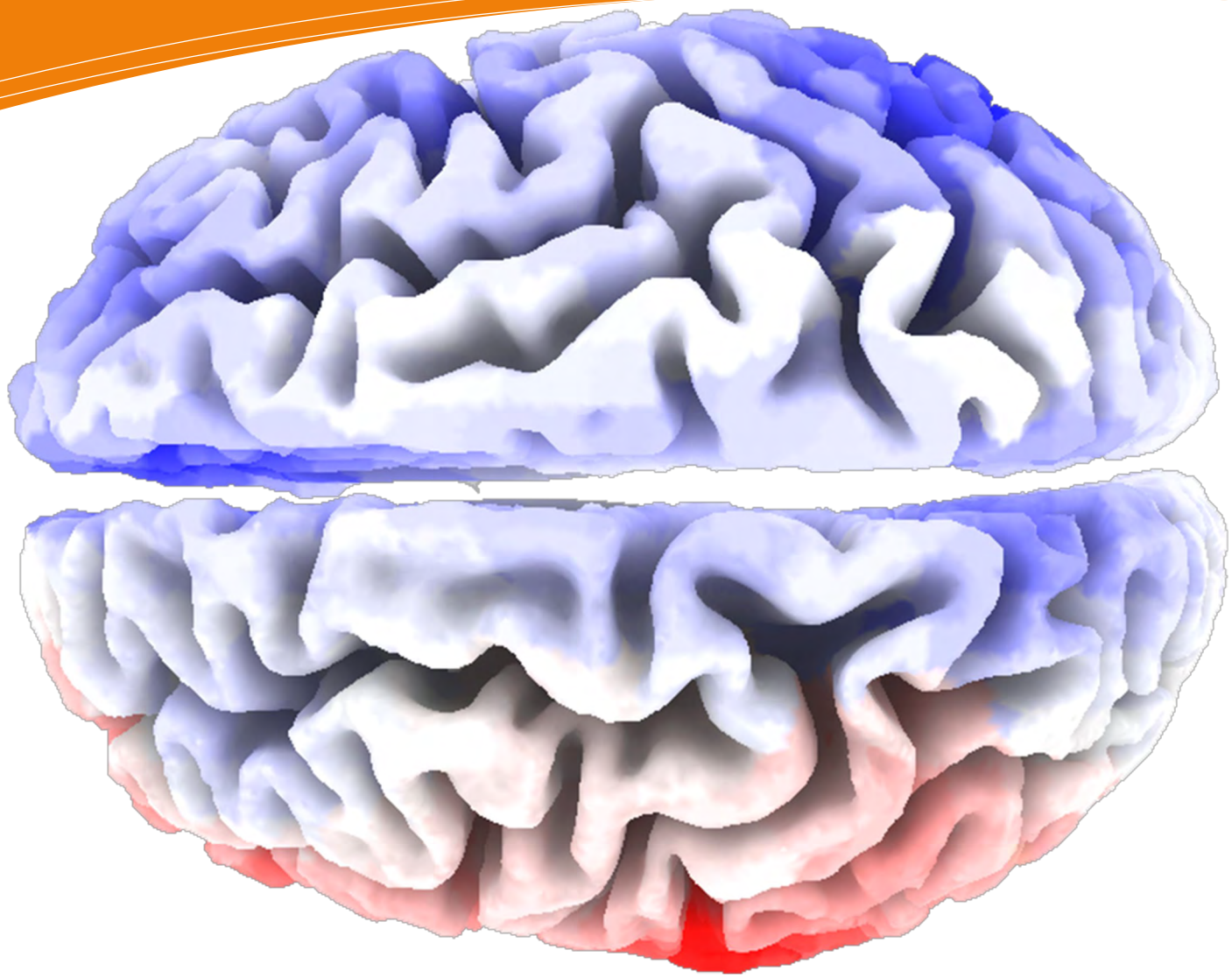
BI-MONTHLY Neurofeedback Newsletter



this issue

"Neurofeedback Training Course in Thailand" Details on page 9

Neuro-Eastern

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EDITOR-IN-CHIEF'S NOTE

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This is the 6th issue of NeuroEastern. As it is a bi-monthly newsletter of APNA, the 6th issue is for November and December 2016. To start with, I would like to remind that Neuro-Eastern is a free platform to share your research and/or clinical experience and your current research projects with other researchers. Therefore, I would like to invite all the interested readers of the Neuro-Eastern newsletter to share your expertise in neurofeedback or related current projects by writing a short article, which can be included in the next issue, and explore new tools for data analysis, especially EEG analysis.

