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Experimental Study on The effects of Visual Stimulus on Beta Brain Waves in traffic accident victims with *Post Traumatic Stress Disorder*

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ABSTRACT

Post traumatic stress disorder (PTSD) is a stress disorder that is caused by traumatic events that are considered a threat to someone's life and to be frightening eventsPost-traumatic stress disorder as a result of traffic accidents are mostly found in Indonesia. This is due to the increasing number of residents who have private vehicles. The aim of this study is to determine the effects of visual stimulus in the form of images of a traffic accident on the beta brain waves of subjects. Therefore the illustration of a PTSD individual's beta brain wave can be obtained. This is important to assist in strengthen the diagnosis of PTSD with different methods using *non-invasive* electroencephalograph device (EEG). It is known that post-traumatic stress disorder has made a dysfunction in the central nervous system area, especially in the area of medial prefrontal cortex, hippocampus, and amygdala (Bremner, 2002). Research conducted by Hammond (2007) shows that the right frontal area (F4), parietal area (P3, P4), and the middle area of the brain (Cz) have a high level of beta brain waves in PTSD subjects. The type of research used is experiment with *nonequivalent control group design*.There are six individuals which makeup the research sample which consists of 3 individuals as experiment group (PTSD) and, three individuals as control group (non PTSD).The analysis result shows that the experimental group experiencesincreasingbeta brain waves in the right frontal area (F4), parietal (P3, P4), and the middle area of the brain (Cz), while the control group has experienced declining beta waves. The conclusion is that Individuals with PTSD experience *anxious arousal* while non-PTSD individuals do not experience anxious arousal.

Keywords: *Posttraumatic stress disorder, Electroencephalography, Brainwave, traffic accident* :

Introduction

Post Traumatic Stress Disorder is a disorder caused by a traumatic event that an individual considered as a threat to their life. There are numbers of traumatic events that can trigger PTSD such as natural disasters, traffic accidents, nuclear explosions, torture, rape, and wars or conflicts (APA, 2000). Based on DSM-IV TR, PTSD is characterized by three main symptoms ;*(1) hyperarousal* (physical and psychological arousal), (2) *re-experiencing of the event* (Individuals feel/ assume that they re-experiencing the same traumatic events), (3) Avoidance (Avoid everything that is associated with the traumatic event).

Referring to the types of traumatic events above, it is known that traffic accident is one of the events that can cause post-traumatic stress. Based on the data published by (WHO) on traffic accidents, Indonesia is the country with the highest increase in traffic accidents. Indonesia is third on the list for the number of accidents. Therefore, Indonesia has great potential for PTSD cases. Based on the data, researcher can make a conclusion that there are victims killed in the traffic accidents and survivors.

Post traumatic stress disorder is closely related to neurobiological and psychological systems. According to DSM –IV TR, PTSD not only resulted in three main symptoms but also neurological response. Brain neural activity presents how active a particular brain area is. According to Horlings (2008), the limbic system is closely related to post traumatic stress disorder. It is known that the amygdala is connected directly to the frontal cortex, thereby measuring brain activity through brain waves using electroencephalography can be done. Brain waves can show a person's consciousness in certain circumstances, such as when they are in a high awareness, relax, sleep, dreamless sleep, even a state of stress.

Electroencephalograph (EEG) is a device that is easily accessible and useful in relation to the measurement of brain activity. When it is compared with other brain imaging devices such as fMRI, MRI, CT-Scan, MEG,

SPECT, and PET, electroencephalography is considered to be more practical and simple to use. EEG does not use chemical substances and does not deliver any radiation to individuals, therefore EEG does not have side effects on the patients. There have been many neuroscience studies on stress response. Unfortunately, the results of those studies are not optimal,especially study results that is related to PTSD and its treatment.

Keep in mind that this study is part of a larger research concerning individual treatment of PTSD through Eye Movement Desensitization and Reprocessing (EMDR) therapy. Therefore, the results of this study are useful as a *baseline* and measurement indicators of the effectiveness of these therapies. In addition, this study is expected to provide the readers with a better understanding/more knowledge about post traumatic stress disorder (PTSD) as viewed from brain wave activity.

