A Study of Noise Effect on the Fast Brain Activity

[1]N.F Mohammad, [1]A.Saidatul, [2]M.R Tamjis,
[1]Biomedical Electronic Engineering Program, School of Mechatronic, Universiti Malaysia Perlis
[2]Mechatronic Engineering Program, School of Mechatronic, Universiti Malaysia Perlis
01000, Perlis, Malaysia.

***Abstract*- This paper describes the effect of noise on the fast brain activity using Electroencephalogram (EEG). This study aims to find the correlation between noise exposures to the development of stress and investigate either it does affect the fast brain activity of human. There were 13 males aged between 20 to 22 years old with no past medical history voluntary participated in this study. PowerLab 4/25T Data Acquisition Systems (ML865; ADInstruments, Canada) were used to measure EEG signal during the experiment. Subjects were exposed to the noise at 90 dB for ten minutes. Noise at 90 dB was generated by using INTERM M500 Power Amplifier (INTERM M500, Cunnings, UK).This study focused only on two types of brain wave which are alpha (8-12 Hz) and beta wave (13-30 Hz). Alpha wave is important as stress indicator meanwhile beta wave is associated with fast brain activity such as analytical problem solving, judgment, decision making and processing information. EEG signals were recorded while subjects performed IQ test with and without noise exposure. High magnitude of alpha wave and low magnitude of beta wave that obtained before the noise exposure indicates that subjects were relaxed yet focused. However, when subjects exposed to the noise, beta waves magnitude increase, indicates that subjects in alert and agitated. Meanwhile, the decrease of alpha wave magnitude shows that subjects in tense. Wilcoxon test showed a statistically significant differences in mean of alpha and beta wave magnitude while performed IQ test with and without noise exposure ($p<0.05$).**

I. INTRODUCTION

Noise is defined as a sound which is commonly referred to as unwanted sound or meaningless sound of greater than usual volume. In our daily's surrounding, noise coming from various source such as traffic, machinery, industries and electronics. The advancement in technology has increase noise pollution and without realize, this excessive level of noise has lead to the potential health effect.

Noise activates the pituitaryadrenal-cortical axis and the sympathetic-adrenal-medullary axis [1]. In the acute and chronic noise experiments, researchers frequently found changes in stress hormones including epinephrine, norepinephrine and cortisol [1].Number of studies [2-7] had showed that noise does affect human behavior and physiological measurement such as blood pressure, heart rate and blood flow.

P. Lercher *et al*. reported the changes of behavior when exposed to the noise above 55 dB [2]. The epidemiological survey was carried out in five rural communities along two major through-traffic routes in the Austrian part of the Alps. The behavioral changes includes the closing of windows, double glazing, moving sleeping room, filing complaints, supporting pressure groups and the wish to move out. This pattern of behavior show physical stresses that lead the residence to do something to reduce the effects. The report also mentioned that noise sensitive persons showed a quite different responses pattern with lower overall nuisance, fewer behavioral actions but stronger health impacts than those persons whom actually having expressed their annoyance.

Y. Aydin *et al*. had performed a study to investigate the noise perception, heart rate and blood pressure in relation to aircraft noise [4]. The study concluded that the population which is exposed to a nocturnal equivalent continuous air traffic noise level of 50 dB for three quarters of a given time has a higher average blood pressure compared to a population exposed to the same equal energy noise level for only one quarter of the time.

As been stated, most of the noise studies are focused on the behavior and physiologically effect. Less is found to study on the effect of noise on brain signal. Brain signal is useful for determination of stress development in human and to investigate the effect of noise on the thinking ability.

In this investigation, study was focused on only two types of brain wave which are alpha and beta wave. Alpha wave (8-12 Hz) is an indicator for development of stress since it is said to occur when human feeling more relaxed yet conscious. Meanwhile beta wave (13-30 Hz) is associated with fast brain activity such as analytical problem solving, judgment, decision making and processing information.

Therefore, the objective of this study is to investigate the effect of noise on the fast brain activity by monitoring the alpha and beta wave magnitude.

