

Experiential knowledge of positive and negative experiences on remembrance and neural response using neuro signature system.

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Abstract

Understanding the human mind has always been a very complex process and so does emotional impact on individual. Positive and negative interpretations of events create deep impacts on memory due to which a person remembers such events and may feel happy or sad. The experiences are created due to four aspects i.e. sensory interpretations, motor responses, proprioceptive response, and emotional arousal. However, individual remembers the negative events better as compared to positive events and responds more to the negative emotions as compared to positive emotions. This research paper explores the human brain and its neural response with reference to positive and negative experiences of an individual through the unique technique Neuro Signature System i.e. Brain Electrical Oscillations Signature profiling (BEOS) developed by Prof. C.R Mukundan. This technique tries to investigate the some of the major cognitive neural networks and various aspects of participation of a person in a particular event. The paper focuses on the impact of negative and positive experiences of an individual and its remembrance. For this study, total 20 participants were selected of age group between 20-25 years. Their remembrance of positive and negative events was tested by using the BEOS system. The results of the study concluded that though the negative experiences were remembered in greater elaboration, both types of experiences were equally remembered. The participants elicited Experiential Knowledge (EK) scores while remembering both their positive and negative life events, although it was difficult to give elaborated version of positive experiences but the number of EKs produced for event remembered was almost equal when positive and negative experiences were share by the participants.

Keywords: Emotions, Positive experiences, Negative experiences, Neuro signature system, Remembrance, Experiential knowledge.

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Introduction

Understanding the human brain with respect to different experiences acquired by them is a very complex phenomenon. Our brain is stored with so many experiences, right from the time we have started making sensory-motor contacts with the world, which are labelled as memories of life. Along with the journey of the life, sometimes we have encountered happy events and sometimes we have encountered sad events. The question here lays which of the two events, happy or sad has more impact on us. As we grown older, whether the negative or the positive events leave a greater impact on us. This study tries to understand the positive and negative experiences of an individual through the unique technique of Brain Electrical Oscillations Signature system [1], who is considered the father of neuropsychology in India. The very system BEOS was developed for use in Forensic settings, to determine the remembrance of autobiographic episodes as the process occurs in the brain. Before moving ahead to BEOS we should be very much clear with the term Forensic Psychology and its applications.

Brain electrical oscillations signature

At the very onset, certain things that are needed to be cleared regarding BEOS is that, it is not a deception detection test. It

has nothing similar with Guilty Knowledge tests or measuring the psychophysiological changes during arousal of guilty knowledge. BEOS is basically a memory based test, and its scientific base is derived from the differences between the two memory systems, one responsible for 'knowing' and the other for 'remembrance' which was originally stated by [2]. Knowing is a process of acquisition or sharing knowledge or information with others. On the other hand, remembrance is that of autobiographic episodes, and episodes are encountered in life by each, which is called experience. Several neuroimaging studies have distinguished between the neural activation patterns in 'knowing' and 'remembering' [3-15]. Several of these studies have reported that remembering is associated with extensive activation of ventral brain, anterior cingulate cortex, orbitofrontal cortex, and medial temporal cortex. Knowing requires brain engagement mainly from the dorsofrontal cortex, which is much smaller engagement of the brain for knowing and retrieving information. This may involve mainly the process of recognition of the external signals or proprioceptive sensations, and their later retrieval for recognition of the same signal. Knowing is essentially a conceptual process, as it allows to build knowledge base in the brain. Knowledge is shared with others, or acquired from multiple external sources like books, lectures, video, etc. On the other hand, experiencing occurs while participating in an

activity and the knowledge acquired through such participation has been termed “*Experiential Knowledge*”. Autobiographic episodes provide opportunity for such experiential acquisition and they are later remembered. Remembrance constitutes neural building of the earlier experience, which may be recreation of the mental imageries of the sensory-motor contacts of the experience, as well as the revoking of emotional effects of the experience. Thus taking part in an activity as well as witnessing an activity constitutes experiences of different dimensions, though both could create emotional effects in the participating as well as witnessing person. Giving a musical performance as well as listening to a musical performance is both experiences, though the natures of participations are widely different. On the other hand listening or reading about such a performance is only known, without any personal experience. Remembrance of personal past events would further require retrieval of place and time of occurrence of an experience, which is called the source memory [16-20]. Only those autobiographical episodes which have an emotional significance to the individual are only remembered for long. Hence both emotional and personal significance of episodes are therefore of crucial importance for their later, when the same emotions may be recreated in varying degrees in the individual remembering the episode. Remembrance of an earlier episode takes place, when its memory is triggered or cued by a related piece of information. The cueing effect is present only in those who have taken part in the experience or episode, whereas the process of remembrance cannot occur at all when one has not had the primary experience. When one has an earlier experience, its cueing by an external reference words or objects would bring about its remembrance in automatic and mandatory manner [21-23].

