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INNOVATION

Spirituality and brain waves

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Abstract

The aim of this study is to investigate the effect of Quran on a Persian-speaking Muslim. Volunteers listened to three different audio files (Verses from Sura 'Forqan' unconsciously; Arabic text unconsciously; Verses from Sura 'Fath' consciously). EEG signals were recorded and the changes in the relative power of theta and alpha band are considered an indicators of relaxation. The findings indicate that conscious listening to Holy Quran increases the relative theta power in most areas of the head, compared to the rest condition, and listening to Quran unconsciously increased relative theta power in the frontal and central lobes of the head significantly, compared to the rest condition. Also, listening to Quran consciously increases the relative alpha power in the frontal lobe, compared to the rest condition.

Keywords

Holy Quran, Persian-speaking Muslim, relative theta power, relative alpha power

History

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1. Introduction

One of the greatest problems threatening human life is anxiety, a phenomenon that causes abnormality in a human and endangers his peace and psychological security. Ways of controlling anxiety include pharmaceutical and non-pharmaceutical methods, but recently there has been an increasing tendency to use non-pharmaceutical methods. One of these methods is using pleasant sound stimuli such as music therapy [1]. The human brain is composed of millions of nerve cells. Listening to music helps neurons to be more active in the brain [2]. Neurological studies have suggested that music is a valuable tool for assessing the brain system [3]. Today, music therapy is used as a way of increasing positive feelings and reducing anxiety, stress and negative emotions [4–7].

Quran is a rhythmic text (prose) which means that it has a melody that comes from the combination of words and letters based on fine and sacred meanings. Psychologists and nurses have studied a great deal about the refreshing effects of the Holy Quran and report that hearing the Quran reduces the pain and anxiety of patients [8–10].

Brain patterns are made of waveforms that are normally sinusoidal. The power spectrum is obtained from an unprocessed EEG signal, using Fourier transform. Sine waves with different frequencies can be seen in the power spectrum, these waves are classified into five main band frequencies: Delta (4–5/0 Hz), theta (8–4 Hz), alpha (12–8 Hz), beta (30–12 Hz) and gamma (40–30 Hz). Previous researches have shown that the feeling of disgust provides less alpha power in the right frontal lobe compared to the feeling of happiness; while happiness causes less alpha power in the left frontal lobe [11]. Increased alpha activity in the brain refers to a state of relaxation and euphoria [12]. Alpha power increases when there is a sense of happiness and anger, and decreases when there is a sense of fear and sadness [13]. Alpha power decreases in the left frontal lobe while listening to pleasant music and decreases in the right frontal lobe when listening to unpleasant music [14]. Theta and alpha power will increase while listening to music [15]. When listening to pleasant music, EEG patterns are changed and theta power increases in the middle frontal lobe [16]. Increase in alpha activity and beta activity is recognized as a sign of relaxation. It has also been reported that listening to music reduces stress and increases the sense of physical relaxation [17]. An increase in alpha and theta power is observed in relaxation and meditation techniques too [18–21].

Few studies have been carried out on the effect of listening to the Holy Quran on the EEG signals; among them, the following studies can be mentioned: Salleh et al. [22] assessed the spectrum of EEG signals during prostration in Muslim prayer and showed that Alpha relative power increased in prostration, compared to an imitated prostration. Khan et al. [23] investigated the effect of Quran recitation on physical, mental and spiritual relaxation. In this study, the best age of relaxation was reported as 28 for men and 25 for women. Quran recitation affects women more than men and women

