INSOMNIA: EVALUATION AND THERAPEUTIC INDICATIONS WITH ADVANCED EEG TECHNIQUES (QEEG)

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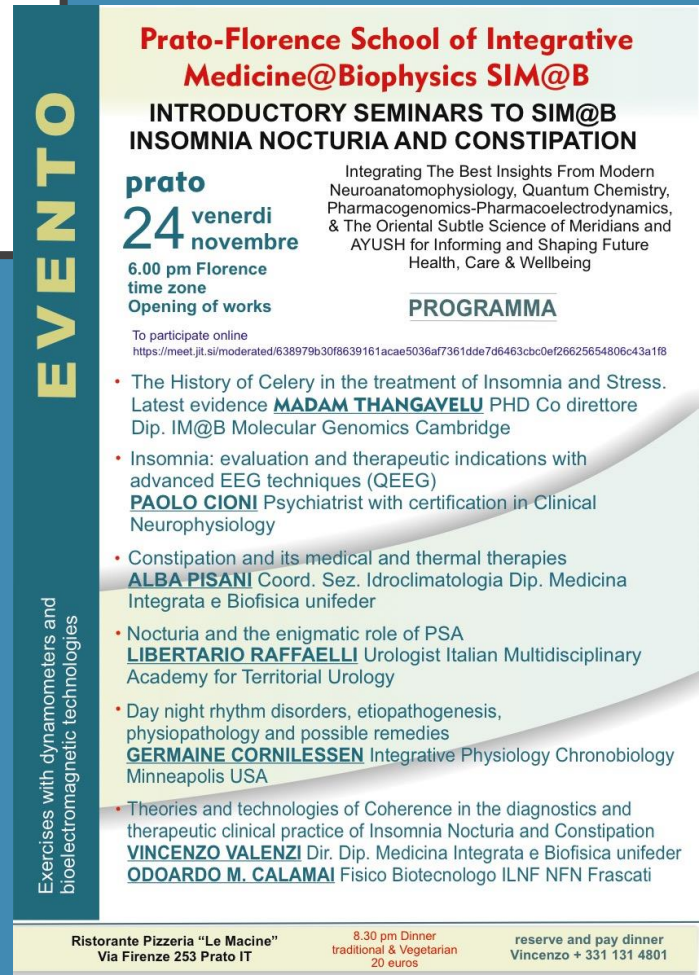
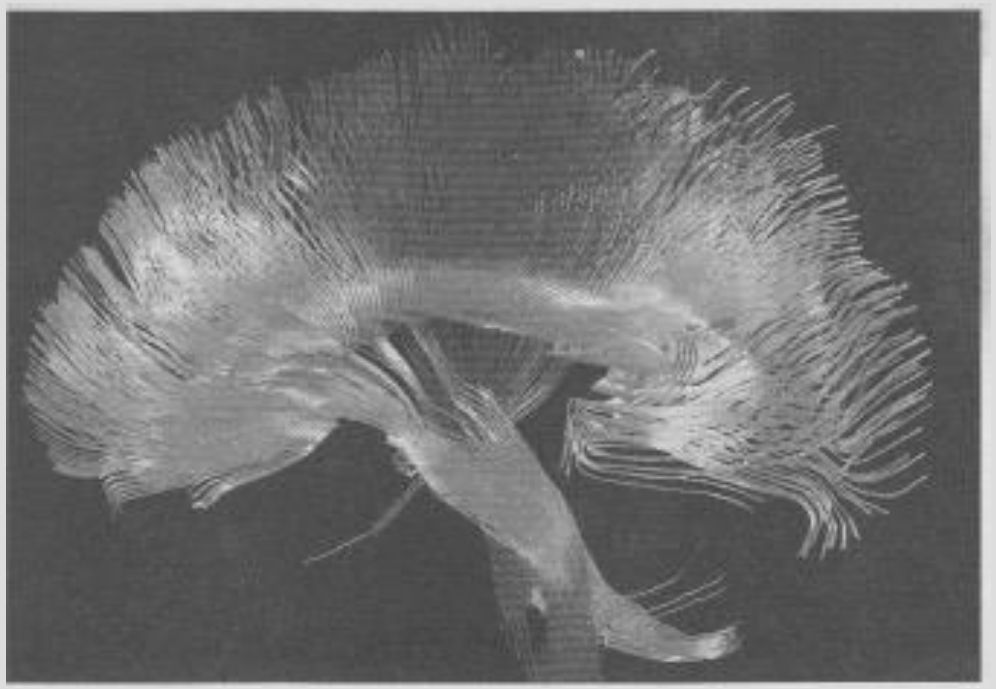


