



Comparison Between Positive And Negative Probes By Using Brain Electrical Oscillation Signature Profiling System

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ABSTRACT

Crime is increasing at an alarming rate. Everyday new types of crimes are being committed. Most of the time, physical evidences are destroyed. So, it is often difficult to find out the culprit. It takes many years for a case to be solved. The Brain Electrical Oscillation Signature Profiling System (BEOS) is a forensic psychological investigative technique which tries to detect whether an individual has experience of an event or not. It is often used as a tool in investigation. It is the most effective psychological investigative instrument till date. The objective of the study is to compare between the number of EK between positive probes and negative probes by using Brain Electrical Oscillation Signature Profiling System. Positive probes were prepared on the basis of the real experience of an individual and negative probes were prepared just as the opposite of positive probes, or the opposite of the experience shared by the individual for preparing the positive probes. 30 subjects were used for the purpose of data collection. Both positive probes and negative probes were administered on each subject. A total of 60 data was collected. The paired t-test was used for the purpose of statistical analysis. After carrying out the statistical analysis it was found out that, the number of EK for positive probes was greater than the number of EK for negative probes. From the result of the study it was found out that BEOS was effective in differentiating between real and false experience. For most of the subjects, EK also came in the negative probes. From this finding, it can be interpreted that even if an individual denies having experienced an event, BEOS will be efficient in finding out the truth and in eliciting EK for the experience.

Keywords: Brain Electrical Oscillation Signature Profiling System, BEOS, Positive probes, Negative probes, Experiential Knowledge, Memory, Positive probes and Negative probes

INTRODUCTION

Crime is an act punishable under law. It is an integral part of our society. Despite several stringent laws, actions taken, and despite the emergence of new technologies to prevent and detect crimes, crime rate is on the increase. Third degree is a type of treatment sometimes used in police stations to gain truth from the suspect, but this is against the human rights of any individual, illegal and can't be justified. Many innocent people are also harassed due to this.

Most of the time, the physical evidences are destroyed even before the forensic experts reach the crime scene. The scene is either contaminated due to the presence of many people, media persons or it is deliberately cleaned to avoid detection of any evidence which may lead to detection of the culprit. In such situations, it becomes very difficult to identify the culprit from physical evidences. In those situations, forensic psychological investigative techniques are used to find out the truth and to identify the culprit.

There are many forensic psychological investigative instruments such as the Polygraph, Suspect Detection System, Layered Voice Analysis, and Narco analysis which are used to find out the truth. Among these forensic psychological investigative techniques, one of the most effective investigative instrument is the Brain Electrical Oscillation Signature Profiling System (BEOS). It is not a lie detector. It is a memory-based instrument. It is a neuropsychological instrument. BEOS is used for investigative purposes. It has a high level of accuracy in terms of memory detection.

Brain Electrical Oscillation Signature Profiling System (BEOS)

Brain Electrical Oscillation Signature Profiling (BEOS or BEOSP) is a technology which is based on a computer system. This system was developed by Prof C. R. Mukundan. It was developed in India. BEOS is a neuropsychological instrument based on the principle of memory. It is an Electroencephalogram (EEG) based technique. This system detects the presence of Experiential Knowledge (EK). EK is elicited only when an individual has experience of an event or has participated in the event. This system tries to detect the presence of EK through a person's brain waves. BEOS is based on a person's cognitive processing. BEOS uses measurement of retrieval of EK (events/ actions participated/committed by self) acquired by an individual in the past. This can be taken as signatures created in the brain. A signature means a specific type of electrical activity in our brain which marks remembrance or EK (Mukundan, S, & M., 2017). BEOS is a technology by which participation of a person in a crime is detected by electing electro physiological impulses.

BEOS is based on the principle of dual memory system. One is knowing and another is remembrance. Neuroimaging studies have found out differences in the neural activation patterns of knowing and remembrance of experience.

System Used in Knowing

It involves knowing using retrieved information. Knowing is memory of conceptual information which is used for the recognition of objects, persons, entities, conditions, changes etc. Knowing is also called recognition. Recognition involves semantic memory. During recognition, generally minimal brain resources are utilized. This is because only minimal information is required for the process of recognition. The areas of the brain involved in recognition are dorsolateral prefrontal cortex and other sensory areas. Mainly the dorsolateral cortex is activated during the mechanism of recognition. Recognition is based on P300. The P300 wave is an event related potential (ERP) component that is elicited when a person is involved in decision making.

