

Brain Behavior Analysis of Mental Stress Before and After Listening to Quranic Recitation Based on EEG signals.

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Abstract— Stress is a chronic problem of the modern world. According to the World Health Organization (WHO), stress is one of the most serious health problem of recent decades and is considered the main threat to individuals, occurring when they lose the balance between the difficulties of daily life and their ability to manage them. It has been shown by numerous studies that Quranic recitation is effective in calming the mind by generating Alpha activities on the human brain that indicate a state of relaxation and calmness. However, Quranic recitation and its effect on mental stress itself is still not fully investigated and understood. This research is therefore being conducted to explore the brain behavior of stressed individuals after listening to Quranic recitation. As a preliminary study, the biosignal of three participants (subjects) was collected using electroencephalogram (EEG), and following by our experimental procedures which involved: 1) filling out the DASS-21 (depression anxiety and stress scales), and 2) based on the DASS-21 scores, EEG data is collected from the subjects before and after listening to the Quranic recitation, and if the subject is stressed, or if the subject is not stressed, only EEG data in the normal state was collected. Topographical maps of the five power bands of EEG for each subject were then created and visualized using Python, and a comparison of these maps was drawn to derive the research results. The result showed that after listening to Quranic recitations, the high Beta power than Alpha that was induced by stress was reduced to be high Alpha power than Beta power, and this indicates the normal state of the subject's brain activities without stress.

Keywords— EEG, Stress, Quran Recitation, Alpha power band, Beta power band.

I. INTRODUCTION

Chronic stress is an unavoidable emotion in daily human life, especially with the rapid changes in society due to technological development, rendering the demands of daily life increasingly beyond the human capacity to handle.

Stress not only impairs a person's cognitive function and ability to make decisions [1], but prolonged stress without coping with it can also be life-threatening, as some studies have indicated that psychological stress is the main contributing factor to most of the physical problems and psychological illnesses a person suffers from, including heart attacks, strokes and depression [2], [3].

Innovations in the field of biomedical instruments have made it possible to detect physical and mental stress in humans by extracting and analyzing physiological signals obtained from these devices such as blood pressure, skin conductance, heart rate, heart rate variability (HRV) [4].

However, researchers have recently shown increased interest in another method called electroencephalogram due to the fact that the biosignals obtained from the latter directly reflect changes in brain activities is considered the

origin of the stress response [5], thus stress biomarkers can be accurately captured using such technique.

The majority of studies conducted on EEG were only interested in identifying stress [6]–[8], [2], [9], [10], whereas the method of stress reduction adopted by the few existing studies in the field was through medical intervention [11], [12].

Most people prefer to listen to music to relax their mind while facing stress [13]. It has been found that this method can bring calm to the human mind, but not as much as listening to the Quran [13]–[15].

Several studies have reported that listening to the Qur'an can lead the human brain to relaxation by generating brain waves that bring calm [13]–[15]. Despite this, no study has addressed the impact of the Qur'an on stress itself, as existing studies on the effect of the Qur'an on brain activity have not taken into account the measurement of stress before listening to the Qur'an.

This study therefore attempted to bridge this research gap by analyzing brain behavior under mental stress before and after listening to Quranic recitation.

TABLE 1 RELATED WORKS

Reference	EEG features	Extraction method	Stress Marker
[1]	Power Spectral Density (PSD)	[No information]	The significant change in the power spectral density of the theta, alpha and beta frequency bands.
[16]	Energy Spectral Density (ESD) Relative Energy Ratio (RER) Shannon Entropy (SE)	Fast Fourier Transform (FFT)	The decrease in the amplitude of Alpha band and increase in the amplitude of Beta band.
[17]	Sub-band: Delta (1-4 Hz), Theta (4-8 Hz), Alpha (8-12.5 Hz) and Beta (12.5-30 Hz).	Wavelet Transform (WT)	The significant increase in the beta rhythm power and significant decrease in the alpha rhythm power.
[18]	Power Spectral Analysis (PSD) Energy Spectrum Density (ESD)	[No information]	The human stress pattern for low and high stress is linked with alpha and beta brain waves.
[19]	Power Spectral Density (PSD) and Energy Spectral Density (ESD)	Fast Fourier Transform (FFT)	The change and asymmetry in Sub-band of alpha.