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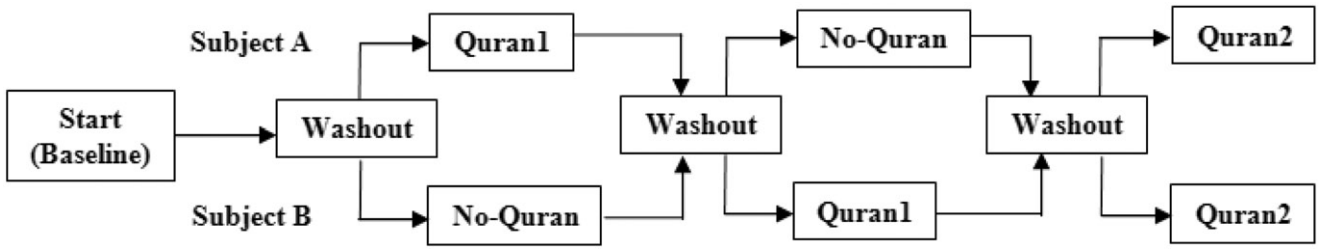

Figure 1. The designed protocol for recording EEG signal.

reach relaxation in less time. The results also showed that the best time for relaxation is in the morning before sunrise and in the evening after sunset. Alwasiti et al. [24] examined the changes in EEG signals during Muslim prayers. In this study, the changes of FFT absolute power and relative power, asymmetrical amplitude difference, coherent FFT difference and Phase delay difference of FFT was assessed in different brain lobes. Julianto and Etsem [25] examined the short-term memory of individuals before and after listening to the Quran and concluded that there is a significant difference in short-term memory before and after listening to the Quran and the brain activity increases during religious activities. Abdullah and Omar [26] investigated EEG changes when listening to Quran and listening to hard music. The results showed that alpha waves are produced when listening to Quran. Zulkurnaini et al. [27] compared the EEG alpha band at the time of listening to Holy Quran and classical music, and reported that the correlation between the brain waves of the left and right hemispheres in the Holy Quran listening are more than classical music mode and also the power of the alpha band at the time of listening to Holy Quran is more, compared to classical music. Kamal et al. [28] compared brain activity while reading the Holy Quran and a book and showed that, for each person, there is a negative correlation between reading of Quran and reading a book, and that Quran reading is a form of meditation, inducing stress reduction compared to the rest mode.

The Quran is the Muslim's holy book and its sound when being sung or recited is a mystical and musical prose which influences the human mental and spiritual states because of its miraculous expressions. In this study, EEG signals of subjects were investigated when listening to Quran to study the relaxation effect of Quran on Persian-speaking Muslims. According to the existing literature in the field of EEG signals associated with the relaxation rate, increases in the relative power of theta and alpha bands are considered and examined as an indicator of relaxation. Also, to compare the relaxation effect of Quran with another method, the Arabic text is used, which has positive semantic content and includes advice and hopeful sentences written by experts in Arabic and has the capability of being read in Tartyl. It should be noted that none of the volunteers were acquainted with Arabic and none of them were Quran reciters and memorizers. Before starting the test, they studied the information papers and stated their consent to participate voluntarily in the study. In the second part of the article the proposed protocol, recording the EEG signal and pre-processing the data have been explained and the analysis of the power spectrum has been defined. In the third section, the results of statistical analysis of EEG are presented and the fourth and the fifth sections deal with discussions and conclusions, respectively.

2. Methods

2.1. Acquisition protocol and subjects

The database was registered in 2012 and has been performed in an acoustic chamber. Forty-seven Persian-speaking healthy Muslim volunteers (19 females and 28 males), with an age range of 16–25 years and a mean age of 21.4 ± 2.708 participated. All subjects were selected voluntarily and randomly. Half of them presented at 10:30 am and the other half at 1 pm. There are three modes of play in the designed protocol: Playing Holy Quran unconsciously (Q1), playing the Arabic text unconsciously (NQ) and playing verses of the Holy Quran consciously (Q2). Conscious means that, based on the information given to them, the participants were aware whether they were listening to the Holy Quran or another Arabic text; Unconscious refers to the fact that the participants did not know the source of the file they listened to. The protocol considered included four stages that are shown in figure 1 and has the following phases:

- Phase I—Basic (Pre): Recording of EEG, 2 min with eyes opened and 2 min with eyes closed;
- Phase II–Unconscious: Recording of EEG, 2 min with eyes opened and 2 min with eyes closed and then random playing of Q1 or NQ and simultaneous recording of EEG with eyes closed for 10 min;
- Phase III–Unconscious: Recording of EEG, 2 min with eyes opened and 2 min with eyes closed and then playing the one that is not selected in phase II, and simultaneous recording of EEG with eyes closed for 10 min; and
- Phase IV–Conscious: Recording of EEG, 2 min with eyes opened and 2 min with eyes closed and then playing the file Q2 and simultaneous recording of EEG with eyes closed for 10 min.