System Used in Remembrance

Remembrance is memory of experiences that are acquired during participation in an act. Remembrance mainly involves the recall of episodic or autobiographical memory. Autobiographical memory is memory of personal life experiences or various events. Remembrance is based on higher mental activity of the brain. It is based mainly on gamma activity. Remembrance in the BEOS system is triggered by presentation of cues to the suspect or subject in the form of probes. Many areas of the brain are activated during remembrance. It involves extensive activation of the Anterior Cingulate Cortex, Medial Temporal Lobes, Orbitofrontal Cortex, Limbic System, Sensory-Motor Cortex.

Accuracy of BEOS

A normative study was conducted which was supported and managed by Technology Information Forecasting and Assessment Council (TIFAC) of India, New Delhi and Directorate of Forensic Science, Gandhinagar. The aim of this study was to determine the accuracy of BEOS. The study was conducted on 56 experimental and 54 control volunteers. These individuals were selected from the city population after examination on General Health Questionnaire. It was a simulation study. In this experiment each subject who were in the experimental group had to do numerous performances using the materials that were in a testing room. The subjects who were in the control group had only knowledge of these acts. The list of probes was read by the subjects of both the experimental and the control group. They read the probes before they were subjected to BEOS administration. The EK scores of both the groups were analyzed. It was found out that BEOS has a sensitivity of 95% and specificity of 94%. With a cut of score using 3-SD of the control group, the specificity reached 100% (Mukundan, et al., 2008). This study has been very helpful in understanding the accuracy of BEOS in its practical application. It has been an aid in the investigation of more than 500 forensic cases in forensic science laboratories of Mumbai and Gujarat.

Procedure of BEOS Administration in Forensic Setup

- a) First of all, for administration of BEOS in investigation, permission from the Court is required.
- b) Then, after the investigating officer shares all the details related to the case, the suspect is brought.
- c) Forensic interview is conducted for understanding the suspect's point of view, for getting their side of the information.
- d) Psychological assessment of the suspect is done to understand whether the person is mentally fit for BEOS administration. BEOS can't be used for investigation of suspects having mental problems.
- e) The suspect is informed about the instrument.
- f) Consent of the suspect is taken.
- g) Then, after necessary preparation, administration of the entire test procedure is done.

Advantages of BEOS Test

- 1) The suspect or subject does not need to give any oral response during the test. So, it is in accordance with Article 20(3), which is an act of the constitution of India, which states that any person cannot be forced to be a witness against himself/herself.
- 2) It is possible to understand the role of each suspect in a crime if multiple suspects are present.

BEOS in the Context of Indian Law

According to the Indian Evidence Act of 1872, evidence includes statements which are permitted by the Court or is made before the Court by the witnesses; it is concerned with those facts which are related to the matters under investigation. These statements are called 'Oral' evidence. Documents are also produced for the inspection of the Court. These types of documents are called 'Documentary' evidence. Evidence is given regarding facts in issue and regarding facts which are relevant. Law of Evidence includes testimony, which can either be oral testimony or written testimony and exhibits (e.g. physical objects). It also includes documents which are admissible in the Court of law. The development of Brain Mapping technology has transformed the direction of the investigation of crime in the country and has obtained acknowledgements by the Judiciary and Investigating agencies. Brain mapping technology has survived a succession of challenges by the legal system under Article 20 (3) and Article 21 of the Indian Constitution (LexisNexis, 2016). Section 45 of the evidence act of India, deals with the importance of opinion of an expert. This law is enforced when the court has to form an opinion regarding a foreign law or science or art, or has to identify the handwriting or finger impression. In such cases, expert opinion in the matter made by a person who is an expert in the matter and is skilled in such foreign law, science or art, or in matters related to the identification of handwriting or finger impression are considered as relevant facts. Such persons are called experts.

What is Memory?