Remembrance is triggered in BEOS by presenting cues to a subject in the form of short verbal statements called the probes. The electrophysiological changes taking places when retrieval is triggered by the cue are measured from the multiple channels of electrical oscillations of the brain. Multiple channels of EEG are analysed to extract the significant changes that occur in the brain EEG while listening to each probe. As the subject is not expected to give any response to the probe heard, only change evoked by listening to a probe is recorded as remembrance. Remembrance of an experience may be triggered by a probe only if the person has personally acquired the experience and stored the information. The analysis programme looks for changes in the electrical activity, which indicates remembrance of autobiographical episodes or experiential knowledge. The EEG frequency and the time domain changes associated with different stages of cognitive processing in remembrance such as semantic processing of the probe, shift in attention, episodic memory, and neutral binding effects [23,24] are extracted, if present and the significant changes are interpreted by the program. The BEOS profiling is carried by using EEG with 30 cephalic channels and 2 eye movement channels. The hardware and the software for data acquisition and analyses were developed by Axxonet System Technologies.

Now understanding about the probes is necessary for the BEOS interpretation which is the crux for the experiential knowledge. At the very onset, the major events of the crime are

classified into separate Scenarios. Probes are designed for cueing the remembrance of specific possible experiences as derived from the information of the case acquired from investigators and interview of concerned persons. Each scenario depicts a specific formulation of happening when the suspect could have carried out a specific activity. The probes are arranged sequentially and systematically. No value based or judgmental words are used. Probes differ in their length in terms of the number of words. Designing of the probes are based on some set criteria i.e., they should be arranged within the time limit of 3.4 sec. There are total four types of probes. The first set of probes are called Neutral probes which are essentially short semantic processing sentences without any personal references and are used to measure and compensate encoding process and its topographic distribution compared to pre-probe base line epoch of 3 sec. The next set of probes are control probes referring to verified autobiographic episodes in the life of the subject tested, which are expected to produce expected remembrance and associated electrophysiological changes. Positive findings in the analysis using the control probes are considered a process of self-validation of the procedure, which the examiner can share with the subject for generating confidence in the test protocol and later during post-test interview. The third set of probes are called Target “A” probes. These lists of probes are designed in different scenarios which form the activities of the suspect/subject prior to, during and following the crime investigated. The last set probes are Target “B” probes, which refer to the version of activities and participation as claimed by the suspect, which he may believe would prove his or her innocence. Once the probes are designed along with respective event markers, indicating beginning of the pre-probe baseline and beginning of probe epoch, release of the probe, and the end of the probe epoch. The probes are recorded using Visual and Auditory Stimulus programming (VASP) in the computer. And after the probes are being recorded, the next step to follow is trimming to check if there is any error while recording. Once this checking is completed the subject is ready to be called for the recording.

Following stages are to be followed for BEOS profiling: Before commencement of the recording, following instructions are to be given:

- Stay calm with eyes closed.
- No need to respond to the probes.
- Remain alert and listen to the probes as the suspect will be asked for recall them later on.
- Inform examiner if the test needs to be paused.
- Instructions regarding posture.

Electrical Oscillations from the brain are picked up by using electrodes placed at standard position such as FP1, FP2, AF3, AF4, F7, F3, F8, F4, FT7, FT8, FC3, FCC4, T3, T4, C3, C4, TP7, CP3, TP8, CP4, T5, T6, P3, P4, O1, O2, Fz, Cz AND CPz respectively. The changes in the power spectrum profile in specific frequency ranges are classified into indicate presence of remembrance EK (Experiential Knowledge), EM (Emotional) Response, NE (Negative) Response, Encoding present and/or Primary Processing alone present. All probes are processed, unless the subject has not attended to any of

them. Changes in the different frequency bands have different meaning in terms of cognitive processing. Software generates the result in the following category for the interpretation from the forensic angle.

Experiential knowledge (EK)

Activity related to remembrance of the experience triggered by the probe present. Presence of statistically significant increase in activation level is the basic requirement.

Emotional Response (ER): Encoding present accompanied by overwhelming blanking of further processing. Probe has produced significant decrease (presence of high level of De-synchronization) in the activity of Delta, Theta, Alpha, Beta, Gamma bands in the beginning of the probe, or no changes in the activation level in the above bands, during and after probe presentation. The response is an indication of emotional stunning on hearing the probe.

Negative Response (NR): Probe has produced negative response equivalent N400. NE values are above 100 micro volts.

Encoding (EN): This is used when the probes has produced significant increase in activation in the Delta, high alpha Beta, Gamma bands for specific duration, but without increase in 0-2Hz activity.

Primary Processing (PP): This is used when the probe has produced significant increase in activity only in the Beta bands.

Inattention (IN): Activity related to registration of the probe is not detected.

EEG is recorded with eyes closed from which baseline parameters are obtained and used for monitoring online EEG and for controlling probe presentation. The probes are presented with the subject sitting silent, listening to their audio presentation with the eyes closed. BEOS uses single trial analysis method, in which the probe-triggered changes are compared in each channel with its own pre probe baseline. There are certain things that are to be taken into considerations while BEOS recording. At the very first, things that are required to be kept ready before the subject enters the laboratory are: EEG head cap, gel, Syringe, needle, harness. Once the subject comes in he/she will be put the head cap, followed by depositing of the gel inside each electrode. Then 5 min baseline will be taken with eyes closed and open, after then, probes will be presented to the subject and the recording will be started. The probes will be automatically presented by the VASP System if the BEOS system does not recognize any other cognitive processing taking place in the baseline resting level.