II. RELATED WORK

Electroencephalography (EEG) is a valuable technique, widely used to diagnose brain disorders and diseases [20] due to the valuable information contained in the brain signals, which provide a clear understanding of neurological behavior in response to disease.

Five different rhythms have been discriminated in EEG: Delta (0.5-4 Hz), Theta (4-8 Hz), Alpha (8-13 Hz), Beta (13-30 Hz) and Gamma (above 30 Hz) [21]. The measurement of the power balance of the higher and lower EEG rhythms had been used by researchers to identify and analyse mental stress. In Table 1, we have summarized the related work in this area and identified the biomarkers that have been shown to be associated with the existence of stress.

The existence of human stress could be identified by the change of the beta and alpha EEG as a previous study [18] has already proved the correlation between these bands and psychological stress levels.

Several studies, moreover, have linked decreases in alpha rhythm power and increases in beta rhythm power as a biomarker of mental stress [1], [16], [19]. Meanwhile, other researchers have considered the increase in the alpha band and decreases in beta band as a biomarker of relaxation [14], [22]. In the same context, many studies have been conducted to compare the effect on EEG while listening to Quranic recitation and listening to music, the results showed that the relaxation pattern was found predominant in the EEG data collected while listening to Quranic recitations compared to music [13]–[15].

Step 1: Each participant was asked to complete the DASS-21.

Step 2: Based on the DASS-21 score, the participant was categorized as either stressed or not stressed.

This study is conducted to assess brain behavior of mental stress before and after listening to the Quran in order to investigate how the human brain undergoing stress responds while listening to Quranic recitations.

III. RESEARCH METHODOLOGY

The goal of this research is achieved through data collection. The following section will describe the procedure adopted for our preliminary experiment to achieve the study objective.

A. Participants

Three postgraduate students at International Islamic University of Malaysia (IIUM), ranging in age from twenty-five to thirty-two, had volunteered to participate in the experiment of the present research. The volunteers were mentally healthy with no brain disorders.

B. EEG Measurement

EEG activity was recorded in this experiment using nineteen surface electrodes. The electrodes were attached to the participant's scalp following the 10-20 electrode placement system, using a conductive gel to ensure good contact between each electrode and the scalp.

C. Experimental Procedure

The procedures followed to acquire participants' EEG data are outlined below:

Step 3: EEG electrodes were then placed on the participant's scalp and then he/she was instructed to minimize movement and be ready to begin the experimental protocol.

Step 4: The participant proceeds with the experimental protocol according to the DASS-21 score obtained in step 1, if the subject belongs to the non-stressed category, only the

EEG data during the initial state are recorded from the individual with eyes closed and eyes open.

Or if the participant belongs to the stressed category, the protocol will start with eyes open /eyes closed for one minute each, followed by listening to the Quran recitation for four minutes with eyes closed, ending with another eyes open /eyes closed for one minute each.

The Quranic verses used in this research are AL-Fatihah, Al-Kursi, Al-inshirah, Al-Ikhlās, AlFalak, Al-Nas, were selected based on the review of existing literature related to listening

to the Quran and relaxing the mind, where these verses were found to be effective for mental relaxation.

The experiment was conducted in lab settings, where the room temperature was set at 25°C and a quiet environment was provided to avoid artifacts in the recording EEG.

The steps performed during the research experiment to obtain the brain signals from the subjects are presented in the diagram shown in Fig.1.