CONNECTOME = GLOBAL MAP OF THE BRAIN'S NEURAL CONNECTIONS



- Aimed at capturing a dynamic image of brain activity and creating a detailed atlas of the mind
- Axons of brain neurons lined up → 150000 km in a 1 ½ liter box
- Electron microscopy techniques
- Functional magnetic resonance imaging (fMRI) → RECENT ADVANCES: diffusion weighted imaging (DWI) → diffusion tensor imaging (DTI) → functional connectome. In vivo
- EEG, MEG, and fMRI

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Review

Methods for analysis of brain connectivity: An IFCN-sponsored review

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HIGHLIGHTS

- There are a variety of technologies valuable for exploring human brain connectivity.
- The main aspects of anatomical, functional and effective connectivity are described.
- A multimodality approach can be useful to evaluate the human brain connectome.

ABSTRACT

The goal of this paper is to examine existing methods to study the "Human Brain Connectome" with a specific focus on the neurophysiological ones. In recent years, a new approach has been developed to evaluate the anatomical and functional organization of the human brain: the aim of this promising multimodality effort is to identify and classify neuronal networks with a number of neurobiologically

Abbreviations: BOLD, Blood Oxygenation Level Dependent; CBI, cerebellar inhibition; CLARITY, clear lipid-exchanged acrylamide-hybridized rigid imaging/immunostaining/in situ hybridization-compatible tissue hydrogel; CNS, Central Nervous System; CRS-R, coma recovery scale-revised; CS, Conditioning Stimulus; CST, Cortico Spinal Tract; dMRI, Diffusion Magnetic Resonance Imaging; DNA, DeoxyriboNucleic Acid; DREADDs, Designer Receptors Exclusively Activated by Designer Drugs; DSI, Diffusion Spectrum Imaging; DTI, Diffusion Tensor Imaging; DWI, Diffusion Weighted Imaging; EEG, electroencephalography; eLORETA, exact Low Resolution Electromagnetic Tomography; EMG, electromyography; ET, Ensemble Tractography; ETC, Ensemble Tractography Connectome; fMRI, functional Magnetic Resonance Imaging; GABA, Gamma-Aminobutyric Acid; GM, Grey Matter; HARDI, High Angular Resolution Diffusion Imaging; HCP, Human Connectome Project; ICA, Independent Component Analysis; ICF, Intracortical Facilitation; ICMs, Intrinsic Coupling Modes; IHF, Interhemispheric Facilitation; ISI, Interstimulus Interval; LCD, Late Cortical Disinhibition; LICI Long Interval Intra Cortical Inhibition; LiFE, Linear Fascicle Evaluation; LIHI, Long Latency Interhemispheric Inhibition; M1, Primary motor cortex; MCS, Minimally Conscious State; MEG, Magnetoencephalography; MEP, Motor Evoked Potential; MRI, Magnetic Resonance Imaging; mTMS, multilocus Transcranial Magnetic Stimulation; NIBS, Non-Invasive Brain Stimulation; pcTMS, paired coil Transcranial Magnetic Stimulation; PFC, Prefrontal Cortex; PMd, dorsal premotor cortex; PMv, ventral premotor cortex; PPC, Posterior Parietal Cortex; ppTMS, paired pulse Transcranial Magnetic Stimulation; ROIs, Regions Of Interest; SAI, Short latency Afferent Inhibition; SICF, Short Interval Intracortical Facilitation; SICI, Short Interval Intracortical Inhibition; SIHI, Short Latency Interhemispheric Inhibition; SMA, Supplementary Motor Area; SPC, Single Parameter Connectomes; spTMS, single pulse Transcranial Magnetic Stimulation; STM, Single Tractography Methods; tACS, transcranial Alternating Current Stimulation; tDCS, transcranial Direct Current Stimulation; TEPs, TMS-evoked EEG Potentials; tES, Transcranial Electrical Stimulation; TMS, Transcranial Magnetic Stimulation; TS, Test stimulus; UWS, Unresponsive Wakefulness Syndrome; VS, Vegetative Wakefulness Syndrome; WM, White Matter.

