NEUROIMAGING ELECTROENCEPHAHLOGRAPHY (EEG) APPLICATION ON HUMAN ELECTRICAL BRAIN ACTIVITIES DURING MEDITATION AND MUSIC LISTENING

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ABSTRACT: Meditation has a positive impact on the life of human beings. Researchers have scientifically measured and reported the positive impact of meditation from various neuroscience and neuroimaging technology such as encephalogram, fMRI, ECG, etc. Therefore, the neurophysiological EEG was used to identify the brain activities after listening to Zikr and compared it to music listening. Five healthy students as subjects were instructed to listen to the Zikr meditation from Asma Ul-Husna and slow rock music. A low-cost 16 electrodes of Emotiv Epoc was used to record the brain waves activities and determined its location in the brain lobes. Statistical analysis by using FFT from the MATLAB EEGLAB Toolbox software was performed to obtain and analyzed the data. The analysis result showed that the right frontal F8 give out high alpha and beta value thus proving that it involves focus and attention. 85% of the lobes involved give out low beta band during listening to Zikr meditation which indicates the person to focus more during Zikr listening session. Hence, Zikr meditation can lead a person into a calmer state when compared to music listening.

KEYWORDS: *Zikr Meditation; Electroencephalography (EEG); Emotiv EPOC; Alpha; Beta*

1.0   INTRODUCTION

The brain activities determines the behaviors and feelings of human, thus by understanding the brain activities when listening to any audio stimuli will be an effective way to reveal the people's affective feelings [1]. Therefore this research is focused on how electroencephalography (EEG) signals can be affected during listening to Zikr meditation by comparing with slow music. Different neuroscience states and physiology can be done by using this method as EEG offers the capability to analyze the brain activity, as it can measures the electrical activities of the brain directly from the scalp which is rich with information on mental activities and emotional states [2]. Apart from known as one of non- invasive procedures, EEG also offers high temporal resolution and the recording session for measure the EEG has no risk or no limitation which can affect the patient and normal people [3]. In past research, music and Quran are claimed to be the best therapy in reducing stress as it can lead someone into relaxation states. Thus, Zikr is used because Zikr is one of the methods for meditation that related with Quran recitation [4].Therefore, the research aims to assess this challenge as a non-clinical therapy benefits for self-regulatory.

Specifically, the target is to accomplish the following: first, to investigate the challenges by observing an electroencephalogram (EEG) recording on listening to Zikr and slow music; second, to observe the brain wave and its effect on the human body and mind; and lastly, to prove that Zikr meditation can lead someone into a state of relaxation and tranquility. Even the Zikr meditation is done in few minutes but it can give more relaxation and alert the feelings of the person meditation. Previous researchers have investigated the effect of EEG signals on various events, such as meditation and listening to music. Thus, the results on the studies claimed that the practice of listening to the Qur'an can help a person relax for Muslims and listening to music for non-Muslims [5] but there must be some differences that can identify between these two methods, Zikr and music [6] . Therefore, in this article, the research is observing the effect of listening to Zikr meditation on EEG signals and the activity of the brain lobes. In order to strengthen the findings, the result will be compared with slow music. The challenge of this research is the appearance of noise due to muscle movements, as well as the heartbeats which can potentially interfere the result of the outcome [7]. The effectiveness of the research is the use of Zikr as the audio stimuli for meditation which can give more relaxation after the meditation to human mind.

This kind of therapy can help the user make the best choice in reducing stress as it is less time consuming and does not require much money. Electronic systems engineering is a wide-ranging engineering field that includes many sub-fields including those that deal with the instrumentation of engineering, power, telecommunications, semiconductor circuit design and others. For example, the device used for obtaining the EEG signals need a related circuit before it can extract the wave for EEG, and so, without the innovation of the electronic system engineering, the device might not have be used.

