The Effects of Neurofeedback on Event Related Potential (ERP) in Zikr Meditation

Nur Arina Ayuni Helman and Muhamad Kamal Mohammed Amin(✉)

Bio Cognition Laboratory, Bio-Inspired System and Technology iKohza (Research Group), Malaysia-Japan International Institute of Technology (MJIIT), Universiti Teknologi Malaysia (UTM), 54100 Kuala Lumpur, Malaysia
nurarinaayuni24@gmail.com, mkamalma@utm.my

Abstract. The study of human brain activity using electroencephalogram (EEG) is a growing multidisciplinary field that links electronics, psychology and cognitive science to learn the effect of human brainwave activities in various fields e.g. meditation. In this research, an experiment is performed to compare the EEG-Alpha rhythm between Zikr meditation and listening relaxing music. The hardware use is the EMOTIV EPOCH Neuroheadset of 16 electrode channels. The investigation are focused on the Electroencephalography (EEG) signal for exploring the relativity of attentional control by observing Topographic Map through Event Related Potential (ERP) analysis to see whether the brain experience any changes. Then, Power Spectrum Density (PSD) through Auditory Evoked Potential (AEP) analysis is recorded to see the different in each of brain lobes. The effect of the EEG spectral analysis on neurofeedback relaxation technique is also been observed. The results were observed from the frontal lobe and the average alpha power in the region is obtained. Comparison of the experiments works were carried out to observe the relaxation states of the subject while listening to Zikr and the relaxing music. Results from 5 subjects shows that 90% of the subjects' alpha wave was dominant to Zikr. From the result, 4 out of 5 students tend to have better relaxation when listening to Zikr thus proving that the participants are much more relax after listening the Zikr.

Keywords: EEG Alpha rhythm · EMOTIV · Zikr meditation

1 Introduction

Stress is a major problem. Cluster of work or life demand give some impact on people daily life include daily hassles or tense. Thus, it can associate with many health problems. World Health Organization (WHO) believes that by year 2020, stress at the workplace problem will become a major threat. Moreover, according to global workplace provider Regus's latest online survey, 70% of Malaysian workers are reporting more stress-related illnesses due to financial problem. Therefore, one of the techniques in reducing stress is using music meditation [1].

For this study, the method used to reduce the stress is zikr meditation. Zikr is used in this study as it has been guided through many verses of Al-Quran e.g. Surah Al-Mulk, verse (67:23), Allah Almighty said "He is the One who has originated you, and

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made for you the ears and the eyes and the hearts. How little you pay gratitude". Thus, the meaning of this verse can be related to the human senses categorized as five types, which are to see, hear, taste, smell, or feel something. Therefore, it has been hypothesized that unique psychological mechanisms by practice to hear any sound can improve well-being for the development of attentional control [2].

Neurofeedback is specializing to train people to gain control over electrophysiological process in the human brain [3]. It also uses information from EEG to show the trainee current pattern in subject's cortex [4]. According to LaVaque [5], neurofeedback used baseline EEG to identify the abnormal patterns. Thus, it mainly uses as therapeutic tool to treat different types of disorder for example attention deficit hyperactivity disorders [6]. In this paper, the Power Spectral Density (PSD) was obtained from the brainwave. The brainwave consists of alpha, theta, gamma, beta and delta. Each wave had its own characteristics. As for alpha, it correlates with healing condition and relaxation [7]. The brainwave was recorded by using EMOTIV EPOCH neuroheadset [8].

In addition, an event related potential (ERP) study [9] and some functional magnetic resonance imaging (fMRI) studies [10]; [11] provided evidence for neural reserve and neural compensation in normal aging. ERP reflects instantly the summated excitatory postsynaptic potential (EPSP) and inhibitory postsynaptic potential (IPSP), primarily of pyramidal cells in the neocortex [12]. The high temporal resolution of ERP enabled the understanding of the neural correlates of cognitive processing and functioning. Our study implemented ERP to investigate the effect of Zikr meditation and relaxing music from both the magnitude of neural activation and the topographic map.

2 Methods

2.1 Participants

In this experiment, there are three male subjects involved ages ranging between 22 and 24 years old. The subjects with short hair are considered for better attachment of electrodes and they also need to be ensured that they did not put any gel or wax to their hair. This is to prevent any interruption while the data is collected. All of them are free from any disease and medication.