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«EEG IS A POWERFUL TOOL FOR MEASURING NEURONAL ACTIVITY AND CONNECTIVITY»

By defining anatomical and functional connections of brain regions on the same map through an integrated approach, comprising both modern neurophysiological and neuroimaging (i.e. flow/metabolic) brain-mapping techniques, network analysis becomes a powerful tool for exploring structural–functional connectivity mechanisms and ***for revealing etiological relationships that link connectivity abnormalities to neuropsychiatric disorders.***

Panel of international experts selected by IFCN -International Federation of Clinical Neurophysiology

QEEG BRAIN MAPPING

Power Spectral Analysis (PSA) is a statistical technique for detecting periodicities within time series data. As employed within electroencephalography, the technique is routinely used to decompose complex wave forms into their constituent frequencies.

Quantification is accomplished by determining the amount of voltage that occurs per Hz for pre-specified bandwidths.

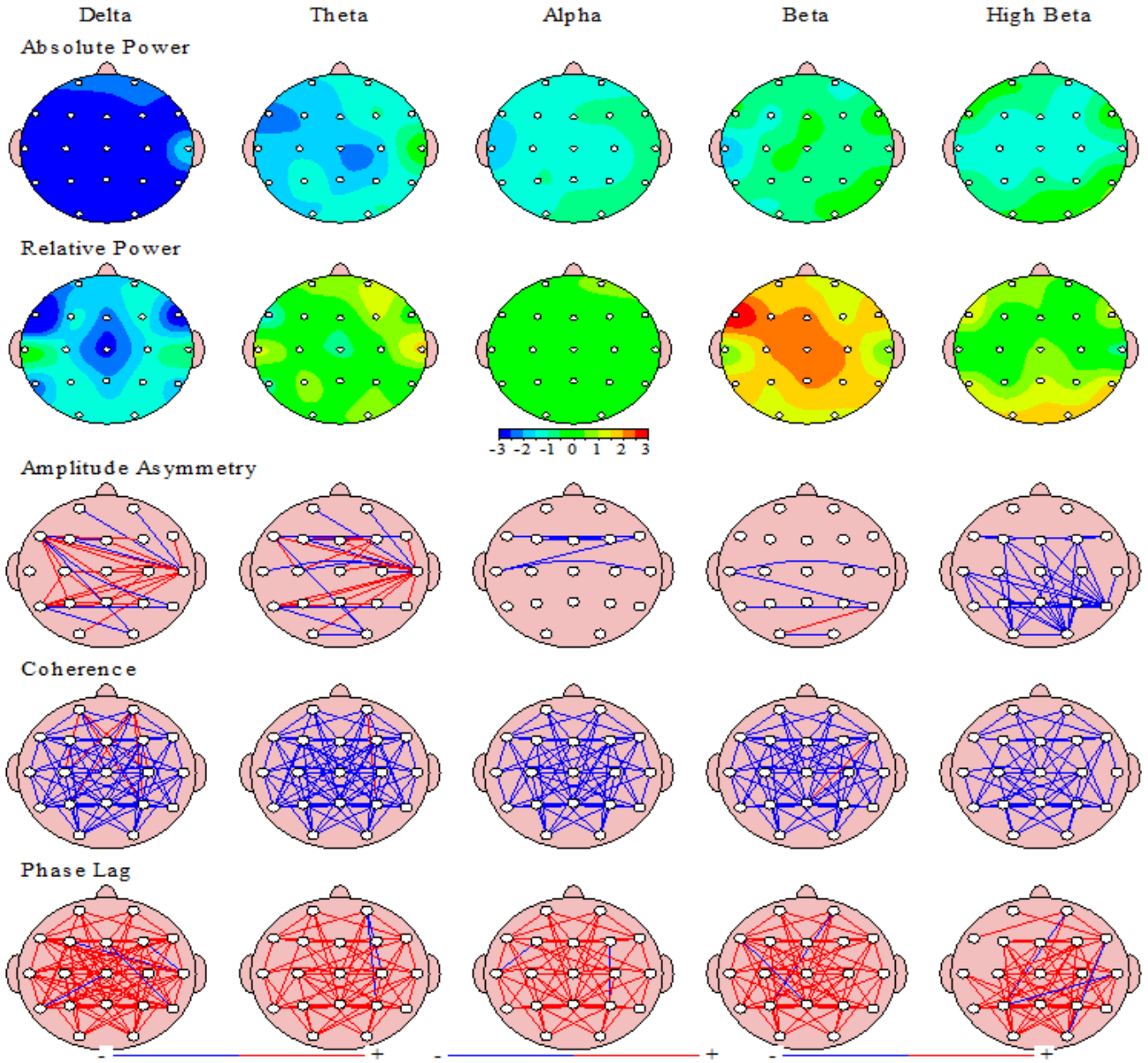
QEEG BRAIN MAPPING
HOW DOES IT WORK?