Considering that the volunteers did not speak Arabic and were not Quran-memorizers, the type of file (Quran or Arabic text) was not declared in the second and third phase (unconsciously) and he/she was just informed in the fourth phase about what file was going to be played (consciously).

A Qari of Quran was asked to read all the files—each of them 10 min long—as similarly as possible in Tartyl, and volunteers listened to these files through headphones. Tartyl means reading the text fluently and correctly. To eliminate the

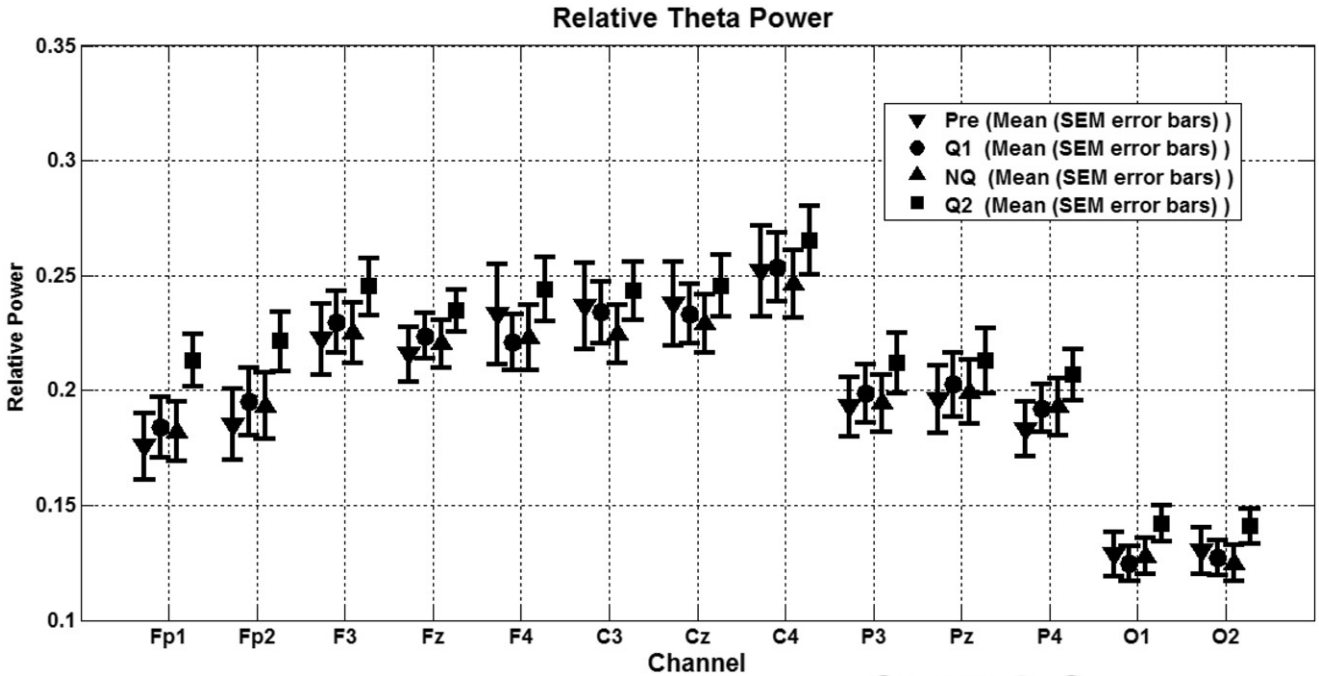

Figure 2. Relative theta power in four phases of Pre, NQ, Q1 and Q2.

effect of sequence between two phases of NQ and Q1, both of which were played unconsciously, they were played randomly to the volunteers. Also, for having no interaction of one phase on another, a 15-min break was used between them. After recording the EEG signal at each stage, the participants were asked to note the number of words they heard and the signals were evaluated by an expert. Then, only the signals of participants who were aware and conscious during all four stages were used in the analysis. In addition to the proposed protocol and recording the EEG signals, the General Health Questionnaire and Spielberger State-Trait Anxiety Inventory were answered and the results indicated that all participants had relative peace.

