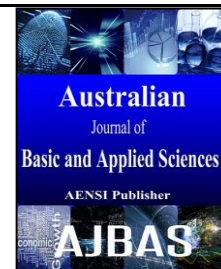




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Effects of an Eye Massage Device Towards Electroencephalography Signals

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ABSTRACT

Background: Eye vision is one of the most important senses in human lives. However, with the highly usage of technology in daily lives, people are exposed to the eyesight problem or also known as asthenopia. This problem is commonly associated with various symptoms such as eyestrain, eye fatigue, headaches and many more. These symptoms often lead to stress condition after a long period of time. One of the alternatives to overcome this problem is by using eye massage device which can relieve the eye muscle activity, as well as promoting relaxation state to mind. Electroencephalography (EEG) is one of the methods to detect the stress level by measuring the electrical activity of the brain. The brain is composed of 4 lobes region that are frontal, temporal, parietal and occipital. Each of the regions has their own function such as movement, memory, sensations and vision. The stress level is most commonly measured by using scalp cap that is attached to the head. The recommended electrode position for the cap according to the International Federation of Societies for Electroencephalography and Clinical Neurophysiology is by 21 electrodes (also called as 10-20). However, for this study, it is only focused on two Channel Points: O₁ and O₂ which involved in visual processing function. Neurofax EEG-9200 machine is used to acquire data and imported it to the MATLAB software for further analysis. *t*-test statistical method is used to validate the data obtained. This study has been conducted to investigate if there is any significant difference for the EEG signals before and after using the eye massage device. The results obtained shown that there are the decrement in the average value of absolute mean for both channel points (O₁: 3.002 μ V, O₂: 2.821 μ V) in the EEG signals. In conclusion, based on it is proven that the eye massage device is effective in promoting relaxation state to mind.

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INTRODUCTION

One of the most important senses in human lives is the eye vision. The inner layer of the eye contains the retina, which is a nervous tissue that is consistent with the brain (Forciea, 2012). It is attached to the eyes with only 2 points that are optic disc and ora serrata (Forciea, 2012). Eye consists of 2 parts of intrinsic muscles that help in eyeball movement: 4 rectus (superior, lateral, median and inferior) and 2 oblique (superior and inferior) (OpenStax College, 2013) as shown in Figure 1.

Nowadays, the technology has been widely evolved around the country as Malaysia has become one of the developing countries in Asian region.

Thus, there are various technologies that facilitate everyday life in various sectors such as education, business and Information Technology (IT).

For an example, children used to play the tablets for the entertainment and playing games, whilst the teenagers were using their smartphone to connect with their friends through social media network, as well as using laptops to complete their assignments (Mansor, 2015). Besides, personal computers or notebooks were also used by the adults to complete their works at homes, offices and elsewhere (Mansor, 2015). They are most probably exposed to the eyesight problem (also called asthenopia) due to excessive usage of technology gadget in a long period of time.

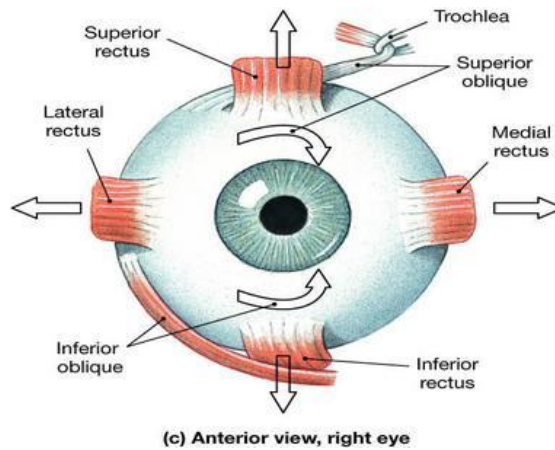


Fig. 1: Intrinsic muscles that helps in eyeball movement (OpenStax College, 2013)

Asthenopia has the most definition of the “eyestrain” (Schapero, Cline and Hofstetter, 1968), which is most commonly related to the computer users (Sheedy, 1992). Most common symptoms that associates with this problem is eyestrain, eye fatigue, discomfort, burning, irritation, pain, ache, sore eyes and headaches (Sheedy, 2003).

These symptoms usually occurred to the person and can lead to the stress condition. There are 3 types of stress such as mental, emotional and physical (Reisman, 1997). EEG is one of the methods to detect the stress level by measuring the electrical activity of the brain (Hoffmann, 2005).

There were many alternatives (treatment of visual conditions and work environment) can be used to overcome this problem as the factors were also varied (Sheedy and Parsons, 1990; Aaras, Horgen, Jorset, Ro and Thoresen, 1998). One of the ways that

has been produced is by using the eye massage device. It used the same concept with the massage chair that uses small push button to massage around the eyes. It also has 7 different types of vibrations with various mode timers: 3, 5, and 10 minutes (Alwi, Mansor and Sudirman, 2015). It can be used anywhere due to its compact size and suitable to be used by all ages.