Based on the above explanation, the researcher will measure brain activity of traffic accident victims who suffer from PTSD. Measurement is conducted using electroencephalography.

The areas of the brain that are measured are right frontal and parietal areas using F4, P3, P4 and Cz electrode channels. Therefore the image (illustration) of brain activity of individuals with PTSD can be obtained by measuring an increase or decrease in *the amplitude spectral density* of beta brain waves.

Research methods

The study design used is *nonequivalent control group* (Christensen, 1988), which in this study the two groups are not equivalent and the difference of these groups are compared from the *baseline* and treatment phases. The experimental group is measured at *baseline* and *treatment*phases before evaluating the decline or the increase.

Control group is also measured at *the phases of baseline 1* and baseline 2 followed by evaluating the decrease and increase.When the stimulus is being given, measurement is conducted to see the difference. Finally, the result of the increasing or the declining of

beta brain waves of each group is compared as shown in table 1.

Table 1. Research Design of non-equivalent *Control Group* (Christensen, 1988)

	Pre	Treatment	Post	Difference
EG	Y_1	X	Y_2	Y_1-Y_2
CG	Y_1		Y_2	Y_1-Y_2

EG = Experimental Group
CG = Control Group

The aim of this study design is to see the effect of giving a visual stimulus on the changes in beta brain waves of individuals suffering from PTSD by comparing the differences between the two groups.

Therefore, the researcher can find some data which illustrate beta brain waves of the individuals suffering from PTSD . Experimental group consists of individuals who suffered from PTSD and Control group consists of individuals who do not suffer from PTSD that become the baseline in evaluating the effects of visual stimulus treatment.

There are six people respondents ,whereas three individuals are in experimental group and three other individuals are in control group. The characteristics of the samples are defined as follows:

1. The individuals (the traffic accident victims) are diagnosed as suffering from PTSD by Psychologists and hospital Medical Doctors.
2. Adults aged between 20 and 25
3. Their five senses are functioning normally
4. They do not have a history of mental illness or brain disorder
5. They never received any psychological treatment concerning PTSD
6. They do not consume addictive or psychoactive drugs
7. They are willing to take the treatment and sign informed consent form provided by the researcher.

EEG study design is divided into three segments, in which each segment has a duration of 3 minutes. The first segment is EEG recording of neutral phase 1, the second is EEG recording

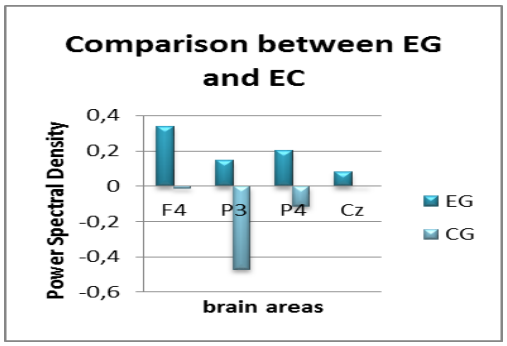
of neutral phase 2, and the third segment is treatment phase. The stimulus used in this study is visual stimulus in the form of pictures of the accident scene displayed on a screen.

Before recording is conducted, the individuals should have enough rest and have had breakfast. During the recording, the individuals are lying on a bed where the stimulus screen is positioned in front of them. This is intended to reduce the brain wave artifacts during the measurement process, because if there are wave artifacts, brain waves cannot be quantified.

When the *Nicolet* electroencephalograph device, the individual, and the measurement staff are ready, EEG electrodes are installed on the individual. During the measuring process, the individuals are asked to open and close their eyes. Measurement is conducted based on the design made. There are several stages in the raw data process. The first stage is to conduct beta brain wave and selected electrode channels filtration.The second stage is to change the raw data of brain waves which have format (.e) into the format (.txt) using EEG LAB *software*, to obtain the value of amplitude *spectral density* that indicates the amplitude of the brain waves. The third stage is the filtration of PSD (Power Spectral Density) number/coefficient based on brain areas/electrode channels used. The fourth stage is to calculate the variance between the two phases in each study group, in order to obtain knowledge about the increasing or decreasing ofbeta brain waves. The last stage is to make the final result into histogram to see the level of the declining of the brain wave amplitude clearly.