The word memory is derived from the Latin term 'memoria', which means past account or remembrance. Memory is a storage of our knowledge and experiences. It is the remembering of our experiences and past events. Memory involves recall and recognition. Memory has three interrelated components. These are-

- **Encoding-** Encoding is the process of receiving, processing, and merging information. In the process of encoding, information from the external world reaches our senses in the form of biochemical and physical stimuli. Encoding is an active process by which information is put into memory.
- **Storage-** Storage refers to the storing of information in memory. In this stage, some parts of the information are stored in various memory stores of the cerebral cortex in the form of neuro-physiological traces. It is also known as retaining.
- **Retrieval-** Retrieval refers to the process of bringing the stored information to the level of consciousness. It is the process of recovering stored information from memory.

There are three types of memory. They are as follows: -

- a. **Sensory Memory-** Any information related to an external stimuli first enters the sensory memory. The capacity of the sensory memory is large. But the duration of sensory information is very short. It has 2 parts- Iconic Memory or Visual Sensory Memory and Echoic or Auditory Sensory Memory.
- b. **Short-term Memory-** The information passing through the sensory memory enters this memory. It has limited capacity and storage time is also limited. It is also called the working memory. Information in this memory is maintained by maintenance rehearsals.
- c. **Long-term Memory-** The information that survives the capacity and duration of Short-term memory enters this memory. The storage here is unlimited and information here is stored permanently. Information in this memory system is encoded semantically. From short-term memory, the information moves to the long-term memory through elaborative rehearsals.

Relevance of Memory in Investigation

Memory distortions tend to occur due to the passage of time (Lacy & Stark, 2013). One of the most important reasons for this is that, some of the memories may deteriorate from being highly detailed to being more generalized, there will be loss of details. This type of forgetting occurs for most of the memories. Also, there are different theories which describe the reason for the forgetting of information. One of them is the decay theory.

According to the decay theory, when an information is not used for a long period of time, the memory for that particular information slowly fades until no trace of the memory is left. Studies have been carried out for finding out the effect of time duration between witnessing a crime and giving testimony related to the crime. These studies have found out that an individual may often not be able to differentiate between true and false memories. BEOS is very much relevant here and is of importance when given as scientific evidence in the court of law. When an individual is not able to differentiate between true and false memories, be it a suspect or witness, then administration of BEOS will be helpful. As BEOS can detect for which of the information an individual has experiential knowledge.

BEOS is based on the principle of episodic memory or autobiographical memory. Autobiographical memory includes memory related to any personal experience. It includes memories of personal experience or events which are of significance to an individual.

The present research study deals with positive probes and negative probes. Positive probes are made on the basis of the information given by the subject regarding any pleasant or unpleasant incident of their life. For example- That day I went to university. Negative probes are created as just the opposite of positive probes or as just the opposite of the information given by the subject or opposite of the experience of the subject. For example, that day I didn't go to university.

LITERATURE REVIEW

Emotion is a major aspect of human memory. Positive feelings and negative feelings are capable of making profound influences on human memory. These experiences are capable of producing experiential knowledge in a person's memory. In 2018, a research study was conducted to explore the positive and negative experiences of an individual through BEOS Profiling and to find out which type of emotions have more influence on memory, i.e. whether positive life events of an individual have more impact on remembrance or negative life events. 20 participants were part of the study. After conducting the study, it was found out that both negative emotion and positive emotion almost equally produces experiential knowledge (Kacker, 2018).

A research was conducted to detect the remembrance of recent memory vs remote memory, i.e. to compare the number of experiential knowledge of subjects between a remote memory and recent memory of their life. 10 subjects were used for the study. Each subject was asked to give 2 memories of their life, one a recent memory which had taken place within one and a half years of their life and another a remote memory which was six to seven years old. Both the recent and remote memory which was taken from a particular subject was of similar nature in terms of emotion and theme. It was a quasi-experimental study. From the study it was found out that BEOS is effective in the detection of experiential knowledge in memories which are many years old. This also led to the conclusion that BEOS is effective in investigation of cold cases. Even investigation of very old cases can be helped with BEOS profiling (Pendse & Kacker, 2020).