Electroencephalography (Eeg):

A) Structure of Brain:

The brain structure can be divided into 4 lobes region (see Figure 2) of the cerebrum: frontal, temporal, parietal and occipital (Noback, Strominger, Demarest and Ruggiero, 2005). These lobes have different function as shown in Table 1. For this study, it will be only focused on occipital lobe as it involves in visual processing function.

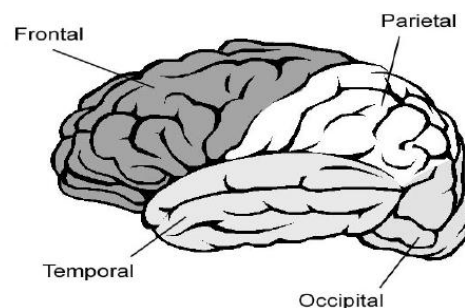


Fig. 2: The lobe regions of the brain (Cleveland Medical Devices Inc., 2006)

Table 1: Lobes region of the brain cerebrum and their different function

Lobe Region	Function
Frontal	<ul style="list-style-type: none"> • Problem solving • Movement • Concentrating • Thinking • Personality
Temporal	<ul style="list-style-type: none"> • Hearing • Speech

	<ul style="list-style-type: none"> • Memory
Parietal	<ul style="list-style-type: none"> • Language • Sensations • Perception • Attention
Occipital	<ul style="list-style-type: none"> • Vision

There are many methods to record the brain structure or their function such as X-ray equipment, ultrasonic equipment, and electrophysiological equipment (Carr and Brown, 2000). By means of electrophysiological equipment, Electroencephalography (EEG) method is used to record the electrical activity produced in the brain.

Electroencephalography (EEG) is the method of recording the electrical potentials produced by the brain and most commonly measured by using scalp cap that was attached to the head (Makeig, 2012). The head area must be cleaned with alcohol or acetone to remove the skin oil (Carr and Brown, 2000). The cap is usually attached with small metal discs (see Figure 3) with good mechanical and electrical properties to collect the brain response (Huang, 2012).

B) Introduction of Eelctroencephalography:



Fig. 3: Position of scalp cap on the head (Alwi, Mansor and Sudirman, 2015)

C) Scalp Electrode:

The setting for the electrode position is by 21 electrodes (also called as 10-20) as suggested by the International Federation of Societies for Electroencephalography and Clinical

Neurophysiology (Jasper, 1958). This electrode position is shown in Figure 4. For this study, the only focused region is the occipital lobe which is denoted by Channel Point O₁ and O₂ because this lobe is important in vision processing function.

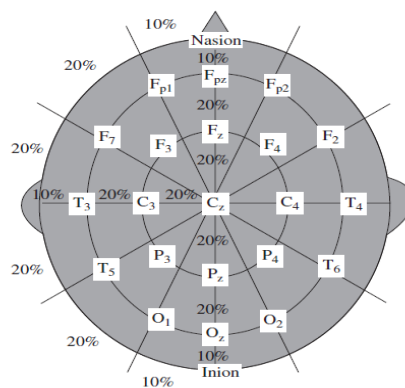


Fig. 4: Placement of 21 electrodes (10-20) electrode position (Sanei and Chambers, 2007)

MATERIALS AND METHOD

A) Experimental Procedure:

There are 4 parts involved in the experimental procedure as shown in Figure 5. Firstly, the subject wears the head scalp and is instructed to sit

comfortably for 60 seconds to obtain the EEG signals before conducting the visual tasks. Then, he must undergo 4 visual tasks designed to give their eyes tiredness as well as interrupt their mind relaxation state. The completion of these tasks shall take about 4 minutes. After the visual tasks finished, he will

then wear the eye massage device for 15 minutes. The device used is using the same concept with the vibration chair. It will massage the eyes for 15 minutes to reduce the fatigues of the eyes after

undergoing the visual tasks. Lastly, after the massage session, his EEG signals are recorded again for 60 seconds.

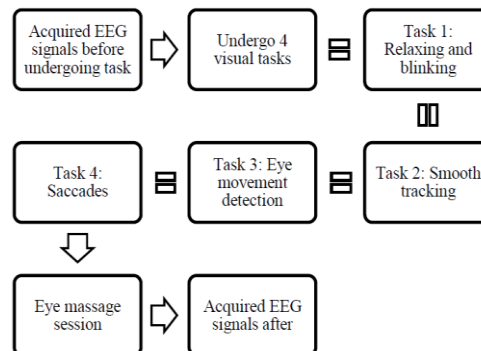


Fig. 5: Flowchart of experimental procedure

B) Visual Tasks:

The 1st visual task is relaxing and blinking. The subject need to blink his eye for 4 times in each 15 seconds interval to record the blinking artefacts and distinguish it from the actual EOG signals obtained throughout the experiment.

