VALIDATION OF OMEGAWAVE´S TECHNOLOGY FOR ASSESSING INFRA SLOW BRAIN ACTIVITY (DC POTENTIAL)

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INTRODUCTION

Direct Current potential (DC potential), is a type of **Infra Slow Brain Activity** (ISBA) registered in the frequency range 0-0.5Hz. ISBA plays a significant role in maintaining the brain's level of cortical excitability and overall dynamism, and it reflects changes in the brain's energy metabolism (changes which are linked to levels of arousal and an ability to execute specific actions). This brain activity corresponds to the dynamic nature of prefrontal oxygenation as it is modulated by incremental exercise, rising in turn between moderate and hard intensities (*Ilyukhina, 2011*).

In the realm of athletic training, DC potential is used as an indicator of the brain's available energetic resources, reflecting the athlete's level of central nervous system (CNS) readiness to perform *(Moskovchenko, 2011).*

Low levels of DC potential (<9mV) indicate a decreased level of arousal, a more rapid onset of psychological and physiological exhaustion, instability and greater lability in the nervous system, and a diminished capacity for adaptation. Low levels of DC potential negatively influence athletic readiness.

Mid-range levels of DC potential (9-44mV) indicate an optimal level of arousal, an adequate ability to respond to any endogenous and exogenous stressor, and the potential for high levels of performance.

High levels of DC potential (>44mV) indicate a high level of emotional and psychological tension, with an inadequate ability to respond to endogenous or exogenous stressors. This level indicates psychological or physiological overloading, a high threshold for adaptive reactions, and lability of nervous processes. High levels of DC potential negatively influence athletic readiness.

STUDY GOAL

This study aimed to validate DC potential registered by the Omegawave mobile technology and to demonstrate that this activity has the same properties as the medical industry-standard reference device Mitsar-202-EEG for recording ISBA in the frequency range 0-0.5Hz.

METHODS

Subjects

31 healthy, right-handed adult male volunteers, each engaging in physical activities at least 3 times per week were recruited. The participants in the group had a mean age of 30 years.

Each participant satisfied all requirements in a volunteer screening, and approved to take part in the study by signed agreement.

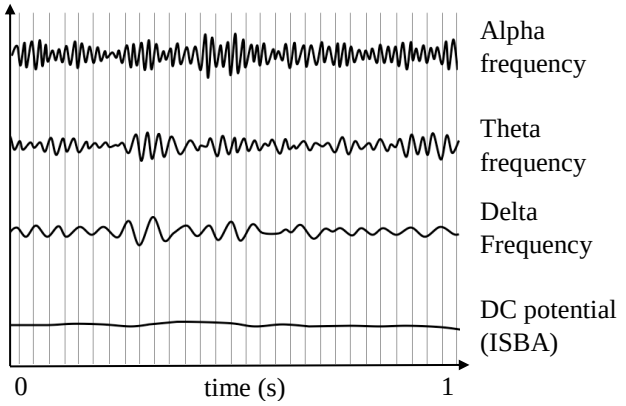

FIGURE 1. Electrical activity of the brain.

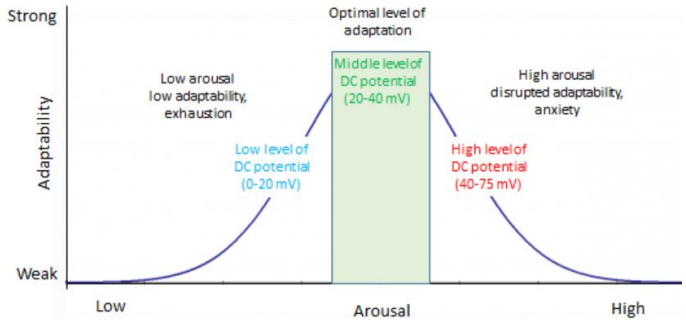

FIGURE 2. DC potential and adaptability relation.

FIGURE 3. 10-20 EEG setup via Mitsar-EEG 202 amplifier and vertex-thenar DC setup via Omegawave.

FIGURE 4. Omegawave technology showing athlete`s readiness.

FIGURE 5. Omegawave Bluethooth sensor, strap and electrodes.

Study design

Registration of ISBA activity was carried out simultaneously in two different settings: 1) Using silver chloride electrodes with Omegawave equipment on the forehead and on the thenar (of the right hand) and 2) With the use of the clinical electroencephalograph Mitsar-202-EEG (produced by Mitsar Ltd). Electrodes for the Mitsar were placed on the scalp at the frontal lobe using clinical electro-gel and on the thenar (of the right hand). The scalp was prepared using alcohol and an abrasive skin prepping gel (Nuprep, USA) to de-grease the participants' skin and increase electrical conductivity. A 19-electrode cap was attached to the head for simultaneous registration of the brain's electrophysiological response to a breath-holding test.