A normative study was conducted which was supported and managed by Technology Information Forecasting and Assessment Council (TIFAC) of India, New Delhi and Directorate of Forensic Science, Gandhinagar. The aim of this study was to determine the accuracy of BEOS. The study was conducted on 56 experimental and 54 control volunteers. These individuals were selected from the city population after examination on General Health Questionnaire. It was a simulation study. In this experiment each subject who were in the experimental group had to do numerous performances using the materials that were in a testing room. The subjects who were in the control group had only knowledge of these acts. The list of probes was read by the subjects of both the experimental and the control group. They read the probes before they were subjected to BEOS administration. The EK scores of both the groups were analyzed. It was found out that BEOS has a sensitivity of 95% and specificity of 94%. With a cut of score using 3-SD of the control group, the specificity reached 100% (Mukundan, et al., 2008). This study has been very helpful in understanding the accuracy of BEOS in its practical application. It has been an aid in the investigation of more than 500 forensic cases in forensic science laboratories of Mumbai and Gujarat.

The BEOS test is a memory-based test. A research was conducted to determine the effectiveness of BEOS for measuring the process of remembrance. It was conducted in Axxonet Brain Research Laboratory of Bangalore, India. Remembrance of a formerly experienced event may be activated by cues presented to a subject. Remembrance of an event occurs only if an individual had either committed an activity or had seen an activity. This is very much unlike from getting to know about the same activity from an outside source. Remembrance of an experience may be choked or lost because of devastating states like repression or deteriorating processes of the brain. In these situations, the test cannot be performed on the individual. The technique has gone through authentication studies and has since been effectively used in forensic investigations. Numerous cases have been examined using this process (Mukundan, S, & M., 2017).

OBJECTIVE

The objective of the present study is to detect whether there is any significant difference in the number of EK between positive probes and negative probes.

METHODS**Design of Study**

The present study is an experimental study. There are two types of variables- Independent variable and Dependent variable.

The Independent Variable (IV) of the present study – Probe, Levels of IV are i) Positive probes, ii) Negative probes

The Dependent Variable (DV) of the present study - Experiential Knowledge of subject

Sample

A total of 30 participants were part of the study. The participants were aged between 18 to 30 years of age. The participants for the study were chosen from Gandhinagar, Gujarat. Purposive sampling method was used for choosing the participants for the study. Both male and female were part of the study.

Inclusion criteria

- a. Individuals aged between 18 to 30 years of age.
- b. Individuals who knew English language were chosen for the study.
- c. Both male and female were included in the study.

Exclusion criteria

- a. Individuals aged less than 18 years or more than 30 years were not included in the study.
- b. Individuals with mental disorders or any mental problem were not taken for the study.
- c. Individuals not having proper knowledge of English language were excluded.

Hypothesis

There will be no significant difference in the number of EK between positive probes and negative probes.

The Instrument used

Brain Electrical Oscillation Signature Profiling (BEOS) was used for the present study. This instrument was developed by C.R. Mukundan, neuroscientist, former professor and head of clinical psychology at the National Institute of Mental Health and Neurosciences in Bangalore. He worked as a Research consultant in the TIFAC DFS project. This instrument was developed in the year of 2003. BEOS consists of the Visual Auditory Stimulus Program (VASP) and the Neuro Signature System (NSS). The VASP is used for entering the probes and auditory recording of the probes and the NSS is used for auditory administration of the probes. The NSS displays the head map, EEG graph etc. Electrode cap, Electrode gel, reference electrode, battery and SPU were used for conducting the research.

Procedure

The objective of the study is to carry out a comparison between the number of EK between positive probes and negatives probes by using Brain Electrical Oscillation Signature Profiling system (BEOS).

Steps of Pre-Test Preparation

- a. Individuals of age ranging between 18 to 30 years were chosen for the study.
- b. Both male and female were part for the study.
- c. Each individual was explained about the topic of the study and the procedure of the study in a detailed manner.
- d. Consent form was filled up by each individual.
- e. Then each individual was asked to give either a pleasant or an unpleasant incident of their life.
- f. A questionnaire was filled up by each one of them, containing their socio-demographic information and also information related to the incident shared by them.
- g. Interview was conducted for each of the subjects.
- h. Audio recording of the interview was done.