The 2nd visual task is smooth tracking. In about 60 seconds, the pen will move to both right and left sides of the screen. Therefore, the subject needs to look for the direction of the pen without been affected by something else. The eye movements involved in this task are looking horizontal right and looking horizontal left.

The 3rd visual task is eye movement detection. The dots will appear on the screen at random directions and the subject need to look for the dots to record another 4 eye movements that are looking up right, looking up left, looking down right and looking down left.

The 4th visual task is saccades. An article paragraph is displayed on the screen and the subject needs to read throughout the article in given 60 seconds. The font article given was in gray light, contrarily to the background which is in dark gray to stress out the eye muscles throughout the task.

C) Flowchart of Data Analysis:

Firstly, the data acquired by using Neurofax EEG-9200 machine is converted to ASCII format and imported to MATLAB software. MATLAB is used to filter the noises as well as gave the average values of absolute mean for each of tasks conducted. The mean results is then averaged and tabulated to look for the difference in the value of EEG signals before and after conducting the eye massage session. *t*-test statistical method is used to validate the results obtained throughout the experiment. The flowchart of data analysis is as shown in Figure 6.

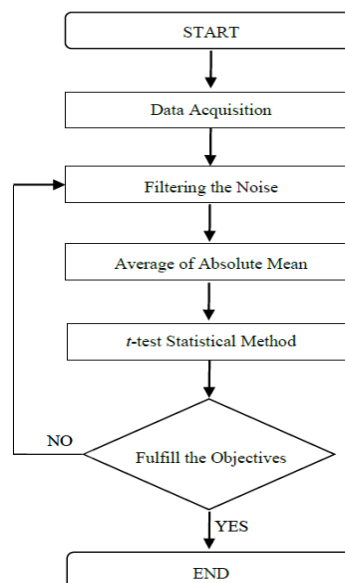


Fig. 6: Flowchart of data analysis

RESULTS AND DISCUSSION

Table 2 shows the comparison of average value of absolute mean and *t*-test condition for both channel point O₁ and O₂. From the results obtained, the average mean value for both channel points has been decreased between the EEG signals before and after using the eye massage device. For Channel Point O₁, the difference of average mean is 3.002 μV, while for Channel Point O₂, the difference of average mean value is 2.821 μV. Figure 7 and 8 shows the graphical view of the comparison between the average value of absolute mean for Channel Point O₁ and O₂ respectively.

In order to validate both results, *t*-test statistical method is used. The test applied is a paired *t*-test as the data came from same sets of people, but in different conditions.

There are 2 hypotheses can be formed in this *t*-test analysis:

a) *Null hypothesis (H₀)* : There is no difference in average of absolute mean values of the EEG

signals before and after using the eye massage device.

b) *Alternative hypothesis (H₁)* : There is a difference in average of absolute mean values of the EEG signals before and after using the eye massage device.

If these conditions are fulfilled, then the null hypothesis is been rejected:

a) *t-statistical* > *t-critical two-tails*

b) *P (T ≤ t) two-tails* ≤ *a* ; *a* = 0.01

Referring to Table 2, two-tailed P-value for Channel Point O₁ is 0.000121. Hence, it means there is only 0.0121 % chance that there is no difference in average of value absolute mean of the EEG signals before and after using the eye massage device. For Channel Point O₂, the value of two-tailed P-value is 0.000063. It means there is only 0.0063 % chance that there is no difference in average of value absolute mean of the EEG signals before and after using the eye massage device. Hence, based on the sample data collected, it is considered that there is a significant different between the EEG signals before and after using the device.

Table 2: Comparison of average value of absolute mean and *t*-test condition for both channel point O₁ and O₂

Channel Point	Average Value of Absolute Mean (μV)			<i>t</i> -test Condition	
	EEG Signals Before	EEG Signals After	Difference of Average Value of Absolute Mean (μV)	<i>t</i> -statistical > <i>t</i> -critical two-tails	<i>P (T ≤ t) two-tails</i> ≤ <i>a</i> ; <i>a</i> = 0.01 ^a
O1	10.469	7.467	3.002	4.544 > 2.787	0.000121 ≤ 0.01
O2	8.853	6.032	2.821	4.798 > 2.787	0.000063 ≤ 0.01