2.0   METHODOLOGY

In Figure 1, the description of the flowchart of the whole process for collecting the raw data started with given informed consent form to 5 male participants who involved in this research. Their details will be kept confidentially. The reason only male involved because the subjects with short hair was considered for better attachment of electrodes to their scalp. They also been told to not put any gel or wax on their hair. This is to prevent any interruption during the recording session. The experiment was conducted at room temperature (22 °C) with air conditioner [8].
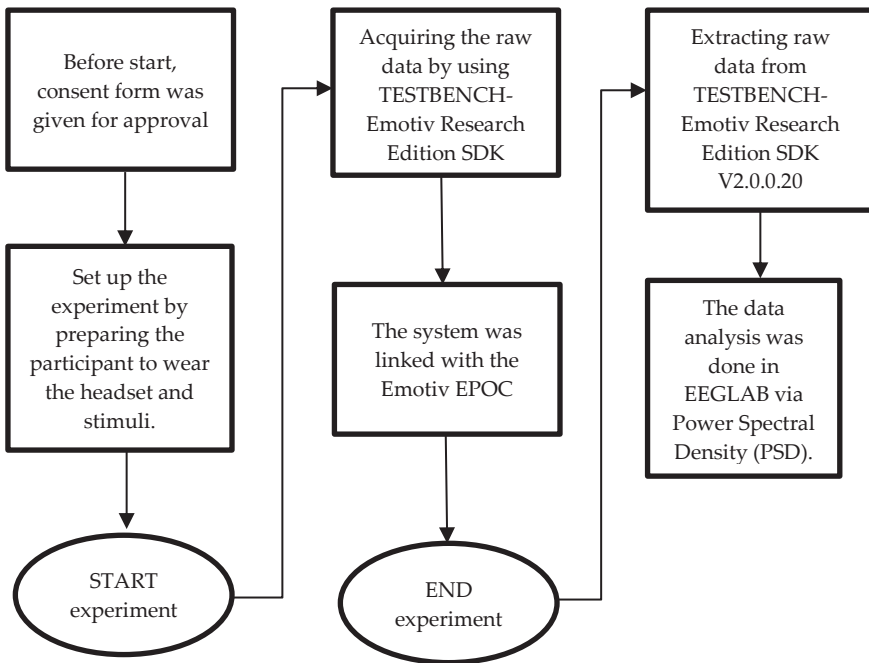
Figure 1: Overall summary of the flowchart of collecting data

The experiment begins with the preparation for the participants to wear the headset as shown in Figure 2 and the stimuli. The Emotiv EPOC as shown in Figure 2 has 14 channels of electrodes such as AF3, AF4, F3, F4, F7, F8, FC5, FC6, T7, T8, P7, P8, O1 and O2 [9]. For this research, participants will be instructed to listen to Zikr and slow music. All of the electrodes will be attached to the scalp of the subject's head.

Figure 2: Emotiv EPOC [10]

After the preparation set up, the subjects were instructed to sit comfortably and relax before the start of the procedure. The students were instructed to rest for 2 minutes and listen to the Zikr meditation from Asma Ul-Husna for another 2 minutes by using earphones with closed eyes as shown in Table 1. After it was completed, they continued to listen to the slow rock music for another 2 minutes, amounting to a total of 6 minutes the intake for data collection.

Table 1: Time frame for sampling data [11]

ZIKR (2 Minutes)	REST (1 Minute)	SLOW MUSIC (2 Minutes)

To avoid overlapping of data during the session, the subject rested for 1 minute before listening to the next stimuli for obtaining a consistent data. The subject had also been advised to sit comfortably and to close their eyes during the session to ensure a decrease in noise recorded that could affect the data collection. The stimuli used for this study are silent recording, zikr recording and slow music from YouTube in format .mv. The stimuli were compiled and simultaneously the whole experiment was recorded using a web camera in Camtasia Studio software (TechSmith Corporation, USA). The software that linked with the Emotiv EPOC was the TESTBENCH-Emotiv Research Edition SDK

V2.0.0.20 to acquire the raw data of the whole session. From this software, whole data from the 14 channel electrodes were obtained at the sampling rate of 128Hz [12].

