2011 International Conference on Food Engineering and Biotechnology
IPCBEE vol.9 (2011) © (2011)IACSIT Press, Singapore

EEG Brainwaves Synchronization Comparison between Electrical Engineering and Sports Science Students: Pre and Post Horizontal Motion Intervention

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Abstract. The purpose of this research is to compare the brainwave patterns between Electrical Engineering students (EE) and Sport Science students (SS) of Universiti Teknologi MARA using Electroencephalogram (EEG) before and after undergoing five sessions of Horizontal Rotation (HR) procedure. EEG signals were captured from 21 EE, 21 SS participants and the signals were filtered, classified into the four frequency bands, and analyzed using paired T test. It was observed that, before HR, EE had higher brainwave synchronization compared to SS for all frequency bands. However, after 5 sessions of HR, SS had overtake EE in three out of four frequency bands namely for Delta, Alpha and Beta. Furthermore, Both EE and SS showed improvement in brainwave synchronization after HR implying existence of evidence that HR could balance brainwaves.

Keywords: EEG, Horizontal Motion, Brainwave Synchronization

1. Introduction

Researchers have shown that balance thinking which directly or indirectly comes from the brain may lead to a balance lifestyle for a healthy and happy life; consequently, improve productivity and socioeconomic of the country. The aim of this research is to compare the effect of HR on brainwave balancing between EE and SS using EEG. This research has been approved by UiTM ethics Committee.

1.1. The Brain and Brainwave

The brain cells are known as neurons and scientists estimated that a normal adult human brain consists of one hundred billion neurons and each neuron is connected to another two hundred fifty thousand other neuron. Thus, like a Central Processing Unit (CPU) to a computer system, the brain employ parallel distributed processing simultaneously across billions of neurons distributed throughout the brain [1],[2].

Neurons are very complex electrochemical system and when activated, able to generate electrical activity represented in terms of waves. Brainwaves are normally categorized into four groups known as Delta, Theta, Alpha and Beta frequency bands [2-4]. Table 1 shows detail of the brainwave frequency band and its relation to the amplitude and frequency.

1.2. Left- Right Brain Hemispheres

Roger Wolcott Sperry (1913-1994), an American scientist and a professor of psychobiology, was a Nobel price winner for his discoveries relating to the functional specialization of the cerebral hemispheres on split brains [6]. He showed that a conscious mind exists in each hemisphere. The left hemisphere is dominant in activities involving language, speech, arithmetic, and analysis whereas the right hemisphere is superior in perceiving, thinking, remembering, emoting and understanding as shown in figure 2 [4], [6], [7]. The discovery of the left and right brain function opened completely new fields of brain research, and in particular, new generations of researchers are working towards brain balancing.

Table 1: Brainwave Level

Brainwaves	Freq (Hz)	Amp (μv)
Beta	13-40	Lowest
Alpha	8-12	Low
Theta	4 -7	High
Delta	0.1 - 3	Highest

Table 2: Left and Right Brain Functions

Left Hemisphere Capabilities	Right Hemisphere Capabilities
Logical and Sequential Operations	Analytical and Conceptual Operations
Communication Skills	Orientation and Awareness Skills
Comprehension & Learning Skills	Performing Complex Physical Tasks
Processing of Experiences	Technical Skill for Precise Physical actions

1.3. The Importance of Balanced Brain

A renowned psychiatrist and Harvard Medical School alumnus, Dr Paul Sorgi enforced in his book "The 7 Systems of Balance: A Natural Prescription" that balance brain (thinking) will lead to balance lifestyles that ultimately produces a sense of well being, happiness, relax, healthy, satisfied and able to interact well with others [8], [9]. Researchers have shown that living in balance leads to a longer and healthier life. The importance of balance brain is massively understood and agreeable. However, one question arise is how to achieve balanced brain?

1.4. Brainwave Balancing Methods and Horizontal Rotation (HR)

Researchers have discovered many methods to promote brain balancing. Some of the modern methods are known as auditory (binaural beat, music, natural sound), visual (BCI, dream machine, mind machine, color/light flashes, pictures), transcranial magnetic or electric stimulation and biofeedback which is also known as Neurofeedback or neurotherapy. Other method are more traditional for example massages (reflexology, acupressure, craniosacral therapy) Herbal Intake, meditation (yoga, harmonization) and acupuncture.