2.2. EEG recording

According to Standard 10-20, 13 gold electrodes at positions Fp1, Fp2, F3, Fz, F4, C3, Cz, C4, P3, Pz, P4, O1 and O2 were used to record the EEG signals. A reference electrode was placed on the right auricle and the ground electrode was placed in the position Fpz and electrodes were connected to an EEG amplifier (g.USBamp, g.tec, Graz, Austria). A band pass filter and internal notch filter g.USBamp was also used. The bandpass filter was set on 0.1–60 Hz and the notch filter was set on 50 Hz. The sampling frequency was 256 Hz.

2.3. Pre-processing

At the time of recording EEG, events such as the head movement, hand movements, feet movements, moving on the chair, respiration and swallowing were listed and, then, that part of the signal was marked. Time windows with the length of 4 s (1024 samples) were selected from EEG signals that did not contain the events listed above. These windows were used for feature extraction of the data.

2.4. Power spectral analyses

A common and known feature in the analysis of brain signals is relative power. The relative power of each frequency band is the ratio of the absolute power of each frequency band to the sum of the absolute power of 0.5–40 Hz. The EEG signal in each frequency has certain characteristics and shows a certain state of consciousness and psychological conditions of a person. For example, theta activity is recognized as closed eyes in the state of deep relaxation like the first stage of sleep, meditation and hypnosis [29] and Alpha activity is seen at relaxation and lack of active cognitive processes [21]. To study the effects of hearing Quran on EEG signals, among five frequency bands of delta, theta, alpha, beta, gamma and theta, two bands of theta (8–4 Hz) and alpha (12–8 Hz) were selected as the relaxation index and frequency analysis was done for these two brain rhythms. By comparing the relative power in the two frequency bands and in four different phases of Pre, NQ, Q1 and Q2, the amount of change was investigated to determine in which phase the relaxation rate had a significant increase.

3. Results

Figures 2 and 3 show the mean relative power and deviation from the mean relative alpha and theta power, for 13 electrodes Fp1, Fp2, F3, Fz, F4, C3, Cz, C4, P3, Pz, P4, O1 and O2 and for four phases of Pre, Q1, NQ and Q2. To compare the difference between theta and alpha relative power in each phase (Pre, Q1, NQ, Q2), the repeated measures test was used. Because the research data was not normal, a non-parametric Friedman test was selected to compare the mean scores of the phases. As the intra-class Friedman analysis of variance is a general test, to compare the mean scores of each of these four phases, an additional Wilcoxon test with a significance level of 0.05 was used.