- Brain mapping is the first step in all non-drug treatment protocols.
- 19 sensors are placed on the patient's scalp that record the brain's activity (EC and EO). The brain is not stimulated in any way and drugs are not administered. Furthermore, brain mapping is completely non-invasive and painless.
- Once the patient's brainwave activity has been recorded and mapped, the results are then compared to a reference normative database of "normal" activity found in same-age individuals, which allows us to identify the regions of the brain that may be experiencing abnormal activity

Montage: Default

EEG ID: Startdate 15-APR-2019 2686 Cioni Medicom_MTD_equipment

Z Scored FFT Summary Information



QEEG AND INSOMNIA

There is robust evidence that insomnia is associated with relatively high frequency :

- increased beta (12-30 Hz) and
- Increased gamma power (30-80),

presumably caused by 'hyperarousal' (for an overview, see: Perlis et al., 2001; Bonnet et al., 2010): insomnia as a chronic physiologic arousal disorder.

The beta waves with multiple and varying frequencies are often associated with active, busy or anxious thinking and active concentration

The gamma rhythm, is modulated by sensory input and internal processes such as working memory and attention.

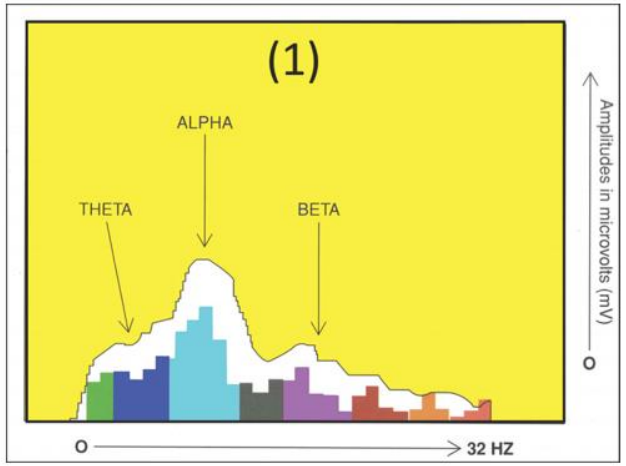
BETA FINDINGS

- The Beta findings are consistent with the psychological data suggesting that patients with insomnia may be hypervigilant and/or excessively ruminative at sleep onset and/or during sleep
- they point to processes (sensory and information processing, attention, long term memory) and implicate structures (thalamus, sensory cortex, prefrontal cortex, hippocampus, etc.) that may be related to sleep initiation and maintenance problems

BALANCED AND UNDERAROUSED POWER RATIO

- Alpha has the highest amplitude.
- Theta and delta are lower than alpha.
- Beta amplitudes steadily decrease as the frequency increases.