Data processing

The analysis consisted of the following stages:

1. Artifact correction and elimination: a) Using a spatial filtration technique based on zeroing the activation curves of individual Independent Component Analysis corresponding to horizontal and vertical eye movements and b) Excluding epochs with excessive amplitude of EEG and excessive faster and slower frequency activity.
2. Fast Fourier Transformation was used for signal processing with MatLab, including computation of power spectra for each condition.
3. All data are presented in graph and number format and can be acquired upon request.

Results

1. The DC potential registered by Omegawave´s technology showed the same properties as ISBA signals in the frequency range 0-0.5Hz obtained by medical device Mitsar-EEG-202.
2. The amplitude varies from subject-to-subject, reflecting individual properties of brain energy metabolism *(Fokin & Ponomareva, 2003)* and Default Mode Network *(Jeffrey et al, 2011; Qian, et al, 2015)* reactivity.
3. In addition to amplitude, the time needed to achieve the peak after an artificial stressor was imposed (breath holding) also reflects the organism's reactivity to stress. The time needed to achieve the baseline after a stress reaction indicates the level of the central nervous system´s lability.

Conclusion

The study has found that the Omegawave technology correctly registers DC potential data from the frontal lobe of the brain. This data may be used to assess individual stress response, and is therefore also suitable in assessing an individual´s central nervous system´s readiness to perform mental and physical activities.

References

- *Ilyukhina, V.A. Continuity and prospects of research in systemic integrative psychophysiology of functional states and cognitive activity. J. Hum Physiol. 2011. 37: 484.*
- *Moskovchenko O.N. Assessment of athletes' adaptability using hardware-software complex "Omega". Theory and Practice of Physical Culture. 2011. V.7. 73-77.*
- *Fokin, V.F. Ponomareva V.F. Energy physiology of the brain. Moscow, 2003.*
- *Anderson J.S. et al. Connectivity Gradients Between the Default Mode and Attention Control Networks. Brain Connectivity. 2011;1(2):147-157.*
- *Qian L, et al. Frequency Dependent Topological Patterns of Resting-State Brain Networks. 2015. PLoS ONE 10(4)*

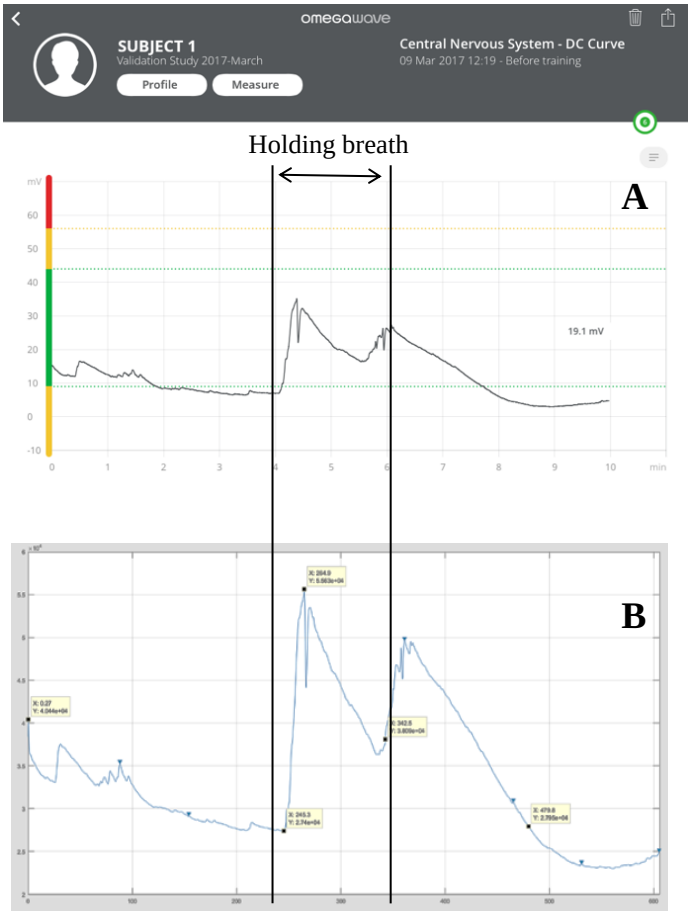

FIGURE 6. Subject 1 – DC Potential data during breath holding test.

A – DC potential obtained by Omegawave device
B – DC potential obtained by Mitsar-202-EEG

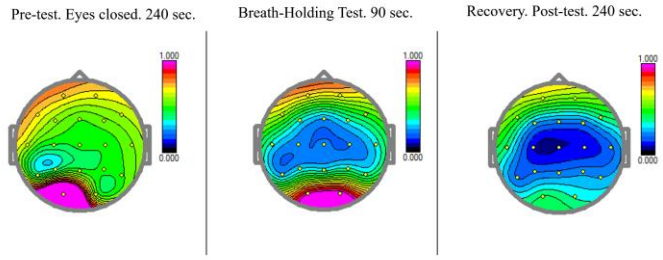

FIGURE 7. Distribution of ISBA activity on the scalp before, during and after breath holding test reflects the same pattern of activity.