Although these methods are widely used, there is an increasing concern that some if these methods exhibit significant problems to the users in particular. Therefore, it is essential to explore a new procedure, for example, HR as an alternative technique for brain balancing.

Michael Hutchison describes in his best-selling book, "Mega Brain Power: Transform Your Life with Mind Machines and Brain Nutrients" that another method for enhancing the brain is physical movement, particularly spinning [21]. Motions is a nutrient for the brain and body, and if one is consistently fail to meet the minimum daily requirement, one become susceptible to chronic health problems [21]. HR is a motion system that employs physically spinning the participant on horizontally rotating platform that stimulates the fluids in the inner ear, known as the vestibular system, thus, sends electrical impulses into cerebellum and continuously into the rest of the brain [21]. Motion also causes the body fluids, including cerebrospinal fluid, blood, and lymph to move about and providing an efficient form of neurological "exercise" for the nervous system [21]. In HR Magnetic Mechanics, Piezoelectric Mechanics and Electrofield Mechanics theories were applied to achieve brain balancing and overall enhancement of one's physical and mental capabilities and performances.

2. The Experiment

Experiments were performed at Biomedical Research and Development Laboratory for Human Potential, Faculty of Electrical Engineering, block 4, level 7 and room 1 (B4-7-1), Science and Technology Building University Teknologi MARA. The objective of this research is to investigate and compare the brainwave patterns of electrical engineering students (EE) and sport science students (SS) of Universiti Teknologi MARA using EEG. EEG data was gathered from 42 healthy participants of whom 21 from EE (9 male and 12 female, age 21 to 26 years) and 21 from SS (11 male and 10 female, age 18 to 26 years).

2.1. EEG Data Acquisitions

Figure 1 shows the EEG data acquisition procedure. The EEG system consists of electrodes with conductive paste, amplifiers with built in filters and 16-bit analog to digital Converter, sampling rate of 256 Hz and a computer. The EEG is captured using 2 channels bipolar connection with electrodes connected to both ear lobes and left and right side of forehead. Channel one captured the right brainwave while channel

two for the left side. The impedance of all electrodes is maintained below 5 kΩ with impedance checker to ensure proper connection between electrodes and scalp.

Fig.1: EEG Data Acquisition Procedure

2.2. The Experimental Procedure

The experimental procedures were performed closely to ensure accuracy and consistency of the EEG data, as follows:

i. Participant registered and signed the consent form.
ii. Participant sat on a comfortable chair with headrest and relaxed.
iii. His / her skin on the forehead and ear lobes was cleaned with nonabrasive alcohol to remove dirt and dead cells for better contact.
iv. The electrodes with conductive paste were connected properly as mentioned in 2.2.
v. At this point, the participant was asked to relax again and close eyes (but not sleep). This is to avoid artifacts from eye blinking and to assure that the dominant brainwave is Alpha since Alpha is the signatory brainwave of an individual [3], [8], [9].
vi. EEG image was captured and stored in the same computer for offline analysis.

2.3. EEG Analysis

Figure 2 shows the flow diagram for the analysis of EEG: The raw data was classified into four different frequency bands: delta (1-3Hz), theta (4-7Hz), alpha (8 12Hz) and beta (13-40Hz). Thus, average values were calculated and graphs were plotted for each frequency band. Furthermore, paired T test was used to calculate the correlation between left and right brainwaves and graphs were plotted to compare the left-right correlation between the two groups.