2.2 Experimental Procedure

The experiment as conducted at room temperature (27 °C) with air conditioning. Subjects will be instructed to sit comfortably and relax before the start of the procedure. Then the students will be instructed to rest for 2 min and listen to the Zikr meditation from Asma Ul-Husna for another 2 min by using headphones with closed eyes. After listening to the Zikr is completed, they continued to listen to the slow rock music for another 2 min. Therefore, the total amount of time taken for data collection is 8 min.

Before start the experiment session, the participants need to fill up the consent form for their approval to use their data for this experiment. They also need to give their signature after they read the form to ensure they clearly understood the information

provided. Their data will be kept strictly confidential to ensure their data not been exposed.

In order to obtain consistent data, the subject rested for 1 min before listening to the next stimuli. The subject has also been advised to sit comfortably and to close their eyes to ensure a decrease in noise recorded that could affect the data collection. The video of the auditory stimuli was recorded using the CAMTASIA 9. This software can also record the movement of the subject during the collecting data. At the same time, the raw data were recorded by using the Emotiv Epoch System version 2.0.0.20-PREMIUM as shown in Fig. 1. The component of Emotiv Epoch System version 2.0.0.20-PREMIUM set consists of the saline solution, headset, Bluetooth device and a USB cable for charging. Basically, the headset consists of 2 reference channels and 14 channels. The channels are AF3, AF4, F3, F4, F7, F8, FC5, FC6, T7, T8, P7, P8, O1 and O2.

The brain area that we are focusing on in this experiment is the frontal area which covered up to 10 channels from 14 channels but only 4 channels is use which are F3, F4, F7 and F8 for collecting the data. The brain waves recorded appears in a group of colored waves. The data is saved for 8 min during a listening session. Each data saved has their own ID number starting from 001 until 005. Since the saved EEG raw data is in .edf format, we converted it to the excel format first before starting the analysis because we are using the MATLAB software which is supported by Excel format applied by EEGLAB.

Fig. 1. The Emotiv EPOCH Neuroheadset

Firstly, we imported the raw data from the Excel into the.mat format through the MATLAB software. After that, we filtered the wave data by applying the Fast Fourier Transform (FFT). The sampling rate is 128 samples per second with the EEG frequencies of 128 Hz and the sampling unit of a microvolt (uV). For the extraction of the band waves, we used the range of frequency 0.625–3 Hz for delta waves, 4–7 Hz for delta waves, 8–13 Hz for alpha waves and 14–30 Hz for beta band waves. The strength of the wave bands is measured in microvolt (μV). Finally, we plotted the waves with correct labeling and title.

2.3 Software

2.3.1 Camtasia 9

Camtasia 9 is video editor created by TechSmith to record the stimuli and the setup program for the whole process via screencast for the further purpose of EEG acquiring system. The experiment was designed in Camtasia using Camtasia 9 software. Two types of auditory stimuli are used for this experiment which consists of Zikr meditation of Asma Ul-Husna and slow music titled as Photograph from Ed Sheeran, which are compiled in one experiment. Both are slow music.

2.3.2 Emotiv Testbench

Emotiv Testbench software came with Emotiv Epoch headset to run as an acquiring system of EEG data. This software shows the sampling rate of 128 samples per second. It also displays battery status which represents the battery of the headset if it is fully charged or not. The Emotiv testbench panel presents the EEG raw data obtained from the experiment session. The EEG raw data obtained by the Emotiv Testbench were saved in .edf format.

2.3.3 MATLAB - EEGLAB Toolbox

To extract the data acquired from the EEG Testbench which is in.edf format, EEGLAB tool was used. EEGLAB is the toolbox in MATLAB that can be downloaded online and it can process EEG, MEG and another type of electrophysiological data. For the extraction of the band waves, we used the range of frequency 8–13 Hz for alpha waves only for this experiment because previous study state that the alpha wave contains the most power amongst delta, theta, alpha, beta, and gamma identified in the brain [13]. The alpha rhythm has been found to be a marker of spontaneous cell firing which occurs during inactivity [14]. The alpha rhythm disappears when the eyes are opened and during concentrated attention when the eyes are closed [15].