The main article in this issue is on 'Brain Stimulation and Neurofeedback'. The fundamentals of neurofeedback and its various applications have been reported in previous issues of NeuroEastern. In this article written by Hafeez Ullah Amin, he briefly highlights the brain stimulation techniques and applications in various brain disorders, such as stroke, mood disorders, epilepsy, Parkinson's, movement disorders, and tremor. Few good references are provided of the related work of brain stimulation. However, he mentions that there is a potential for brain stimulation and NFB researchers to work further for compression of brain stimulation and NFB in mood disorders.

The resources pages discuss the Advanced Source Analysis (ASA), an analysis software tool developed by 'eemagine Medical Imaging Solutions GmbH', Germany. It is one of the most important tools for EEG analysis and source localization. It is capable of analyzing EEG, MEG, and MRI data. The various features of ASA software are discussed, as well as how it can be useful in EEG analysis. The user manual of the ASA tool is freely available on the internet. However, the software tool needs a license.

Brain Stimulation and Neurofeedback

The event page contains news of the neurofeedback course which was held on September 5-16, 2016 at Chiangmai, Thailand. Dr. Kenneth Kang was the featured speaker in this event and the participants were health care professionals.

We look forward to your feedback on this issue.

Aamir

Asia Pacific Neuro-biofeedback Association (APNA)

President's Message

Dr. Kenneth Kang

Head of Spectrum Learning

It is my sincere pleasure to welcome you to join APNA.

APNA was established to provide an oversight of the field of neurofeedback and biofeedback so as to promote and expand it, as well as to safeguard consumer interests.

I would like to express my deepest gratitude for the practitioners and researchers who have come together to help make the establishment of APNA possible. With that, I also want to extend my warmest invitation to anyone who is passionate about this field to come join us and grow this field, hand in hand, with the community for the benefit of mankind.

Brief Description

APNA is a non-profit organization for the purpose of joining the expertise of clinicians and researchers who are involved in health care research, and the clinical applications of neurofeedback and biofeedback for serving society. There is a growing number of professional clinicians, biomedical, and computing engineers, who have expertise in medicine, psychology, therapy, engineering, and development of new advanced computing solutions to biomedical problems.

These diverse experts started sharing their expertise, joint research collaboration, organizing joint events, and developing their professional networks under the umbrella of APNA. These activities are at initial stages and expected to peak in the future, including all the countries in the Asia Pacific region. It is very encouraging that the growing network of these professionals is promoting the clinical use of neurofeedback and biofeedback interventions to the general public for maximum benefits. Consequently, it will help people consult certified practitioners of neurofeedback rather than non-certified consultants.

VISION

1. To deepen our understanding of Asian mindfulness and meditation techniques and its health benefits with rigorous science
2. To promote its application in society to improve health, performance and quality of life

MISSION

1. To promote research collaboration between researchers, clinicians and the community
2. To promote professional clinical use of neurofeedback and biofeedback in the AP region
3. To promote awareness of the benefits of neurofeedback and biofeedback to the general public

BRAIN STIMULATION AND NEUROFEEDBACK

By **Hafeez Ullah Amin**
Email: hafeezullahamin@gmail.com

Introduction

EEG provides a way to study brain and behavior and how the two are correlated. The monitoring of EEG signals in certain brain states and/or cognitive tasks allow examining the dynamics of electrical potentials inside the brain. Clinically, EEG is useful in diagnosis of epileptic seizures, stroke, tumors, coma, dementia, depression, stress, Parkinson's and Alzheimer's disease. The EEG just records the electrical potentials and do not alter the neuronal activities. However, researchers have focused on *brain stimulation* techniques to develop methods for treating abnormal brains. The brain stimulation is a technique in which the patient's brain is electrically stimulated. This is rapidly transforming the research with in how the brain works and developing new ways to treat diseases. In this article, the various types of brain stimulation are highlighted in connection with neurofeedback. Neurofeedback has been discussed many times in the previous issues of this newsletter. Here, the focused will be on brain stimulation.

The functions of the healthy brain can be studied, by measuring the changes in the brain's state using EEG or functional MRI, or by disrupting the activities of the brain through the use of brain stimulation. The early experiments of Wilder Penfield and colleagues in the 1950s showed brain stimulation in people whose brains were exposed in surgery, and unfolded the possibility of inducing changes in the brain to show the involvement of specific brain regions in certain functions [1]. Brain stimulation can be non-invasive or fully invasive. In non-invasive brain stimulation, the intervention does not require any surgery, and the electrodes are placed on the surface of the scalp. However, in invasive stimulation, electrodes are placed inside the brain, such as deep brain stimulation [2].