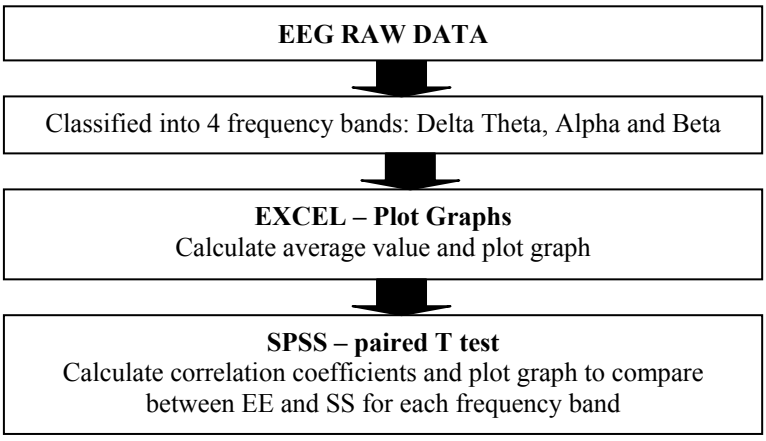

Fig. 2: Flow Diagram for the Analysis of EEG

3. Results and Discussions

Figure 3 shows the average left-right correlation plot between EE and SS for all frequency bands before HR while Figure 4 shows left-right correlation after HR. To summarize, Figure 5 shows the overall (EE and SS combined) left-right correlation before and after five sessions of HR. From Figure 3, it is obvious that before HR, EE brainwave correlation is higher than SS for all frequency bands. However, after 5 sessions of HR, SS had overtaken EE in three out of four frequency bands with increment of 3% for Delta, 8% for Alpha and 17% for Beta. Nevertheless, EE maintain superior with 19.5% higher for Theta band. The overall

correlation values increases for all frequency bands after five sessions of HR (Figure 5). Highest increment is for Delta with the value of 37% while the lowest increment is at 6% for Theta. Thus, after HR, brainwaves are more synchronized for all frequency bands implying in general the brainwaves are more balanced.

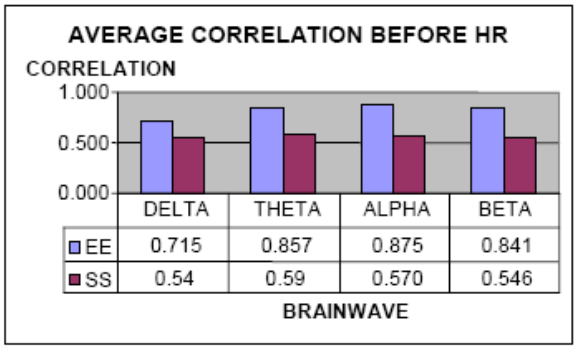

Fig. 3: Average Left-Right Correlation between EE and SS before HR

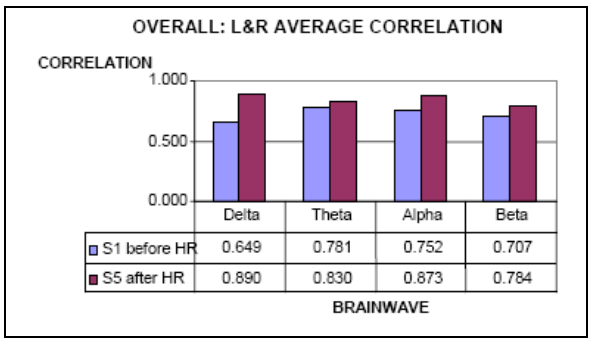

Fig. 4: Average Left-Right Correlation between EE and SS after HR

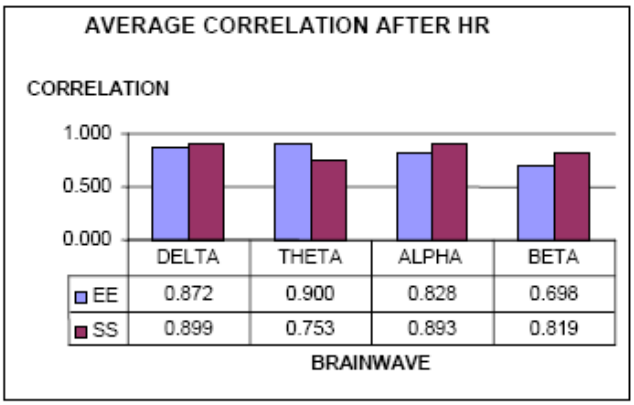

Fig. 5: Overall Left-Right Correlation before & after five sessions of HR

4. Conclusion

The results from this experiment proved that brainwaves were more synchronized for both EE and SS and for all frequency bands after five sessions of HR. Additionally, SS group benefited more than EE from HR. There were indications that the brainwaves were in a more relaxed and calmed condition for all frequency bands after HR. Further investigations could probe into the effect of reducing stress after HR.

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