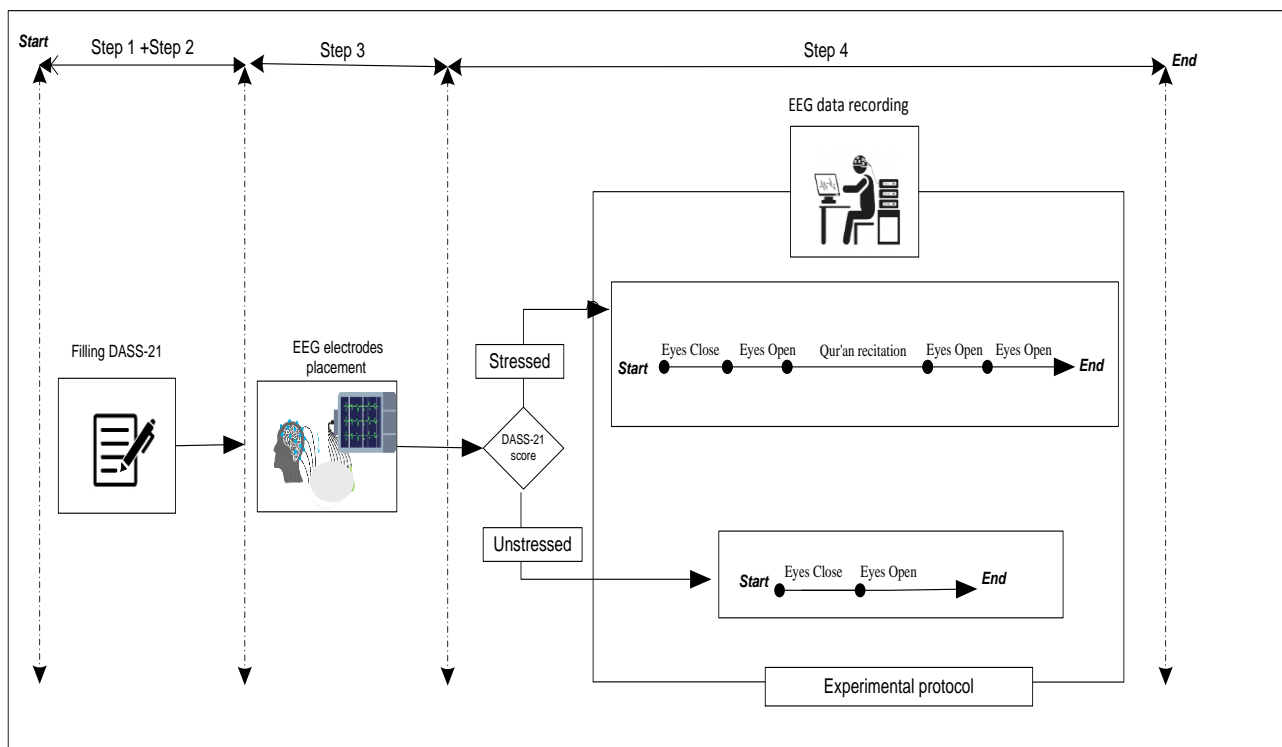


Fig. 1 A diagram illustrating the main steps involved in the research procedures for acquiring participants' EEG data.

D. EEG Data Analysis

The EEG data from the previous section was analyzed using Python and the open source package MNE, to create and visualize topographic maps of the power of the five EEG bands for each subject.

A comparison between the topographic maps before and after listening to the Qur'an was then drawn to determine the changes on the brain activation patterns of the subjects, in order to derive the results of the study on the behavior of the brain with stress and how the human brain deals this stress after listening to the Qur'an recitation.

IV. RESULT AND DISCUSSION

The following subsections present the experimental results and discussion of these results by analyzing the data collected from the previous section.

A. DASS-21 result

DASS-21 stress scores ranged from 0 to 37+, where scores of 0-4, 15-18, 19-25, 26-33, and 37+ represent the level of stress experienced by the subjects as normal, mild, moderate, severe, and extremely severe respectively.

The figure Fig. 2 below shows the result after analysis of the DASS-21 scores collected from the participants.