Noninvasive Brain Stimulation

Non-invasive brain stimulation is a method to modulate human brain functions via electric or magnetic waves. There are two main non-invasive brain stimulation techniques available for human brain stimulation: Transcranial magnetic stimulation (TMS) and Transcranial direct current stimulation (tDCS).

Transcranial magnetic stimulation (TMS)

TMS is a non-invasive method of brain stimulation that is based on Faraday's principles of electromagnetic induction. A pulse is generated using insulated coil placed over the scalp and focused on a target area of the brain. The coil generates brief magnetic pulses, which travel through the skull into the brain painlessly. The pulses are administered in rapid succession and referred to as 'repetitive TMS' or rTMS. These pulses can produce long-lasting changes in brain activity. It is a safe and well tolerated procedure for effective treatment of brain disorders, such as major depression disorder, stroke and pain. McNamara and colleagues used rTMS for treatment of patients of depression, bipolar affective disorder and schizophrenia [3]. The findings show beneficial effects of rTMS compared to placebo in depression patients. Hummel and colleagues [4] reviewed the non-invasive brain stimulation techniques for stroke rehabilitation. They described studies of TMS and rTMS, which reported significant improvements for chronic stroke patients. For more detail about the applications of TMS on brain disorders, see the reviews [5, 6].

Transcranial direct current stimulation (tDCS)

Transcranial direct current stimulation, tDCS, is a non-invasive current stimulation in which the brain is stimulated by a constant direct current (low electric current) through a pair of surface electrodes known as the anode and the cathode. The intensity of the current is between 1 to 2 mA. tDCS works by inducing current into the brain via electrodes at the specified area, facilitating the depolarization or hyperpolarization of neurons, respectively. The positioning of the anode and cathode is used to influence the currents flow. The current delivered by tDCS is not strong enough to trigger an *action potential* (*the change in electrical potential associated with the passage of an impulse along the membrane of a neuron*). However, it can facilitate by bringing the neurons closer to or farther from firing. A typical view of tDCS is shown in Figure 1. The currently being explored applications of tDCS are: stroke, depression, epilepsy, chronic pain, motor rehabilitation, attention, and addiction.

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San-juan and colleagues [7] reviewed the efficacy of tDCS for epilepsy in humans. They searched tDCS studies in which a total of 65 human epilepsy patients were studied. The findings showed that direct current stimulation effectively decreased epileptic seizures in 67% of clinical studies, and reduced the inter-ictal epileptiform activity in 83% of studies.

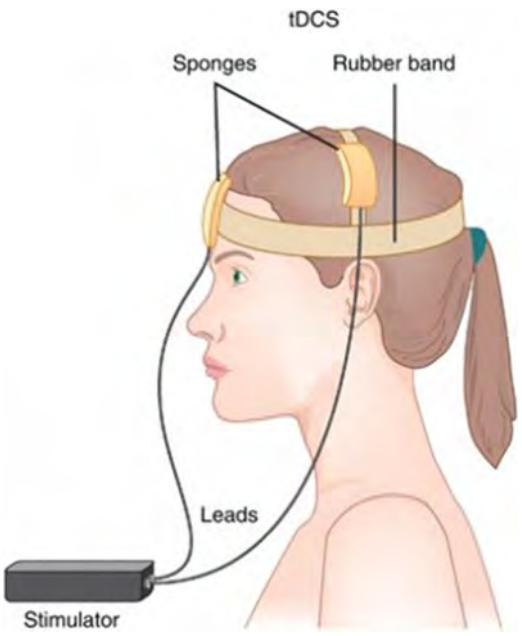

Figure 1: A typical view of tDCS

Adam Green and Peter Turkeltaub used the tDCS to stimulate the area of the brain (frontopolar cortex) associated with creative analogical reasoning [8]. In the experiment, the tDCS was used and the frontopolar cortex was targeted in two creativity tasks, which allowed the subjects to form more creative analogical connections between a set of words and generate more creative associations between the words. The results of the study suggested that giving individual a "zap" of electrical stimulation enhances the brain's natural thinking cap boost in creativity. Thus, the use of tDCS enhances the conscious augmentation of creativity elicited by cognitive intervention. For more detail about the applications of tDCS in brain disorders, see the review [9].