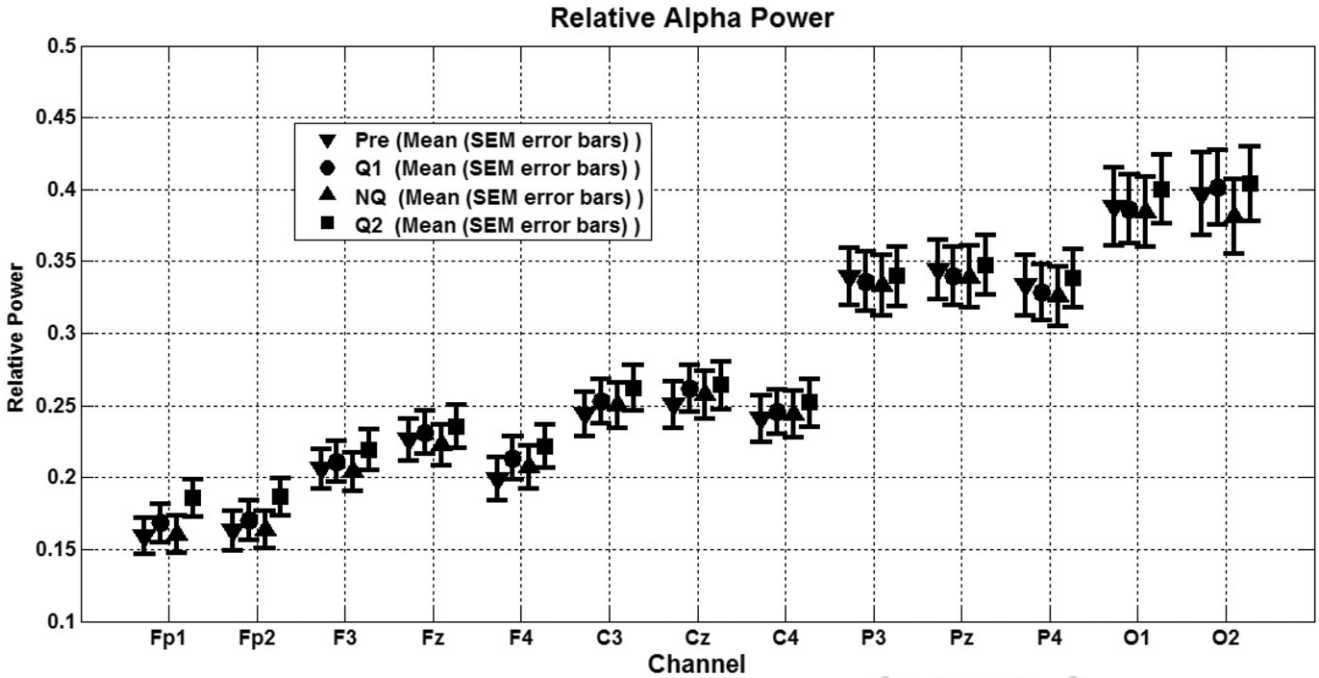

Figure 3. Relative alpha power in four phases of Pre, NQ, Q1 and Q2.

Table 1. The results of the Friedman test and Wilcoxon additional test for relative theta power in 13 electrodes.

	Friedman test			Wilcoxon test					
Theta relative power	Chi-square	df	Sig	Pre–Q1	Pre–NQ	Pre–Q2	Q1–NQ	Q1–Q2	NQ–Q2
Fp1	25.720	3	0.000*	0.036**	0.212	0.000**	0.261	0.000**	0.000**
Fp2	29.720	3	0.000*	0.034**	0.108	0.000**	0.266	0.000**	0.000**
F3	20.333	3	0.000*	0.011**	0.144	0.001**	0.110	0.011**	0.001**
Fz	20.061	3	0.000*	0.007**	0.102	0.000**	0.240	0.016**	0.004**
F4	17.427	3	0.001*	0.009**	0.129	0.002**	0.335	0.042**	0.002**
C3	10.147	3	0.017*	0.056	0.453	0.010**	0.170	0.376	0.019**
Cz	11.427	3	0.010*	0.050**	0.067	0.001**	0.531	0.087	0.019**
C4	11.453	3	0.010*	0.034**	0.087	0.003**	0.382	0.054	0.034**
P3	6.861	3	0.076	0.627	0.428	0.021	0.627	0.080	0.015
Pz	6.391	3	0.094	0.323	0.211	0.025	0.544	0.151	0.054
P4	9.773	3	0.021*	0.033**	0.003**	0.000**	0.388	0.141	0.015**
O1	9.873	3	0.020*	0.981	0.797	0.054	0.414	0.036**	0.018**
O2	10.147	3	0.017*	0.623	0.826	0.048**	0.516	0.054	0.006**

*Meaningfulness of Friedman test; **Meaningfulness of Wilcoxon test.