II. SUBJECTS AND METHODS

A. Subjects

A total of 13 students from University Malaysia Perlis were voluntarily participated in this study. All of them were male aged between 20 to 22 years old with the same educational level background. All of them had been proved with no chronic medical history.

B. Methods

The noise level of the silent room was measured between 40 to 60 dB. Therefore higher levels of noise need to be exposed to the subject in order to induce stress. The EEG recordings had been divided to two parts. In parts one, the EEG signals were recorded while subjects performed IQ test without 90 dB

noise exposure. In the second part, subjects were exposed with 90 dB noise while performed IQ test.

Part One

In this study, ML865 PowerLab 4/25T Data Acquisition System is used to record and acquire EEG signals. Before the recording start, subjects were given 10 minutes time to rest. The montage used is the standard montage of 10-20 system and the technique of placing the electrodes is bipolar technique. Bipolar technique refers to the technique of measuring the impedance between two active electrodes. In this study only the frontal part of the brain has been focused as it is most associated to the sense of thinking. The EEG signal is then recorded while subjects performing the IQ test.

Second Part

Before the second session start, subjects were given 10 minutes time to relax. In this sessions noise was generated using INTERM M500 Power Amplifier and a sound generator while noise level was measured using SOLO Sound Level Meter. While exposed to the noise, subjects were given a different set of IQ test and the EEG signals were recorded at the same time.

Signal processing

The EEG signals obtained were pre-processing using PowerLab Bandpass filter to classify alpha and beta waves. Then the filtered signals were converted into power spectral density (PSD) representation by using the Chart5, PowerLab software in order to measure the magnitude of each alpha and beta wave. Figure 1 shows the flow for steps taken in getting PSD.

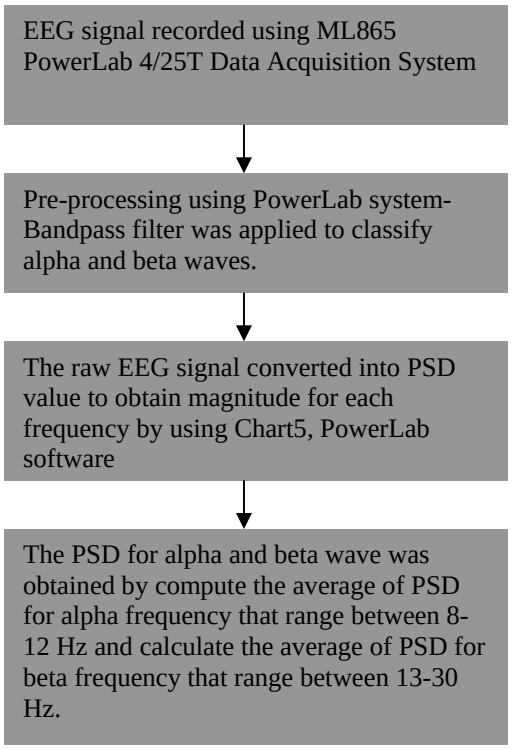

Fig. 1. The flow chart shows the steps taken in processing EEG signal

Statistical Analysis

The statistical analysis was performed using SPSS statistical package version 16.0 for Windows. A nonparametric Wilcoxon test was performed to analyze whether there is a statistically significant differences in mean of alpha and beta wave magnitude while performed IQ test with and without noise exposure. A probability level of $p<0.05$ was taken as significant.

III. Results And Discussion

Fig. 2 shows the mean value of PSD of alpha waves while answering IQ test question with and without noise exposure. The result demonstrated highly significance difference between these two conditions; the mean of alpha's PSD during noise exposure is lower than during without noise exposure. To further investigate the effectiveness of alpha as stress indicator, the mean of alpha's PSD for both conditions was assessed using Wilcoxon test. The statistical results are show in Table 1. The findings showed that there are significant positive difference ($p<0.05$) between the mean value of the alpha's PSD during without (27.51×10^{-12}) and with (13.89×10^{-12}) 90 dB noise exposure. This result indicates that 90 dB noises had distracted and induced tense in subjects.