Invasive Brain Stimulation

Deep brain stimulation (DBS) is a surgical procedure, and invasive brain stimulation, to treat a variety of disabling neurological symptoms, such as Parkinson's disease, motor disorder, tremor, rigidity, etc. The DBS system consists of three main components: 1) the electrode (a thin insulated wire is inserted through an opening in the skull and implanted in the brain). The tip of the electrode is positioned within the targeted brain area, e.g. thalamus, 2) the extension (an insulated wire that is passed under the skin of the head, neck, and shoulder, connecting the electrode to the neurostimulator), and 3) the neurostimulator (it is a battery operated medical device like a stopwatch, to deliver electrical

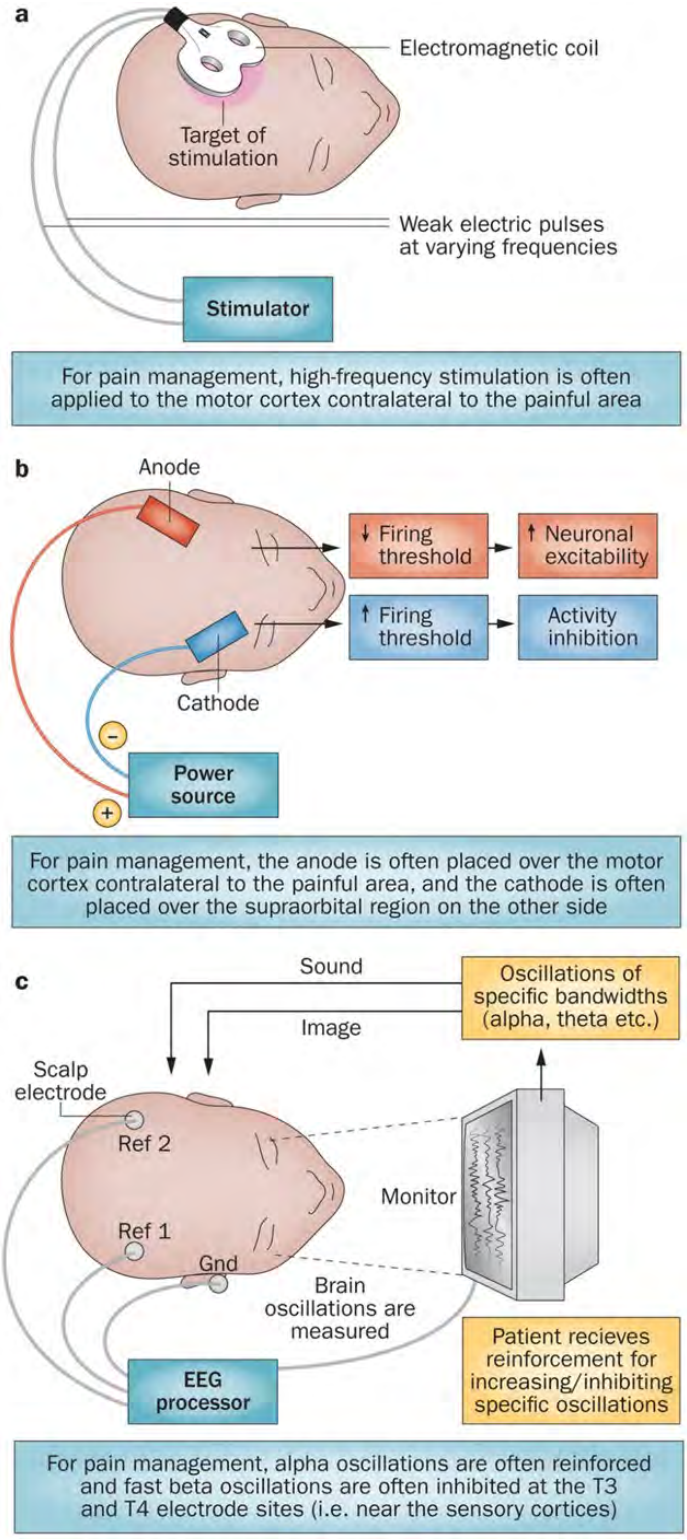

Figure 2: Non-invasive brain stimulation and neurofeedback techniques for the treatment of chronic pain. a) Repetitive transcranial magnetic stimulation. b) Transcranial direct current stimulation. c) EEG biofeedback (neurofeedback). Reprinted with permission from Jensen, M. P. *et al.* (2014) [11].

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Deep Brain Stimulation, see [10]. The DBS has many advantages over traditional surgical procedures, such as safety and effectiveness, fewer long-term complications, and adjustable stimulator as per patient's need. However, the deep brain stimulation is quite expensive to setup and difficult to maintain.