After finished the experiment, the data was analyzed by extracting the data acquired from the EEG Test bench which is in .pdf format in EEGLAB from the toolbox in MATLAB [13]. EEGLAB provides a graphic user interface (GUI) that allows users to process complex EEG data as well as other types of electrophysiological data. The raw data can be classified from the EEGLAB toolbox by applying Fast Fourier Transform (FFT) to obtain the Power Spectrum Density of the signal for each electrode in the time-frequency domain (Hz) [14].

3.0   RESULTS AND DISCUSSION

EEG measures the electrical potential from the asynchronous firing of billions of neurons system on the scalp that is rich with information on mental activities and emotional states [15]. In medical perspective, EEG became one of the most effective tools in measuring brain activity because of its high abilities in detecting the normal and abnormal brain electrical activity [16]. The behavior of the subject can be observed from frontal, occipital, temporal and parietal lobe. From the lobe description, frontal lobe was related to focus and attention. These abilities are useful for planning, solving problems and judging morals. Furthermore, the frontal asymmetry was observed because it's important for mental health and stress adaptation [17]. Thus, for this research, we consider only the frontal lobes to observe the behavior of the subject via EEG signal

For EEG brainwave signal, there were four main types of brainwave that consists of Delta, Theta, Alpha and Beta [18]. Alpha is chosen because of its significance to deep relaxation and meditation while eyes closed. While beta wave is chosen because it related with the waking state of consciousness and engaged on focused and mental activity. The reason why beta also been consider for this study is because during meditation, the subject need to close their eyes. Therefore, for validation the result, beta is used to ensure the subject is awake during the session and not sleeping.

Therefore, the results for the auditory stimuli were analyzed from 4 channels of electrodes. The signal average of EEG signal was compared between listening to Zikr meditation and slow music. The ranges of frequency of the brain waves of alpha and beta band are measured in

this experiment which is 8-13Hz for alpha and 13-30Hz for the beta [19]. The subject is considered calm when their alpha wave is high and at ease when their beta band is low.

3.1 Comparison between Auditory Stimuli for Alpha Band

Table 2 shows the strength average value for the alpha band (Figure 3). For zikr meditation, the highest alpha wave reading was recorded from subject 4. The channel F8 of the subject 4 gives the highest alpha band among other subjects which was 17.527 µV. From the channel above, only several channels give out the negative alpha band which means that during the session, the subject is not calm. Those channels are F3 subject 1 and F3, F4, F7 for subject 2.

As for slow music, the observation shows that the highest alpha band was recorded from subject 5 at the channel F8 which was 20.882 µV. Among the channel above, only several channels give out negative alpha band which means that during the session, this channel was not calm. Those channels are all subject for channel F4 and F7 for subject 2.

Figure 3 shows the comparison of Power Spectral Density of both auditory stimuli in term of the strength average from Fast Fourier Transform application from extracting data for music meditation and slow music. Meanwhile, Table 2 also represents the value of the auditory stimuli for alpha band for all of the subject.
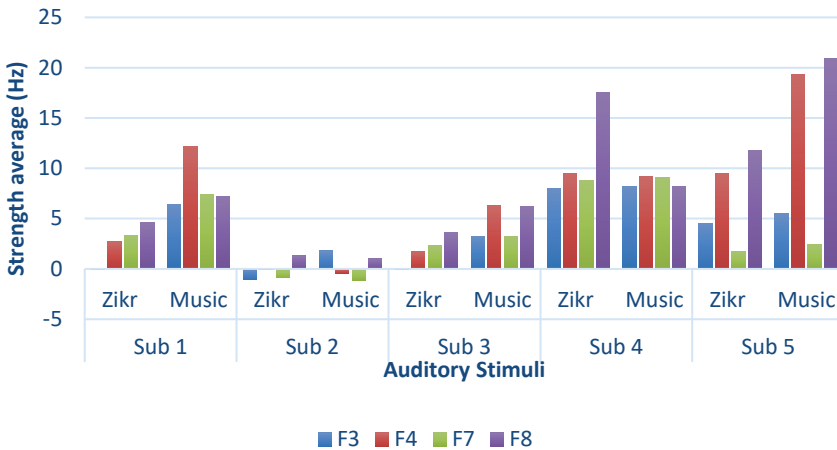