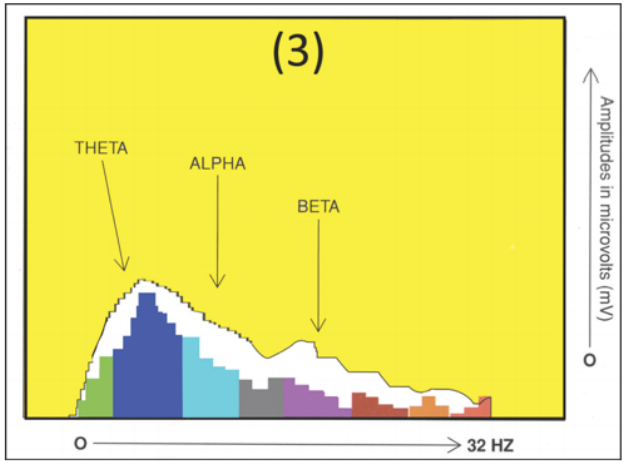
Figure 10.5. Balanced Adult Power Ratio at Cz (EC)



Two-dimensional chart adapted from BrainMaster Technologies, Inc. software

he called Thalpha. Chart 10.2 provides a developmental perspective of theta-to-beta ratios.

Figure 10.7. Power Ratio Is Underaroused



Two-dimensional chart adapted from BrainMaster Technologies, Inc. software

Chart 10.2: Average Theta-to-Beta Ratios at Cz

Age	Theta/Beta RATIO

OVERAROUSED POWER RATIO

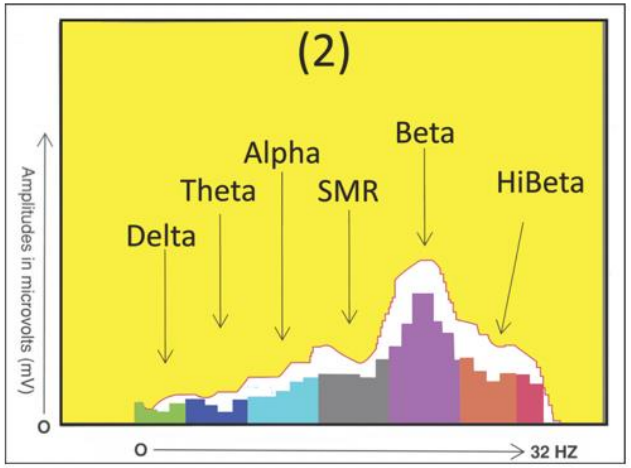
Overaroused Ratio

Figure 10.6 shows an overaroused power ratio because fast waves are far greater than slow waves.

- Fast waves (beta) are greater than slow waves (alpha and theta).
- As the frequency increases, the amplitude increases.

Figure 10.6 depicts an overaroused EEG presentation. The typical overaroused subject has symptoms such as anxiety, OCD, worry, obsessions, perfectionism, insomnia, or migraines. It's difficult for overaroused clients to relax and let go. The power ratio is beta greater than theta or beta greater than alpha. Often, increases in fast-wave beta are accompanied by decreases in slow-wave alpha or theta. Sometimes children with an overaroused pattern are hyperactive or inattentive; they may be misdiagnosed with ADHD, but the real problem is anxiety.

Figure 10.6. Power Ratio Is Overaroused



Two-dimensional chart adapted from BrainMaster Technologies, Inc. software

Underaroused Ratio

THE EXCESS BETA BAND POWER MAY PURELY BE CAUSED BY THE PSYCHO-ACTIVE SUBSTANCE

STIMULANTS

Acute effects: Decreased delta and theta power, increased beta power (Johnstone & Lunt, 2011; Fink et al., 1969). Possible changes in measures of connectivity such as coherence and phase lag (Fink et al., 1969).
Long-term effects: Unknown

ANTIDEPRESSANTS

Acute effects: Selective Serotonin Reuptake Inhibitors (SSRIs) can result in increased beta power (Siepmann et al., 2003). Tricyclic antidepressants can result in increased of delta and theta power, decreased alpha power and increased beta power (Saletu et al., 1983).
Long-term effects: Unknown

SEDATIVES

Acute effects: Increased beta power (Fink et al., 1969), decreased alpha power and increased delta power for high doses (Saletu et al., 1983).
Long-term effects: Unknown.