In contrast to brain stimulation, neurofeedback is a passive therapy that involves changing neuronal activity without inducing any current or implanting an electrode (see Figure 2 for brain stimulation and neurofeedback). The fundamentals of neurofeedback, its applications and future research works have already been discussed in the previous issues of this newsletter. The comparison of brain stimulation and neurofeedback for certain brain disorders is debatable, and needs further work and discussion.

It has been proven from previous experimental studies that brain stimulation has good effects for many disorders. Moreover, it has also been proven that brain stimulation has become a suitable tool for studying diverse features of human brain in healthy volunteers [12]. However, no brain stimulation is completely free of side effects.

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Advanced Source Analysis (ASA)

By Hafeez Ullah Amin
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Introduction:

ASA™ is a highly flexible EEG/ERP and MEG analysis package with a variety of source reconstruction, signal analysis and MRI processing features. ASA combines functional brain imaging with the visualization and incorporation of morphological information obtained from MRI or CT. ASA is a highly interactive and flexible software tool that can be applied to neurophysiological and clinical brain research.

ASA gives a realistic impression of your experimental configuration, together with topographical mapping of EEG and MEG and the results of your analysis. ASA is developed for and by people dedicated to brain research. The concept of flexibility and openness covers even the most complex analysis demands. The ASA environment is particularly attractive for those that wish to develop their own methods in third party packages, like Matlab™, and use ASA for pre-processing and visualization purposes.