Figure 3: The comparison of power spectral density value of the alpha band for auditory stimuli for each subject

Table 2: Value of strength average for alpha band for auditory stimuli

Electrode	Sub 1		Sub 2		Sub 3		Sub 4		Sub 5	
	Zikr	Music	Zikr	Music	Zikr	Music	Zikr	Music	Zikr	Music
F3	-0.03	6.43	-1.1	1.78	-0.02	3.27	8.02	8.23	4.55	5.53
F4	2.69	12.2	-0.01	-0.42	1.69	6.28	9.44	9.17	9.44	19.33
F7	3.33	7.4	-0.9	-1.13	2.33	3.27	8.79	9.09	1.70	2.38
F8	4.61	7.21	1.31	1.01	3.61	6.2	17.53	8.19	11.79	20.88

3.2 Comparison between Auditory Stimuli for Beta Band

Figure 4 shows all channels give the negative beta band for zikr meditation. Thus, it means the subject is not calm during the session, except for subject 4 and subject 5 who showed positive beta band for frontal lobe only. The average value for the F8 for subject 4 is 15.759 µV while subject 5 is 3.810 µV which can be seen in Table 3. Thus, the value shows that the person is excited during the session which reflected from the high volume of the zikr meditation audio.
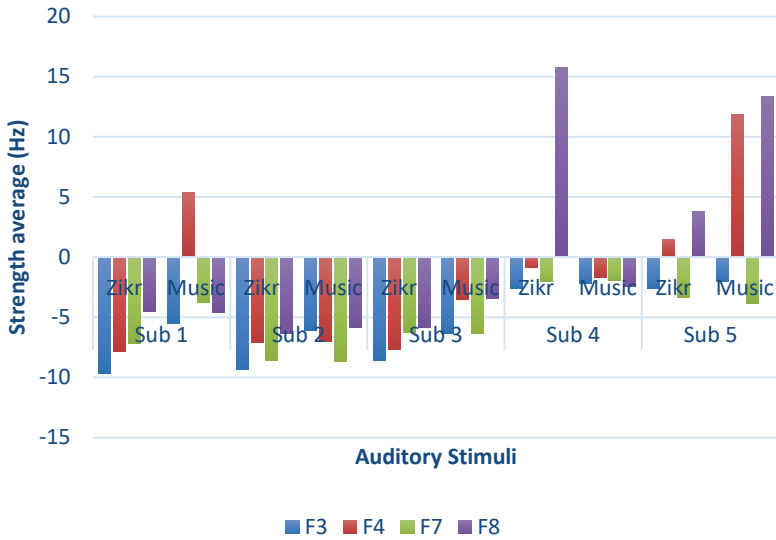

Figure 4: Comparison of Power Spectral Density value of the beta band for Auditory Stimuli (zikr meditation and slow music)

Table 3: Value of strength average for beta band for zikr meditation
and slow music

Electrode	Sub 1		Sub 2		Sub 3		Sub 4		Sub 5	
	Zikr	Music	Zikr	Music	Zikr	Music	Zikr	Music	Zikr	Music
F3	-9.66	-5.50	-9.38	-6.08	-8.56	-6.38	-2.59	-2.23	-2.59	-2.02
F4	-7.89	5.356	-7.12	-6.99	-7.69	-3.55	-0.87	-1.69	1.49	11.88
F7	-7.17	-3.81	-8.62	-8.64	-6.27	-6.38	-2.05	-1.94	-3.33	-3.83
F8	-4.56	-4.59	-6.34	-5.85	-5.85	-3.41	15.76	-2.48	3.81	13.36