^a a is the coefficient

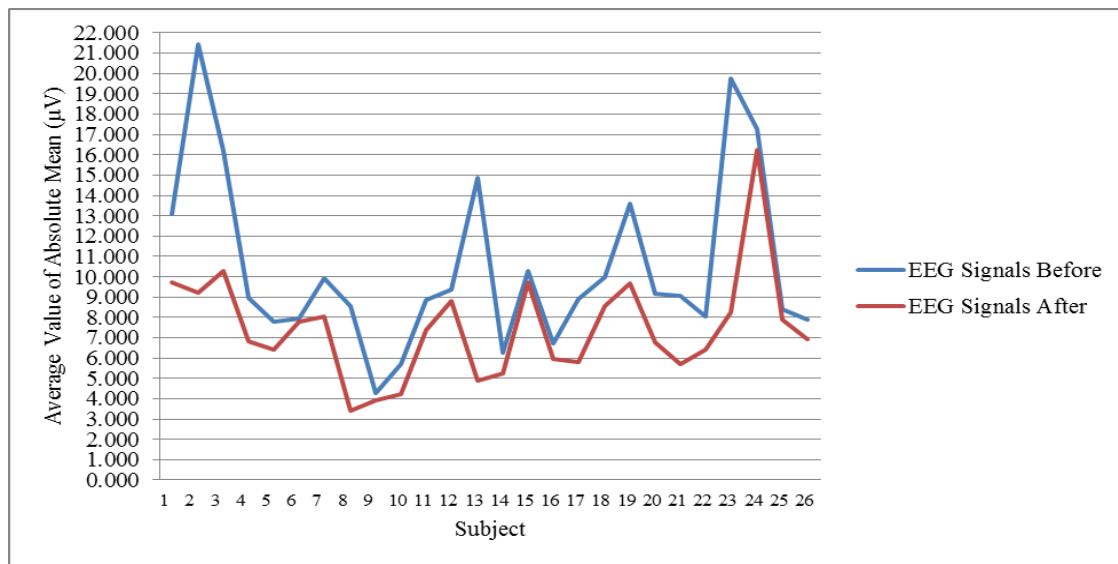


Fig. 7: Graph of average value of absolute mean for both EEG signals before and after using the eye massaging device for Channel Point O₁

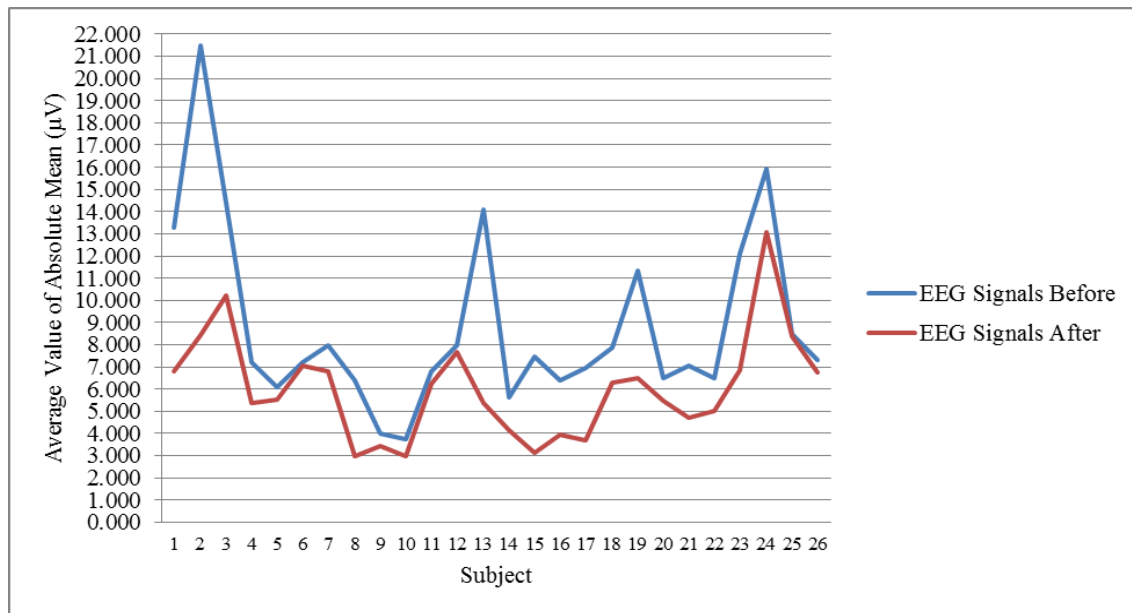


Fig. 8: Graph of average value of absolute mean for both EEG signals before and after using the eye massaging device for Channel Point O₂

Conclusion:

It can be concluded that there is a significant difference between the EEG signals before and after using the eye massage device based on the sample data collected in this study. Mostly, the amplitude of EEG signals is decreasing after using the device. The *t*-test statistical analysis has validated that the Channel Point O₁ and O₂ have small chances that there is no difference in both conditions tested. However, it is highly recommended that more study is required in the future as the sample size in this study is much smaller in value.

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