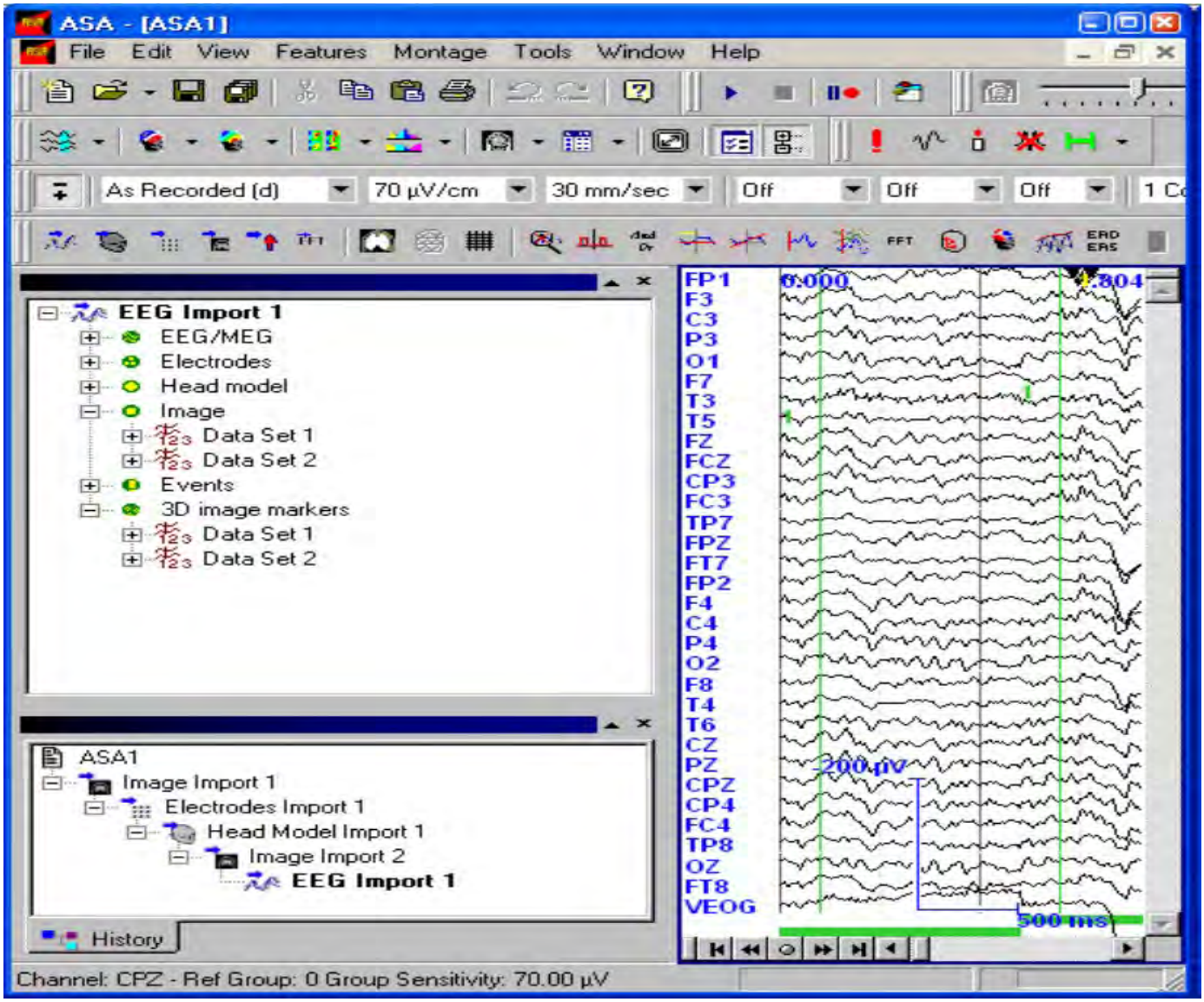

Figure 1: ASA Workspace

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Key Features:

Pre-processing

- EEG/MEG review capabilities, support of most EEG and MEG file formats. Paging, scrolling, event marker review, different editable montages, filters
- Compressed display (minutes and hours of recording in one page) and compressed spectral density array (CDSA) • MRI import (DICOM, Analyze, Nifty, ASA) and review of images
- Full support of event information, easy navigation through events in the data • 3D EEG/FFT mapping completely synchronized with EEG and event table
- Automation via scripting (VB, VBA, Javascript, Matlab, COM support)

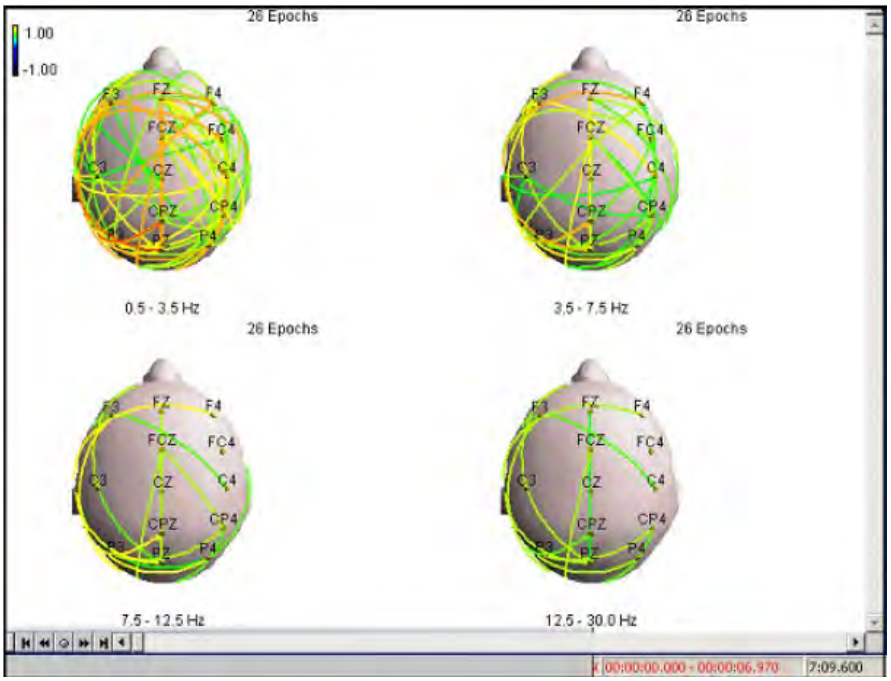

Figure 2: Display of Coherence amplitude. The value of coherence is scaled to absolute 1.

EEG/ERP Signal conditioning

- Filtering, artefact detection, baseline correction, detrending, data template subtraction for artefact removal, grand averaging
- EOG artefact correction based on blind source separation (SOBI)
- (Grand) averaging over multiple conditions
- Interpolation of bad channels
- 3D Current Source Density (CSD, surface Laplacian) mapping
- Event-Related Desynchronization (ERD) based on band pass filtering and Hilbert transform
  Data export in various formats, such as ASA, ASCII and extended EDF format

Time-frequency analysis

- Coherence mapping and phase analysis, based on FFT and wavelets, with display of amplitude and phase coherence in adjustable frequency bands by means of arrow plots
- 3D FFT mapping and spectral analysis, adjustable to specific requirements, with comparison of groups vs. single subject spectra
- Event-related/EEG wavelet analysis and wavelet mapping

Source reconstruction

- Multiple spatio-temporal dipole modeling
- MUSIC (multiple signal classification)
- LORETA (low resolution tomographic analysis)
- sLORETA and swLORETA
- Cortical imaging
- True 3D reconstruction in frequency domain
- Forward simulation of EEG and MEG