Tables 1 and 2 show the results of the Friedman test and the Wilcoxon additional test for theta and alpha relative power on each of the 13 electrodes. The results of the Friedman and Wilcoxon tests for relative theta power are as follows:

- For electrodes Fp1, Fp2, F3, Fz and F4: Friedman non-parametric test results showed that there are significant differences between the four phases of Pre, Q1, NQ and Q2 (p value < 0.05). Also, using the Wilcoxon test, it can be concluded that the relative power of theta in phase Q2 has a significant increase compared to Pre, Q1 and NQ, and the relative power of theta in Q1 has an increase compared to Pre.
- For electrodes O2 and C3: Friedman non-parametric test results showed that there are significant differences between the four phases of Pre, Q1, NQ and Q2 (p value < 0.05). Also, using the Wilcoxon test, we can conclude that the relative power of theta in phase Q2 has a significant increase compared to Pre and NQ.
- For electrodes C4 and Cz: Friedman non-parametric test results showed that there are significant differences between the four phases of Pre, Q1, NQ and Q2 (p value < 0.05). Moreover, using the Wilcoxon test it can be concluded that the relative power of theta in phase Q2 has a significant increase compared to Pre and NQ and the relative power of theta in Q1 has an increase compared to Pre.
- For electrodes P3 and Pz: Friedman non-parametric test results showed that there are no significant differences between the four phases of Pre, Q1, NQ and Q2 (p value > 0.05).
- For electrode P4: Friedman non-parametric test results showed that there are significant differences between the

Table 2. The results of the Friedman test and Wilcoxon additional test for relative alpha power in 13 electrodes.

	Friedman test			Wilcoxon test					
Alpha relative power	Chi-square	df	Sig	Pre–Q1	Pre–NQ	Pre–Q2	Q1–NQ	Q1–Q2	NQ–Q2
Fp1	12.574	3	0.006*	0.300	0.0958	0.017**	0.220	0.009**	0.000**
Fp2	10.455	3	0.015*	0.391	0.983	0.036**	0.290	0.010**	0.001**
F3	5.426	3	0.143	0.751	0.589	0.310	0.216	0.253	0.013
Fz	5.885	3	0.117	0.619	0.485	0.310	0.103	0.472	0.012
F4	4.736	3	0.192	0.409	0.816	0.176	0.162	0.440	0.036
C3	2.821	3	0.420	0.672	0.874	0.240	0.325	0.172	0.085
Cz	2.311	3	0.510	0.597	0.751	0.310	0.208	0.539	0.117
C4	4.353	3	0.226	0.891	0.719	0.452	0.519	0.300	0.120
P3	2.362	3	0.501	0.791	0.519	0.832	0.539	0.386	0.216
Pz	2.515	3	0.473	0.808	0.619	0.546	0.546	0.186	0.117
P4	6.498	3	0.090	0.808	0.285	0.539	0.341	0.249	0.063
O1	2.055	3	0.561	0.816	0.916	0.519	0.966	0.276	0.162
O2	6.702	3	0.082	0.604	0.589	0.478	0.172	0.626	0.035

*Meaningfulness of Friedman test; **Meaningfulness of Wilcoxon test.

four phases of Pre, Q1, NQ and Q2 (p value < 0.05). Using the Wilcoxon test, we can conclude that the relative power of theta in phase Q2 has a significant increase compared to Pre and NQ and the relative power of theta in NQ and Q1 has an increase compared to Pre.

- For electrode O1: Friedman non-parametric test results showed that there are significant differences between the four phases of Pre, Q1, NQ and Q2 (p value < 0.05). In addition, using the Wilcoxon test, we can conclude that the relative power of theta in phase Q2 has a significant increase compared to Q1 and NQ.

The results of Friedman and Wilcoxon test for relative alpha power is as follows:

- For electrodes Fp1 and Fp2: Friedman non-parametric test results showed that there are significant differences between the four phases of Pre, Q1, NQ and Q2 (p value < 0.05). Also, using the Wilcoxon test, we can conclude that the relative power of theta in phase Q2 has a significant increase compared to Pre, Q1 and NQ.
- For electrodes F3, Fz, F4, C3, Cz, P3, Pz, P4, O1 and O2: Friedman non-parametric test results showed that there are no significant differences between the four phases of Pre, Q1, NQ and Q2 (p value > 0.05).