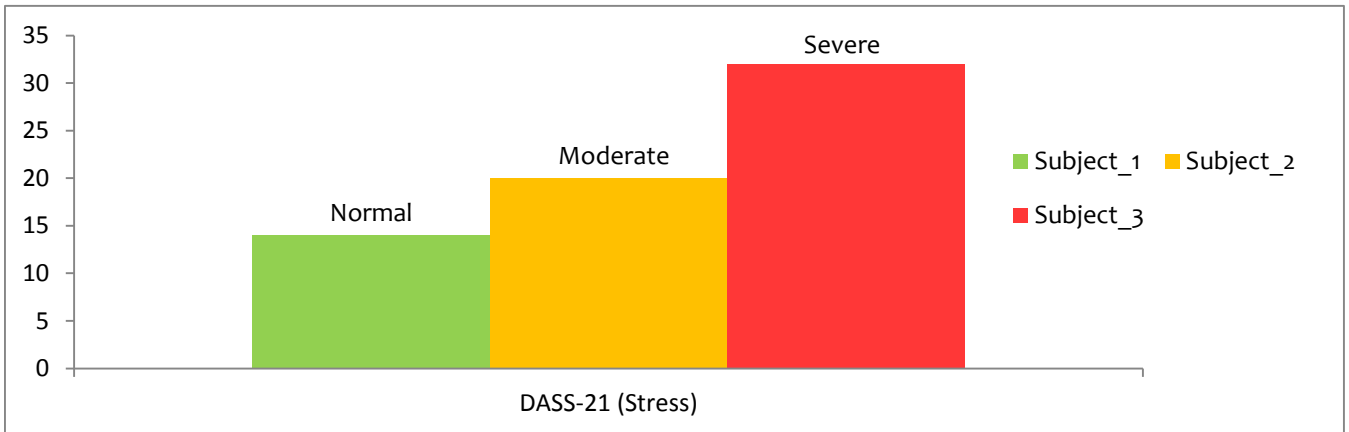


Fig. 2 Stress level of the subjects based on the DASS-21 score.

In this study, we considered individuals with a DASS-21 stress score (multiplied by two) equal to or greater than 20 as stressed participants and those with a score below 20 as nonstressed participants.

The three participants were categorized accordingly, as subject one non-stressed individual, and both subjects two and three were considered stressed individuals.

B. Brain Behavior Analysis

According to [16], the stress pattern can be clearly seen in the Alpha and Beta bands compared to the Delta and Theta bands, since the Alpha bands reflect the quietness of brain activity while the Beta band reflects the alert state of brain activity, whereas capturing stress biomarkers is difficult using the Delta and Theta bands that reflect brain activity during deep and light sleep respectively.

Therefore, due to the limited amount of data, only Alpha and Beta were considered in the topographic map analysis of the collected data.