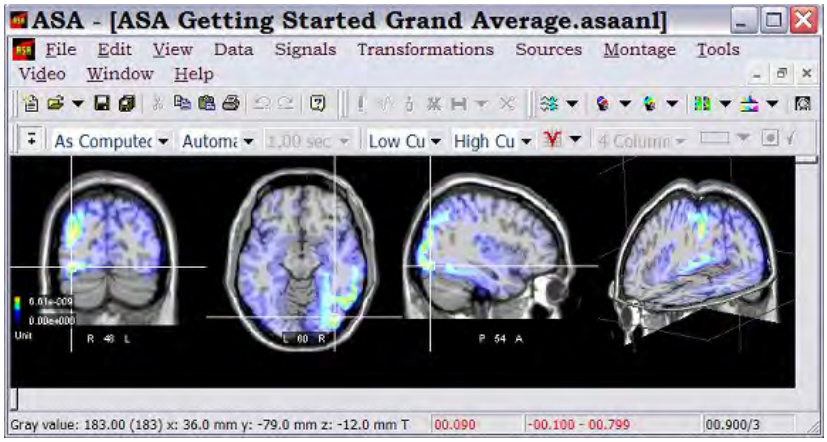

Figure 3: Source localization analysis as shown in MRI view

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MRI and head modeling

- Automatic segmentation of MRI/CT data
- Generation of realistically shaped head models based on Boundary Element Method (BEM)
- Standardized MRI, head models and electrode configurations for all methods, EEG and MEG
- Transformation to Talairach system

Advanced signal conditioning

- TMS artefact correction for mono- and biphasic magnetic pulses
- fMRI gradient and pulse artefact removal
- Group analysis and statistics with the ASA Experiment Manager

Recording options and real-time processing

- Synchronized high quality video recording (MPEG4, MPEG2 and others)
- Real-time access to EEG recording (even over local area network)
- Toolbox for brain-computer interface (BCI) and neuro-feedback
- Online trigger statistics, artefact detection and averaging

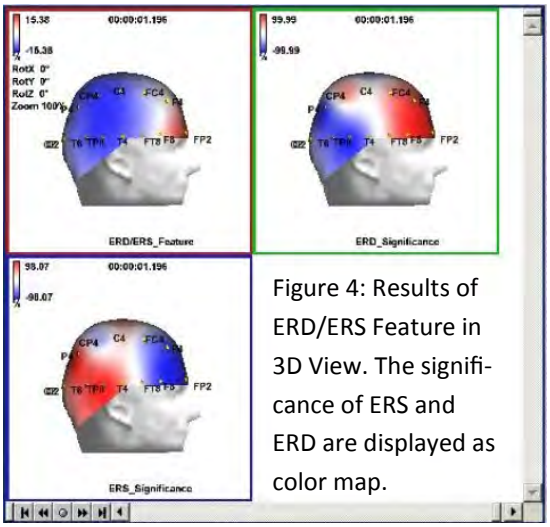

Figure 4: Results of ERD/ERS Feature in 3D View. The significance of ERS and ERD are displayed as color map.

Integration with third-party programs

- Online and offline automated interaction with programs such as Matlab® and other advanced analysis packages
- Library of Matlab functions for data import/export
- COM interface for advanced scripting