3 Experimental Results

3.1 Event 1: Silent

See Figs. 2 and 3.

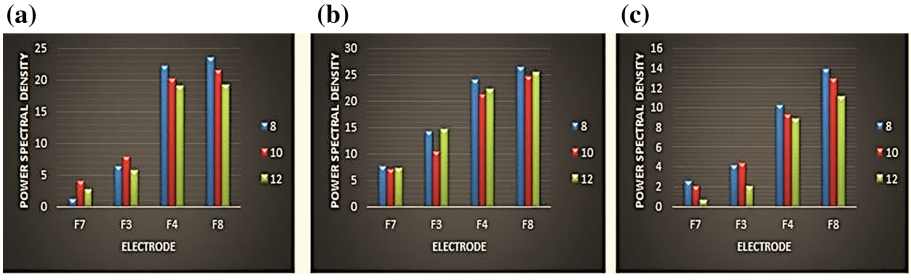

Fig. 2. (a) PSD value of repetition 1. (b) PSD value of repetition 2. (c) PSD value of repetition 3.

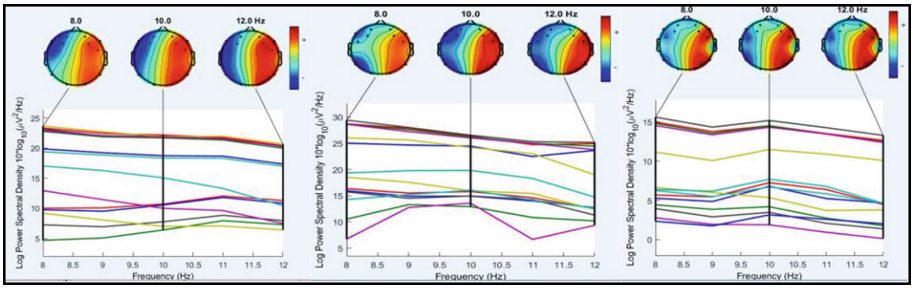

Fig. 3. Topographic map of Event 1.

3.2 Event 2: Zikr

See Figs. 4 and 5.

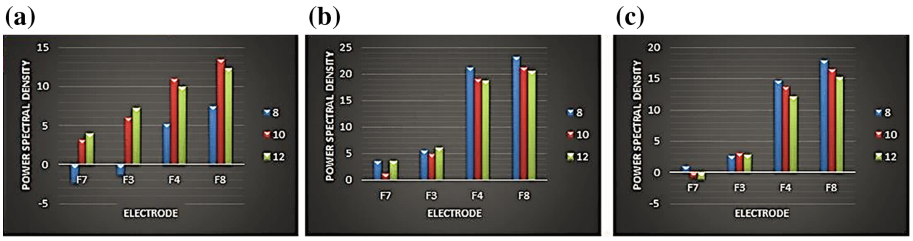

Fig. 4. (a) PSD value of repetition 1. (b) PSD value of repetition 2. (c) PSD value of repetition 3.

3.3 Event 3: Relaxing Music

Alpha waves were detected by EEG and predominantly originate from the brain lobe with closed eyes. When high alpha band was observed during the session, the participant is considered relaxed and calm but low alpha band shows that the subject is excited during the session. Thus, it proves that Zikr meditation can lead a person to relaxation but it all depends on the individual itself. Among the frontal lobe, the right frontal F8 chose to give out high alpha thus proving that it involves focus and attention (Figs. 6 and 7).

The mean value of Alpha band combining the left and the right brainwaves for Zikr and relaxing music were shown in Fig. 8 respectively. The highest alpha wave silent, follow by zikr and music. Thus, zikr create more relaxation to subject. Subject 4 was at relaxed state during the experiment session because he had the highest alpha wave during listening to no sound music. Subject 5 had the highest alpha wave value for zikr among others subject. Thus, it shows that subject 5 more attracted to Zikr for relaxation.