Designing of Probes

Either a pleasant or unpleasant incident of the individual's life was used for preparation of the probes. 2 sets of probes were prepared for each individual. One set was of positive probes and another set was of negative probes. Positive probes were developed on the basis of the information received from the individual. Negative probes were developed as just the opposite of the positive probes. For example, positive probe- I went to my home, negative probe- I didn't go to my home. In each set, the number of probes ranged from 115 to 120.

Process of Administration

The probes, both positive probes and negative probes, were entered into the VASP. In the VASP, auditory recording of the probes were done. Then, the auditory probes were exported to the NSS. After that, each subject was brought to the lab for the BEOS administration. The subjects were asked to wash their hair before coming for the test. The subject was made to sit on a chair designated for the administration process. The subject was made to wear an electrode cap and electrode gel was injected into the electrodes with the help of a blunt needle. Reference electrodes were connected to the earlobes of both the ear, gel was also put into those electrodes. After all the necessary connections and arrangements were made, the test was conducted. Both the positive probe set and the negative probe set were administered with a gap of few minutes. After the test was over, the report was autogenerated.

RESULT AND ANALYSIS

Statistical analysis was carried out using the SPSS software. Paired t-test was used for carrying out the statistical analysis. Mean value and Standard Deviation value was also found out for the number of EK in positive probes and for the number of EK in negative probes.

Table 1- This table shows the value of mean and SD for the number of EK in positive probes and negative probes

| TYPES OF PROBES | MEAN | STANDARD DEVIATION |
|-----------------|-------|--------------------|
| Positive | 18.40 | 10.324 |
| Negative | 13.97 | 10.829 |

From this table, it can be seen that the value of mean for the positive probes is 18.40 and the value of mean for the negative probes is 13.97. The mean value indicates that the value of mean is more for the number of EK for positive probes than for the number of EK for negative probes. From this value, it can be inferred that the number of EK is more for positive probes in comparison to the number of EK for negative probes.

Table 2- This Table shows the value of paired sample t-test for the number of EK in positive probes and negative probes

| PROBES | T | Df | Sig. 2 tailed |
|--------------------------|-------|----|---------------|
| Positive EK- Negative EK | 3.603 | 29 | 0.001 |

The paired t-test value for the number of EK in positive probes and negative probes is 3.603. The significance value is 0.001. The null hypothesis was that there will no significant difference between the number of EK in positive probes and negative probes. The significance value found from the statistical analysis indicates that there is significant difference in the number of EK between positive probes and negative probes. Thus, the null hypothesis is rejected.

Table 3- This table shows the number of EK for each subject for positive probes and negative probes

| NAME | POSITIVE EK | NEGATIVE EK |
|------------|-------------|-------------|
| Subject 1 | 33 | 33 |
| Subject 2 | 33 | 12 |
| Subject 3 | 19 | 23 |
| Subject 4 | 9 | 4 |
| Subject 5 | 10 | 9 |
| Subject 6 | 28 | 27 |
| Subject 7 | 21 | 18 |
| Subject 8 | 19 | 23 |
| Subject 9 | 38 | 26 |
| Subject 10 | 12 | 2 |
| Subject 11 | 21 | 21 |
| Subject 12 | 23 | 11 |
| Subject 13 | 22 | 18 |
| Subject 14 | 21 | 9 |

| | | |
|------------|----|----|
| Subject 15 | 31 | 29 |
| Subject 16 | 34 | 34 |
| Subject 17 | 19 | 14 |
| Subject 18 | 8 | 3 |
| Subject 19 | 5 | 0 |
| Subject 20 | 17 | 23 |
| Subject 21 | 24 | 12 |
| Subject 22 | 25 | 24 |
| Subject 23 | 17 | 0 |
| Subject 24 | 28 | 13 |
| Subject 25 | 4 | 1 |
| Subject 26 | 4 | 3 |
| Subject 27 | 4 | 1 |
| Subject 28 | 3 | 1 |
| Subject 29 | 4 | 2 |
| Subject 30 | 16 | 23 |

From this table, it can be seen that for a few subjects the number of EK is equal for positive and negative probes, for a few EK is greater for negative probes and for most of the subjects the EK is more for positive probes.