4. Discussion

In this paper, the frequency changes of brain signals were studied in 47 Persian-speaking Muslim volunteers who had not mastered the Arabic language and had not memorized Holy Quran, in three conditions of listening to Quran consciously (Q2), listening to Quran unconsciously (Q1) and listening to an Arabic text unconsciously (NQ). According to the results of previous literature, two brain rhythms of theta and alpha were selected as the indicators of relaxation and analysed statically. It can be concluded from the results that:

(1) The relative theta power in phase Q2, compared to the Pre phase, had a significant increase in the electrodes Fp1, Fp2, F3, Fz, F4, C3, Cz, C4, P4 and O2.
(2) The relative theta power in phase Q2, compared to the NQ phase, had a significant increase in the electrodes Fp1, Fp2, F3, Fz, F4, C3, Cz, C4, P4, O1 and O2.
(3) The relative theta power in phase Q2, compared to the Q1 phase, had a significant increase in the electrodes Fp1, Fp2, F3, Fz, F4 and O1.
(4) The relative theta power in phase Q1, compared to the Pre phase, had a significant increase in the electrodes Fp1, Fp2, F3, Fz, F4, Cz, C4 and P4.
(5) The relative theta power in phase NQ, compared to the Pre phase, had a significant increase in the electrode P4.
(6) The relative alpha power in phase Q2, compared to the Pre phase, had a significant increase in the electrodes Fp1 and Fp2.
(7) The relative alpha power in phase Q2, compared to the NQ phase, had a significant increase in the electrodes Fp1, Fp2, F3 and F4.
(8) The relative alpha power in the Q2 phase compared to the Q1 phase had a significant increase in the electrodes Fp1 and Fp2.

So, listening to Quran consciously (Q2) increased relative theta power in most areas of the brain compared to the rest condition (Pre). Listening to Quran unconsciously (Q1) significantly increased relative theta power in the frontal and central lobes of the head, compared to the rest condition (Pre). Listening to Quran consciously (Q2) significantly increased relative alpha power in the frontal lobe, compared to the rest condition (Pre).

Increasing of alpha occurs at the mental and physical break of the body [30]. Since the Quran stimuli consciously increased alpha power in the frontal lobe, it can be concluded that the person is put in the relaxation state. Theta production with closed eyes is a sign of a deep state of relaxation, such as the first phase of sleeping, meditation and hypnosis [29]. Thus, according to the significant increase in relative theta power in listening to Quran, we can conclude that listening to Quran causes a pleasant mental health condition for Muslim people.

When we compare the results of this study with the findings of other researches, the results of Kamal et al. [28], which showed, when reciting Quran, the EEG power spectrum in the frequency range of Alpha band has an increase compared to reading Quran, can be mentioned. Zulkurnaini et al. [27] compared listening to classical music and Holy Quran and stated that alpha power increased more when

listening to Holy Quran. Abdullah and Omar [26] examined the effect of religious activities such as listening to Quran. The results showed an increase in alpha power when the person was listening to the Holy Quran.

5. Conclusion

The Quran is the holy book of Muslims that has a holiness and special position in the Muslims' minds and has a pleasant and soothing sound when sung or recited. In this study, the Holy Quran is used as a useful technique for reducing anxiety among Persian-speaking Muslims. Investigating the EEG signals of the volunteers showed that, when a Persian-speaking Muslim listens to the Quran consciously, meaning that he knows it is from the Holy Quran, the relative power of theta and alpha brain signals will increase. Also, when he is listening to the Quran unconsciously, which means that he does not know it is from the Holy Quran, the relative power of theta brain signal will increase.

When the participant is listening to the Quran consciously he is more relaxed, which can be related to the participant' religious beliefs, since he was aware that the audio file had been selected from the Holy Quran.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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