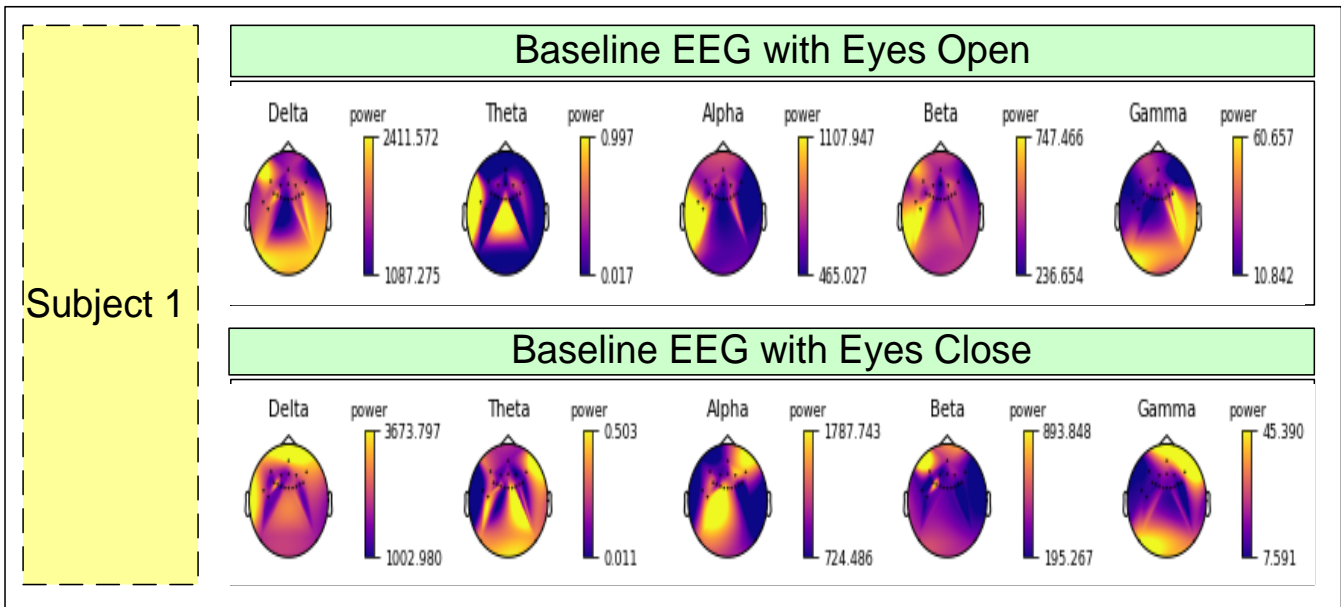


Fig.3 Topographical maps of the EEG bands of subject one in the normal state with eyes open / eyes closed.

The result of the first subject (see Fig. 3) in the non-stressed state shows that the alpha power is higher than the beta power in both cases with the eyes open or closed, indicating that the brain reflects the calmness by the

imbalance of the alpha and beta bands, so that the alpha frequency is more dominant than the beta frequency.

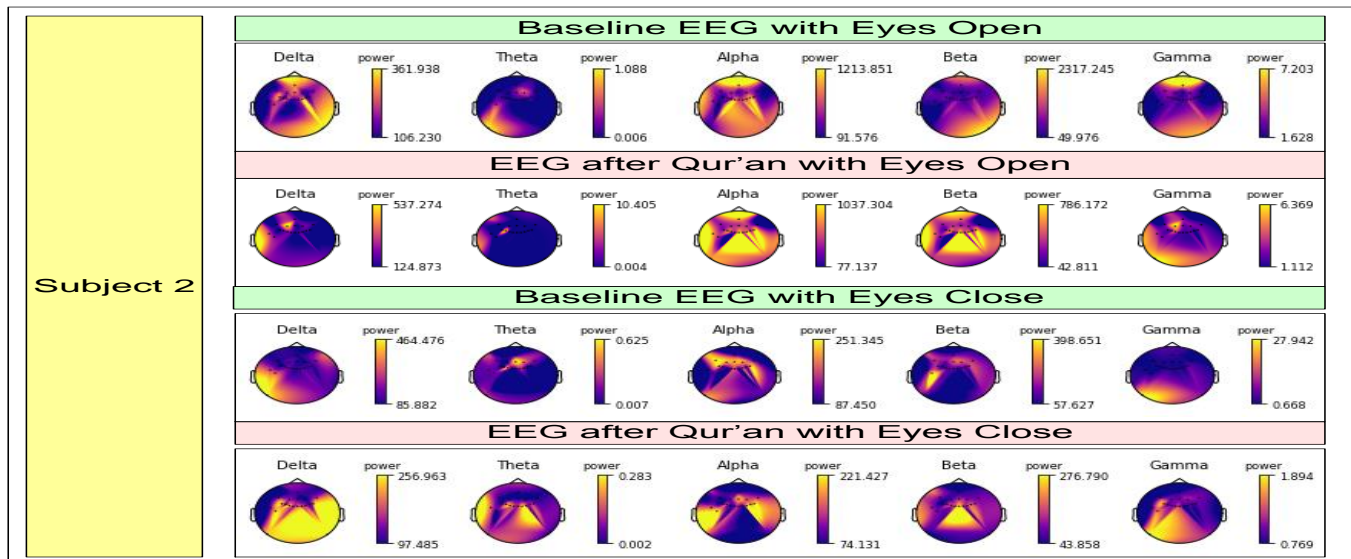


Fig.4 Topographical maps of the EEG bands of the second subject both in the normal state and after the Quran recitations with eyes open / eyes closed.

The result of subject two (see Fig. 4) with stress shows that beta wave activity was dominant compared to alpha activity in both cases with eyes open or closed, these observations have been proven in several previous studies as an index of stress. However, the data acquired after listening to the Quran recitation with eyes open clearly shows that subject two's brain was able to reverse the imbalance of alpha and beta bands to provide a relaxed state by generating more alpha waves than beta waves.

Brain waves obtained from the same subject (subject 2) after the Quran while his eyes were closed, show that beta waves remain slightly higher than alpha waves, as beta waves have significantly decreased compared to the data taken before listening to the Quran.