ANTIPSYCHOTICS

Acute effects: Overall increase of power across frequency bands (Knott et al., 2001). Decreased gamma power (Jones et al., 2012). Possible increase of epileptiform activity (Olanzapine; Amann et al., 2003).
Long-term effects: Decreased alpha and beta power, increased delta and theta power (Knott et al., 2001; Gross et al., 2004).

ANTICONVULSANTS

Acute effects: Increased delta and theta power (Herkes et al., 1993; Salinsky et al., 2007).
Long-term effects: Decreased alpha peak frequency and increased delta and theta power (Knott et al., 2001; Gross et al., 2004).

ALCOHOL

Acute effects: Increased delta and theta power (Little, 1999).
Long-term effects: Decreased delta and theta power, increased beta power (Coutin-Churchman et al., 2006).

CANNABIS

Acute effects: Increased alpha power (Lukas et al., 1995). Decreased power and connectivity in frequencies below 30 Hz, increased gamma power (Nottage et al., 2015).
Long-term effects: Increased frontal alpha power and alpha coherence, decreased alpha peak frequency (Struve et al., 1989; 1994; 1999) decreased posterior alpha power (Herning et al., 2008) and decreased gamma power (Skosnik et al., 2012).

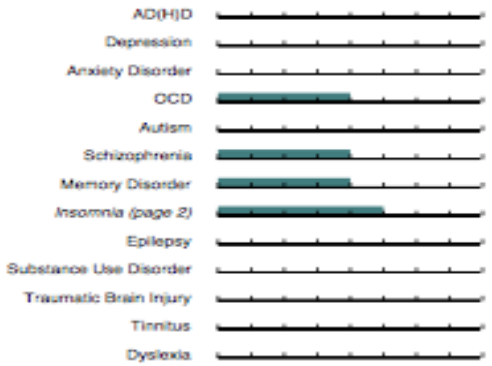
OPIATES

Acute effects: Increased delta and theta power, decreased alpha peak frequency (Volavka et al., 1970; 1974).
Long-term effects : Increased delta and theta power, decreased alpha peak frequency (Shufman et al., 1996).

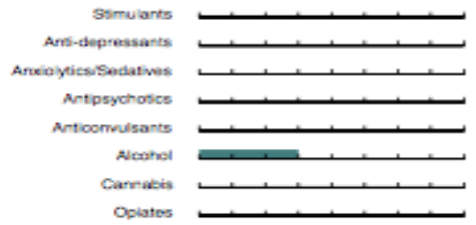
QEEG Informed Protocol Recommendation

EEG ID: 885766
Age: 55.9, Gender: Female,Eyes Closed

Psychopathology Rating



Substance Use



Recommended protocols have been determined for the disorders printed in italics.

General Information

Input EEG: 885766

EEG recorded on: 08-Sep-2023
Protol recommendation processed on: 18-Nov-2023 09:28h

MONTAGE: Linked Ears

SUBJECT INFORMATION:

EEG ID: 885766
Age: 55.9
Gender: female
Handedness: right
Condition: Eyes Closed

ARTIFACT REJECTION/CORRECTION RESULTS:

Noisy channels:
High frequency artifacts will be ignored in these channels.
Percentage rejected data: 2%
(High percentages indicate bad data quality)
Record length: 5:11
Edit length: 5:04

Relevant EEG Biomarker Overview

Delta excess
(Schizophrenia/Memory/Epilepsy)
NO

Theta excess
(ADHD/OCD/Schizophrenia/Memory/Tinnitus)
NO

Alpha excess
(ADHD/OCD/Autism)
YES

Alpha deficit
(Anxiety/Schizophrenia/Memory/Tinnitus)
YES

Beta excess
(ADHD/Anxiety/Schizophrenia/Sleep/Tinnitus)
YES

Beta deficit
(ADHD/Memory)
YES

Gamma excess
(Sleep/Tinnitus)
YES

Gamma deficit
(Schizophrenia)
YES

Low voltage
(ADHD)
NO

Low Alpha peak frequency
(ADHD)
NO

Frontal Alpha Asymmetry
(Depression/Anxiety)
NO

WHAT IS NEUROFEEDBACK?