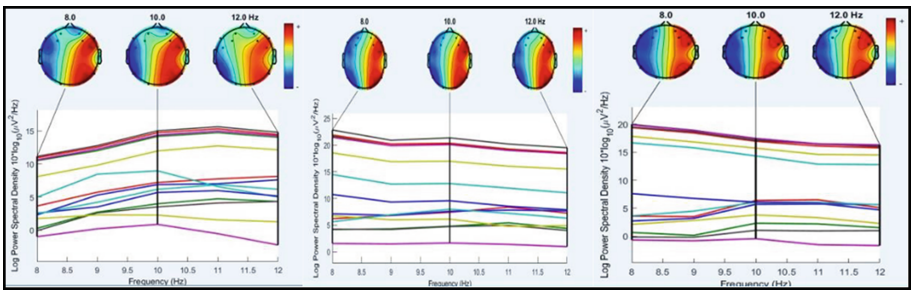

Fig. 5. Topographic map of Event 2.

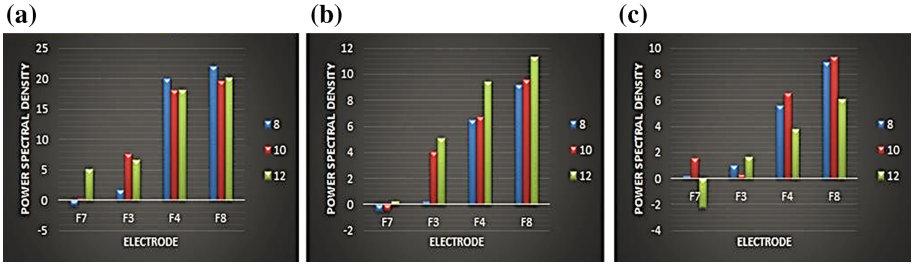

Fig. 6. (a) PSD value of repetition 1. (b) PSD value of repetition 2. (c) PSD value of repetition 3.

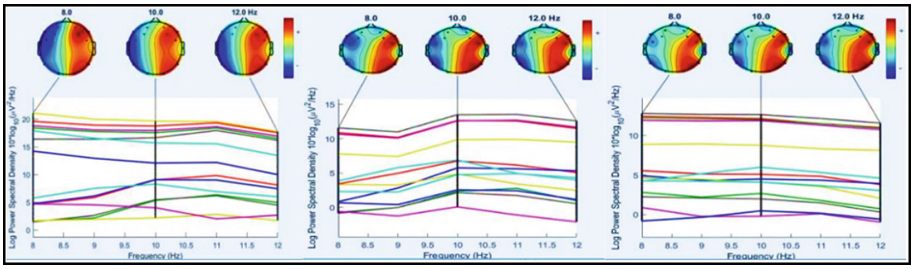

Fig. 7. Topographic map of Event 3.

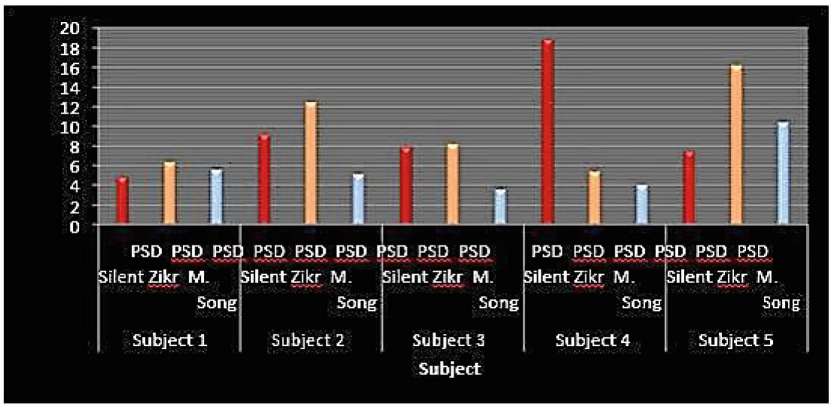

Fig. 8. Summarization of alpha power from both Zikr and relaxing music of five subjects.

4 Conclusion

By conducting this study, the effect of listening to music and Zikr on the brain wave signal was found using AEP test. After analyzing the data for each of the subject, the result shows that, 4 out of 5 students tend to have better relaxation when listening to Zikr. Thus it proved that the participants were relaxing more after listening to Zikr. The result also demonstrate which section of brain that produce more alpha wave which in this experiment, right side of brain produce greater alpha wave than the left side of the brain. This study suggests that listening to Zikr meditation can be considered as a method to gain relaxation, release tension, relives boringness and release stress beside listen to music.

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