The result of the third subject (see Fig. 5) who was also considered stressed, shows that the biomarkers of stress were not apparent on the data collected in case of open eyes. It is also interesting to note from the observed results that hearing Quran has not affected the imbalance of the two brain waves and the alpha remained dominant compared to the beta.

whereas stress was clearly noticeable on the subject's data while his eyes were closed before listening to the Quran, this stress however decreased significantly after listening to the Quranic verses as it is obvious that the beta waves experienced a significant decrease compared to the alpha waves which remain almost the same.

These finding, although preliminary, confirms that the biomarkers associated with stress disappeared after listening to the Quran and the Quranic recitation stimulates the brain to generate other biomarkers that were found to be associated with a calm and relaxed state.

The main hypothesis was to identify whether Quran can have a positive effect on the individual under stress and the finding of this research confirmed that listening to Quran while feeling stressed has a specific effect against stress which leads the human brain to make certain changes in brain activity that reflect stress reduction and provided mental relaxation.

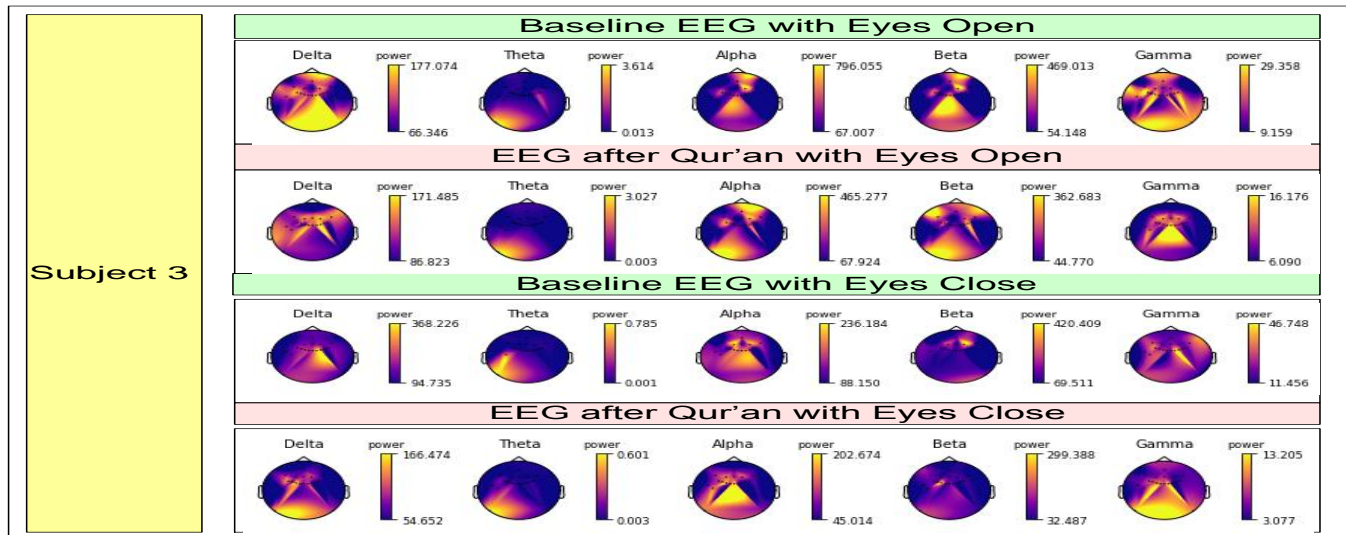


Fig.5 Topographical maps of the EEG bands of the third subject both in the normal state and after the Quran recitations with eyes open / eyes closed.

IV. CONCLUSIONS

The purpose of this paper is to study the brain behavior of mental stress before and after listening to Quranic verses by analyzing the power balance of EEG frequency bands. Although the study findings are preliminary limited by number of participants and data, the most obvious finding to emerge from this study is that after listening to Quranic recitations, the high Beta power than Alpha that was induced by stress was reduced to be high Alpha power than Beta power, and this indicates the calm state of human brain. Additional data collection is needed to improve the outcomes of this research and provide a better understanding of the relationship between Quran and mental stress.

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