All channels for slow music showed the negative beta band excepted for subject 1 for F4 and subject 5 for F4 and F8 channel. The average value for the F8 for subject 5 obtained the high beta wave which is 13.395 μV. Subject 5 is excited during the session due to the stress occurred.
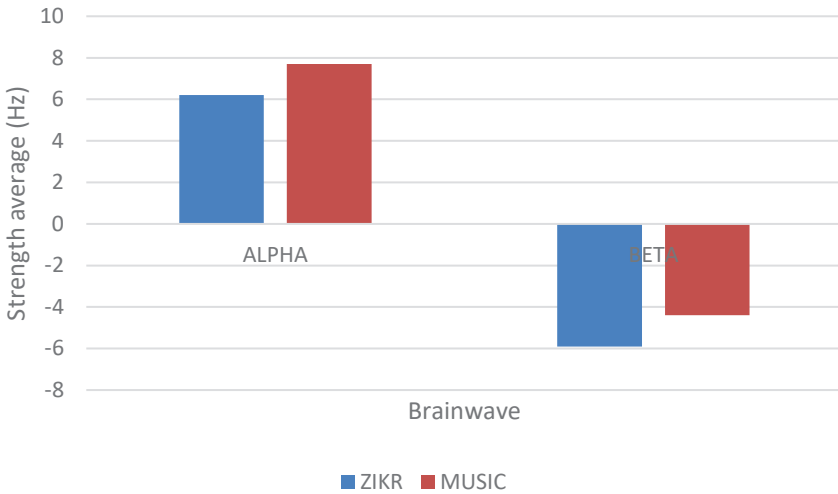

Figure 5: Comparison of average value of power spectral density in hertz (Hz) of the alpha band and beta band for all subjects

From the result in Figure 5 showed high beta may lead us to experience excessive either anxiety or stress but from the comparison above, the result showed that all subjects got low beta frequencies noted that subjects were very calm and relaxed during the session whereas high alpha frequencies meant that during the session, subjects very relaxed and calm.

4.0   CONCLUSION

The analysis result from this study showed that alpha wave is high and the beta wave is low during Zikr meditation which can lead the person in a calm state compared to listening to music. Thus, it proved that Zikr meditation can lead a person to relaxation but it all depends on the individual itself. During the experiment session, subjects were instructed to close their eyes but the noise and artifact from the result still there. Thus, the use of FFT for filtering is done to remove the noise. The low value of the beta wave recording proved that none of the subjects was sleeping during the session. Among the frontal lobe, the right frontal F8 chose to give out high alpha and beta band thus proving that it involves focus and attention. 85% of the lobes involved give out low beta band during listening to Zikr meditation which proved that Zikr meditation can lead someone into a state of relaxation and tranquillity. In addition, these findings provide possible usage of EEG device as meditation tool for individual self-regulatory purposes. Hence, EEG technology-driven biofeedback technique may contribute to the self-regulatory mobile device manufacturing industry which is rapidly growing today.

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REFERENCES

[1]   H.Marzbani, H.Marateb and M. Mansourian, "Methodological Note: Neurofeedback: A Comprehensive Review on System Design, Methodology and Clinical Applications," *Basic and Clinical Neuroscience Journal*, vol. 7, no. 2, pp. 143–158, 2016.

[2]   A. M. Bhatti, M. Majid, S. M. Anwar, and B. Khan, "Human emotion recognition and analysis in response to audio music using brain signals," *Computers in Human Behavior*, vol. 65, pp. 267–275, 2016.

[3]   M. Teplan, "Fundamentals of EEG measurement," *Measurement Science Review*, vol. 2, no. 2, pp. 1–11, 2002.