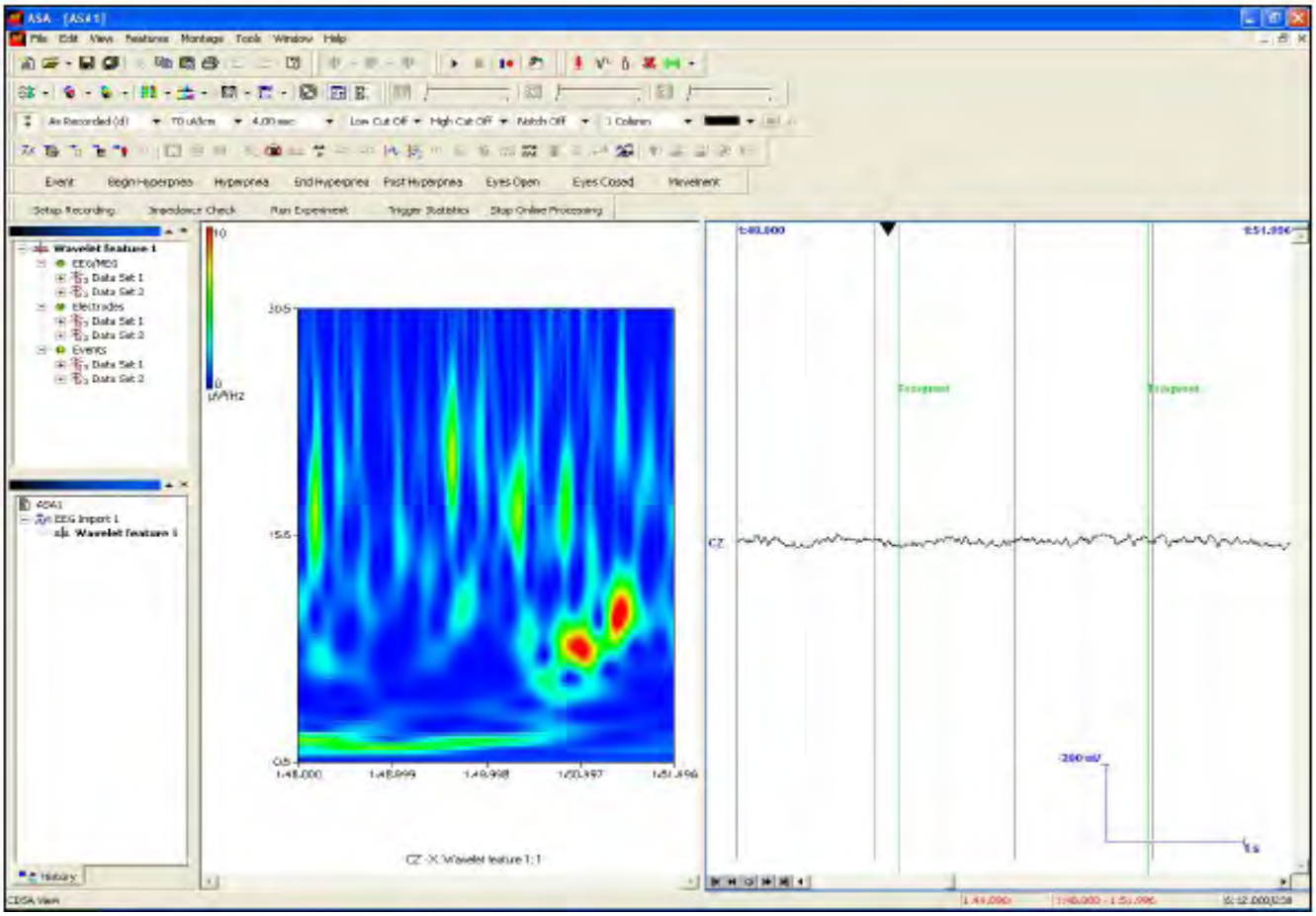

Figure 5: Wavelet results in the time-frequency map of EEG signals

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Neurofeedback training course

Chiangmai, Thailand, Sep 5-16, 2016 *(by Dr. Panu Khuwuthyakorn, MD)*

Over 20 participants from Suanprung Psychiatric Hospital (SPH), Rajanagarindra Institute of Child Development (RICD), and College of Art Media and Technology (CAMT) stepped away from their routine work for 2 weeks to take part in an interesting training course. "APNA: Neurofeedback training course" was held in Chiangmai on September 5-16, 2016. It was a part of the first Neurofeedback excellent center project in Thailand which was due to the cooperation of the 3 organizations. Participants were psychiatrists, neurologists, nurses, and other health care professionals.

The Deputy Director General of the Department of Mental health of Thailand (Dr. Chinoros Leesawat) and the Director of SPH (Dr. Samai Sirithongthaworn) were the chairman and Cochairman of the opening ceremony of the training. Dr Kenneth Kang (Principal Consultant of Spectrum Learning) was the featured speaker inspiring participants to find the worth of neurofeedback, and taught them about core principles of it. He not only donated valuable neurofeedback machines to the center, but also provided 3 other neurofeedback experts (Ms. Eleanor Fong, Ms. Marilyn De Cotta and Mr. Samuel Lam) to train them in the proper methodology of nurofeedback.

Dr. Kenneth Kang presenting certificate to Dr. Samai Sirithongthaworn

Right after the training, they have opened their neurofeedback clinic at RICD and used the knowledge they have learned to help local people with mental health problems get a better quality of life.

In pictures, views of the neurofeedback clinic in the course showing participants with Spectrum Learning professionals practicing their knowledge.

Acknowledgment: ***The event is reported by Dr. Panu Khuwuthyakorn, MD from Saunprung Psychiatric Hospital, Chiangmai, Thailand, for November issue of NeuroEastern.***