Result

Based on the results of data processing , an output is obtained in which there is an increasing beta brain wave of the four brain areas ; right frontal (F4), the left and right parietal (P3, P4) and the mid- brain (Cz) but, the opposite happens in the control group. It is shown in graph 1.



Graph 1 The amplitude of beta brain wave of each individual

*Amplitude spectral*the increasing and decreasing beta brain wavesin each brain area is presented in table 2 below:

	EG	CG
F4	0.34	-0.01
P3	0.15	-0.47
P4	0.2	-0.11
Cz	0.08	0

Table 2 Average Amplitude of Spectral Density between EG and CG

F = Frontal
P = Parietal
Cz=Central Zone

Based on the graph and the table, it is clear that the right frontal area (F4) of the experimental group experience hyperactivity characterized by increased beta brain waves (PSD = 0.34). Meanwhile, the control group experiences a decreased brain activity that is characterized by decreased beta brain wave (PSD = 0.01).

The experimental group‘s left parietal area (P3) experiences hyperactivity characterized by increased beta brain wave (PSD = 0.15), meanwhile the control group experiences decreased betawave (PSD = 0.47).

In the right parietal are (P4) of experimental group, there is increased beta brain wave (PSD = 0.2), while the control group experienced decreased beta brain wave (0.11

In the mid brain (Cz), the experimental group has experienced increased brain activity that is characterized by increased value of PSD (0.08).On the other hand, there is no changes in brain activity (PSD=0) of the individuals in experimental group.

Discussion

Beta brain wave indicates that a person is at a relatively high level of awareness, including when the person is in a depressed condition. The increase of beta brain wave in certain areas of the brain indicates an activity

is happening in that brain area. Similarly, the decline of beta brain waves in specific brain areas indicates there is decreasing activity in that brain area.

Based on Emotional Dimensional models introduced by Davidson (1999) and Horlings (2008), there are two dimensions which are positive-negative / like-dislike / approach-avoidance and, arousal / annoyed. The right hemisphere of eachindividual in experimental group is more active than the left hemisphere. This means that on the first dimension, the individuals of experimental group have experienced avoidance to the stimuli that is associated with the traumatic experience.

In the second dimension, the right hemisphere is dominantly more active than the left hemisphere. This indicates that the individuals have experienced anxious arousal. This is also supported by the hyperactivity of the right frontal area (F4) which is responsible for the emotion processing. The experimental group has experienced the increased strength / hyperactivity of beta brain waves. This indicates that individuals with PTSD experience emotional arousal. There is also an increase in parietal area (P3, P4) which can indicate that the experimental group has experienced anxiety and wariness.

In addition, the central area of the brain (Cz) of the experimental group also shows an increase / hyperactivity. This supports the existence of a specific motor response which is also a reflex response of brain activity / excessive anxiety and avoidance of the individuals in experimentalgroup / individuals with PTSD.

Conclusion

1. There are effects of visual stimulus treatment in the form of images of traffic accidents to the individuals with PTSD indicated by an increase in the value of *the amplitude spectral density* of beta brain waves.
2. The increased amplitude of beta brain waves indicates that individuals with PTSD have experienced withdrawal or avoidance,*anxious arousal),*

anxiety, and excessive negative emotions (fear).

3. Each individual with PTSD has a different *range of* beta brain waves strength/level because every individual has his/her own characteristics.

Suggestion

1. For further research, it is recommended that control group should consist of the individuals with PTSD, in order to see a better and clear dynamic that occurs.
2. More research subjects/individuals are needed to enable significance test (statistic) to be used and PSD standard value can be made based on total result of individuals' brain wave measurement.
3. It is recommended to select individuals with PTSD who suffered from traffic accidents that happened at the same / relatively close period of time.

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