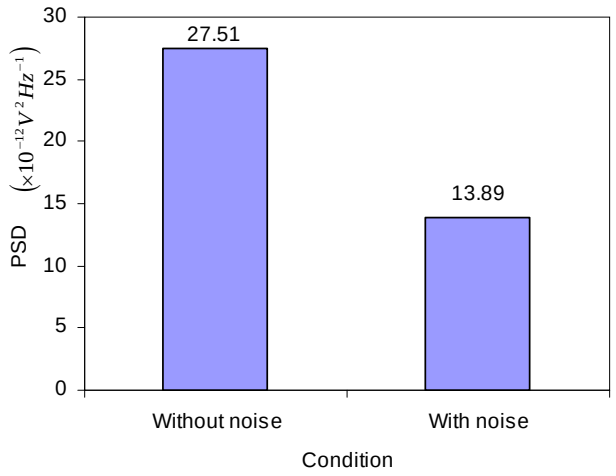

Fig. 2. The bar graph shows the mean value of Power Spectral Density (PSD) of alpha wave while performed IQ test with and without noise exposure

TABLE I
The Mean of Power Spectral Density of Alpha Waves With And Without Noise Exposure for Thirteen male Subjects

EEG signals	Power Spectral Density ($x10^{-12}$ V^2Hz^{-1})		*p*-value
	Without noise	With noise	
Alpha waves	27.51	13.89	< 0.05
Beta waves	1.28	2.65	< 0.05

The mean of PSD of beta waves while answering IQ test question with and without noise exposure are contrast with the

alpha waves analysis. From Fig 3, it is observed that the mean of beta's PSD during noise exposure is higher than during without noise exposure. The statistical analysis proved that the mean of beta's PSD in these two conditions is significantly difference (see Table 1).

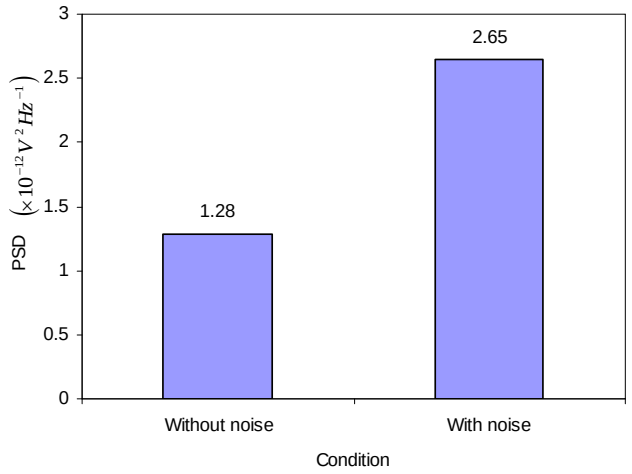

Fig. 3. The bar graph shows the mean value of Power Spectral Density (PSD) of beta wave while performed IQ test with and without noise exposure

TABLE 2
THE MEAN OF IQ TEST SCORE ANSWERED WITH AND WITHOUT NOISE EXPOSURE FOR THIRTEEN MALE SUBJECTS

Test 1 (Without noise)	Test 2 (With noise)	*p-value*
2.89	1.81	< 0.05

The results obtained from this study proved that noise does affect the fast brain activity, this support by the mean score of IQ test and the mean of beta's PSD. From the Table 2, the score for IQ Test 2 that performed during noise exposure is lower than the test taken before the noise exposure. The lower score obtained due to the difficulty to answer the questions in noise environment. The decrease of alpha magnitude and increase of beta magnitude in the noise condition indicates that subjects become tense and the thinking activity of the brain increase. High beta wave/low alpha wave activity has been shown in people with depression, stress, anxiety, epilepsy, and even schizophrenia [5].

IV. CONCLUSION

In conclusion, noise does affect the fast brain activity by increase the magnitude of beta wave and decrease the magnitude of alpha wave. The decrease of alpha waves indicates those subjects in tense and having difficulty to answer the IQ test and as a result the information processing activity in the brain increase represent by the increase of beta waves magnitude. This study also demonstrated that the magnitude of alpha wave can be used as indicator either the person in stress or not.

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