[4]   I. Wulandari, A. Huriyati and M. Kep, "Anxiety's Level of Bantenes Patient's: The Effect of Dhikr Therapy Before Surgical Procedure," *International Journal of Research in Medical Sciences*, vol. 3, no. 1, pp. 36–40, 2015.

[5]   N. I. C. Marzuki, N. H. Mahmood, and N. M. Safri, "Type of music associated with relaxation based on EEG signal analysis," *Jurnal Teknologi* , vol. 61, no. 2 , pp. 65–70, 2013.

[6]   B. R. Cahn and J. Polich, "Meditation states and traits: EEG, ERP, and neuroimaging studies," *Psychological Bulletin*, vol. 132, no. 2, pp. 180–211, 2006.

[7]   S. M. Alarcao and M. J. Fonseca, "Emotions Recognition Using EEG Signals: A Survey," *IEEE Transactions on Affective Computing*, vol. 10, no. 3, pp. 374-393, 2017.

[8]   M. S. Shekha, A. O. Hassan, and S. A. Othman, "Effects of Quran Listening and Music on Electroencephalogram Brain Waves," *The Egyption Journal of Experimental Biology (Zoology)*, vol. 9, no. 1, pp. 119–121, 2013.

[9]   EMOTIV EPOC. (2014). *Brain Computer Interface & Scientific Contextual EEG* [Online]. Availabel: https://www.emotiv.com/files/Emotiv-EPOC-Product-Sheet-2014.pdf

[10]   J. D. Jacoby, M. Tory, and J. Tanaka, "Evoked response potential training on a consumer EEG headset," in IEEE Pacific RIM Conference on Communications,Computers and Signal Processing, Hong Kong, 2015, pp. 485-490.

[11]   Q. Zhang and N. Yoshimine, "A Study on Human Brain Activity during Music Listening using EEG Measurement," *Tama University School of Global Studies Bulletin*, vol. 8, pp. 149–157, 2015.

[12]   N. Behboodian and M. Kamal, K. Natsume and T. Kitajima, "Frequency analysis of Brain signals for Biometric Application ", *International Journal of Pure and Applied Mathematics*, vol. 118, no. 24, pp. 1–14, 2018.

[13]   A. Delorme and S. Makeig, "EEGLAB: An open source toolbox for analysis of single-trial EEG dynamics including independent component analysis," *Journal of Neuroscience Methods*, vol. 134, no. 1, pp. 9–21, 2004.

[14]   D. J. Lee, E. Kulubya, P. Goldin, A. Goodarzi, and F. Girgis, "Review of the neural oscillations underlying meditation," *Frontiers in Neuroscience*, vol. 12, pp. 1–7, 2018.

[15]   J. Tee and W. Leong, "EEG Extraction for Meditation," *Journal of Engineering Science and Technology*, vol. 13, no. 7, pp. 2125–2135, 2018.

[16] R. Bhoria, P. Singal and D. Verma, "Analysis of Effect of Sound Levels on EEG," *International Journal of Advanced Engineering Research and Technology* , vol. 2, no. 2, pp. 121–124, 2012.

[17] C. W. Quaedflieg, F. T. Smulders, T. Meyer, F. P. M. L. Peeters, H. L. G. J. Merckelbach and T. Smeets, "The validity of individual frontal alpha asymmetry EEG neurofeedback," *Social Cognitive and Affective Neuroscience*, vol. 11, no. 1, pp. 33–43, 2015.

[18] B. Farnsworth. (2019). *EEG (Electroencephalography): The Complete Pocket Guide* [Online]. Available: https://imotions.com/blog/eeg/

[19] E. A. Larsen, "Classification of EEG Signals in a Brain- Computer Interface System," M.S. thesis, Department of Computer and Information Science, Norwegian University of Science and Technology, Trondheim, Norway, 2011.