- Neurofeedback is a type of biofeedback, sometimes referred to as EEG biofeedback. . While biofeedback measures and records certain physical functions (e.g., hand temperature, muscle tension, heart rate variability, etc.), neurofeedback measures and records brainwave activity..
- For treatment, sensors are placed on the scalp that records the brain's activity measured in brainwaves.
- We then use these findings to create a custom-designed neurofeedback treatment protocol to address the patient's unique needs and symptoms.
- Throughout treatment, patients will learn how to produce desired neurophysiological changes to improve control of their health and mental functioning.

NFB AND INSOMNIA

Neurofeedback research has shown that:

- uptraining Sensori-Motor Rhythm (SMR) localized at the sensorimotor cortex (12-15 Hz in C3, Cz, C4) CLASSIC NFB, and
- regulating Slow Cortical Potentials (SCPs)

is effective for treating insomnia (Arns et al., 2014).

Uptraining SMR results in decreased sleep latency (Hoedlmoser et al., 2008)

and increased total sleep time (Cortoos et al., 2010; Hoedlmoser et al., 2008). Uptraining SMR also results in increased sleep spindle density during sleep (Hoedlmoser et al., 2008; Sterman et al., 1970), presumably the result of the spectral overlap between SMR and sleep spindle activity.

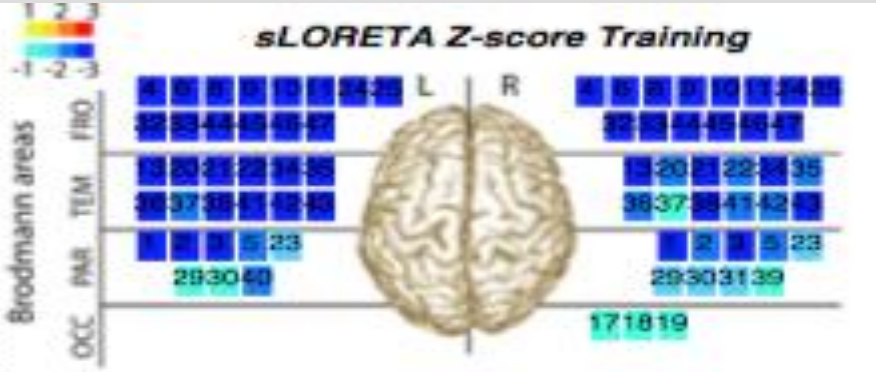
OTHER PROTOCOLS FOR INSOMNIA

- Beta 2 (19-30 Hz) down (inhibition) → reduce alertness
- Alpha (8-12 Hz) up (enhancement) → promote relaxation

NFB PROTOCOL: BETA DOWN ON C4

Recommended Protocol, Classic Neurofeedback

1st: 20-22 Hz Down on C4
Reward percentage: 60%
Sustained reward criterion: 300 ms



Recommended Protocol, Z-score Training

Locations: FP1 FP2 C3 C4
Excess beta activity found on C4 at 21 Hz

	Delta	Theta	Alpha	loBeta	Beta	hiBeta	Gamma
Frontal	L	R	L+R			L	L+R
Temporal			L+R			L	L+R
Parietal		L+R	L+R			L	L+R
Occipital			R				

Scientific Support

Specificity

Degree Of Deviance

Data Quality

Scientific Support:
The level of Scientific Support is determined by the current scientific status of neurofeedback treatment of the diagnosis to treat and the level of agreement between the EEG results and the symptoms of the patient.

Specificity:
Deviant activity can have a broad or narrow distribution across frequencies and electrode sites. Moreover, the relevant deviant activity can be accompanied by other distinct deviant EEG measures.

Degree Of Deviance:
The more extreme the z-score of the relevant deviant activity, the higher the Degree Of Deviance.

Data Quality:
The percentage rejected data, the detection of bad channels and the total artifact free recording time contribute to the level of Data Quality.