Table 4- This table shows for each subject the number of probes for which EK came in both the positive probes and negative probes

| NAME | NUMBER OF PROBES WHERE EK CAME IN BOTH POSITIVE AND NEGATIVE PROBES |
|------------|---|
| Subject 1 | 7 |
| Subject 2 | 5 |
| Subject 3 | 6 |
| Subject 4 | 1 |
| Subject 5 | 1 |
| Subject 6 | 3 |
| Subject 7 | 5 |
| Subject 8 | 4 |
| Subject 9 | 8 |
| Subject 11 | 5 |
| Subject 12 | 3 |
| Subject 13 | 3 |
| Subject 14 | 1 |

| | |
|------------|---|
| Subject 15 | 7 |
| Subject 17 | 2 |
| Subject 20 | 2 |
| Subject 21 | 3 |
| Subject 22 | 4 |
| Subject 24 | 3 |
| Subject 30 | 6 |

From this table, it can be seen that for many subjects EK was elicited in both the positive probes and negative probes.

Thus, from the findings of the statistical analysis it can be interpreted that there is significant difference in the number of EK between positive and negative probes and the number of EK is more for positive probes in comparison to the number of EK for negative probes. From this finding it can be interpreted that BEOS was effective in differentiating between real experience and false experience. BEOS was able to differentiate between the event which was experienced by an individual and which was not experienced by an individual. This again reaffirms the accuracy rate of BEOS in detecting the experiential knowledge of an individual in relation to any event. According to the TIFAC study, BEOS has a specificity of 94% and sensitivity of 95% (Mukundan, et al., 2008). The result of the present study supports the findings of the TIFAC study, that BEOS is effective in finding out the experiential knowledge of an individual in relation to an event.

Another significant finding denotes that for almost most of the subjects EK also came for the negative probes. For a few subjects it was equal to or more than the number of EK in positive probes. From this finding it can be interpreted that if an individual has experienced an event and if he or she denies having experienced that event, despite that fact the individual's brain will respond to that event and EK will be elicited for that information. Even if a person denies having experienced an event, the person's brain will detect whether or not the person has experienced the event and if the person has really experienced the event, EK will be elicited. This is mainly due to two reasons, which have been explained below:-

1. Firstly, due to association EK also came in the negative probe set.
2. A second very important and significant reason is that, our brain can't perceive the words no, don't, didn't etc. Our unconscious mind can't process negative words. Even if our brain hears the word no, don't or didn't and even if we say these words to ourselves, a positive image is presented in our mind instead of a negative image (dummies, 2016). For example, if we say to ourselves not to imagine a green tree, the thought will be perceived not in a negative way and we will immediately imagine a green tree even if we didn't want to. According to another article, written by Matt James, it is stated by him that our brain can't process negative (James, 2013).

Similarly, from the aspect of crime, if an individual has committed a crime and tries to deny by saying that he/she has not committed the crime, brain will not perceive the word no and since the individual has committed the crime so images of that crime will appear in the mind of the person, even if the person denies having committed the crime. So, when the positive and negative probes were presented to the subjects, the 2 sets of probes were almost similar to their brain. Some of the subjects provided their feedback at the end of the administration process. They often reported that the positive and negative probes were almost similar for them and even in the negative probe set they were able to recall the incidents and see the images in their mind even though the probes were made in denial mode. So, from this it can be understood that even if a suspect denies having experienced an event, the suspect's brain will detect the experience and BEOS will be successful in finding out the truth and eliciting EK for the experience.

Also, the number of probes where EK came in both positive and negative probe is high for some subjects. It can be interpreted that, in the positive set the person agreed having experienced the event and since it was a real experience so EK came for the particular probe and in the negative set it was prepared in such a way that it denied the experience but despite that EK came in the negative probe. This finding is again a proof of the fact that because our brain can't perceive the words in no, so, even if a person denies having experienced an event, the memories of the event will become activated and BEOS will be able to detect the experience and BEOS will be successful in eliciting EK for the experience even if the person denies having experienced the event. Also, since an individual has experienced the event, EK came in the negative probe due to the person's association with the particular information.

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