Emotions and its relation with brain

Events of emotional significance are mostly to be remembered more vividly as compared to events which are related to mundane activities and neurological researchers have proved that occurrence of effective responses will have a greater impact on memory [25]. It has been found that adult's age impacts some, but not all [26]. Across a number of studies it

has been noted that memory for negative information often includes more item specific visual details than memory for positive information. For example, people have hard time remembering the details the butterfly than the details of a gun or a knife, snake or a dirty toilet. The benefit in memory for negative items occurs only if the participant is exposed to the stimulus for a longer duration of time. Right hemisphere has been proposed to be critical for the processing of negative effects. In an attempt to optimize these processes, we took advantage of the fact that the right hemisphere has been proposed to be critical for the processing of negative affect. Describing emotions is as tough as describing life. According to William James, a mental state is "*stream of consciousness*" present at any given time, implying a state underlying mental activity [27]. Mandler [2] described two states related to emotion, one being characterized by a "*conscious-experiential-flavour*" and other a neuro/cognitive structure and dynamics. Emotions results from the perception of changes in physiological states, especially the vasomotor changes triggered by the perception of stimuli in the environment. The famous example is that of "*I am running and I am scared as I am running*". The knowledge of the body response initiates emotional experience which is further augmented by self-perception of changes in the automatic responses such as elevated heart rate, arrest in respiration, etc. In essence, emotion is said to occur when one perceives the body.

Hypothalamus is considered the central core from which all emotions derive their emotive force. Hypothalamus acts a center for pleasure and reward. Psychological manifestations of hypothalamic activity especially emotions are largely non-directed, short-lived and unconnected with the events occurring in the external environment. It has no sense of morals, danger, values, logic, etc., and undifferentiated, consisting of feelings such as pleasure, unpleasant, aversion, rage, hunger, thirst. Etc. Hypothalamus mediates all lower order emotions accessing the raw force required for emotional expressions [23]. Another important is neural hijack in which fear and other related emotions result. Amygdala also plays a major role in social-emotional behaviour. The bilateral destruction of amygdala results in a condition sometimes referred to as '*psychic blindness*' or Kluver-Bucy syndrome. These individuals indiscriminately pick up various objects and place them in their mouth regardless of its appropriateness. They will immediately pick it up and place it again in the mouth as if it were a completely unfamiliar object [23]. There are three behaviourally relevant functional systems originating from the frontal lobes of the brain [28]. They are the Orbitofrontal (ventral) system, the Dorsolateral Prefrontal (Dorsal), system, and the Anterior Cingulate system. Orbitofrontal cortex plays crucial role in maintaining several emotional, psychomotor, and cognitive functions under optimum levels by inhibiting the concerned processing areas of the brain. There exists a four-level circular connectivity in each functional system between a prefrontal cortical centre and the thalamus through the basal ganglia. These functional systems exercise the cognitive, behavioural and experiential functional controls of the brain-mind.

- **The ventral system:** The orbitofrontal cortex is one of the central centres, which control centres, which controls the ventromedial caudate, which in turn controls the medial dorsomedial Globus pallidus.
- **The dorsal system:** The dorsolateral prefrontal cortex is another control centre, which controls the dorsolateral caudate, which in turn controls the lateral dorsomedial Globus pallidus.
- **The anterior:** The Anterior cingulate cortex is the third major behavioural control centre which controls the Nucleus Accumbens.
- **The orbitofrontal functional system:** The functional system is considered responsible for the development and maintenance of personality of the individual, social behaviour, spontaneous arousal of attention, motivational arousal and its maintenance, initiation of goal directed and purposeful behaviour, and ability to change mindset. Lesions and malfunction in this circuit result in instinctive disinhibition, elevation of mood, less worried about self. Loss of purposiveness, lack of initiative, inability to delay responses and actions and the consequent need for immediate gratification resulting in impulsiveness, loss of tact in dealing with others and utilization behaviour.

Memory

There have been several studies using neuroimaging, electrophysiological, and neuropsychological tests for establishing the involvement of prefrontal cortex, and temporal lobes in various aspects of writing into and retrieval from memory. Recall from memory takes place for, using the recalled information for the identification of external objects, entities, and words, and using the recalled knowledge for interpreting relationships among concepts, entities, objects, etc., and for remembrance of past events in life. Shallice et al. [29] found in study using PET imaging that encoding and acquisition was associated with activity in the left prefrontal cortex and retrosplenial area, whereas retrieval of the encoded information was associated with activity in the right prefrontal cortex and precuneus. Shallice et al. [29] and Fletcher et al. [30] studied normal subjects with verbal encoding and retrieval tasks and found activation of the left prefrontal cortex and retrosplenial area of the cingulate cortex during the encoding stage, and activation of the right prefrontal cortex and bilateral activation of the precuneus during the retrieval stage. They concluded that separate brain systems are engaged during the encoding and retrieval phases of episodic auditory verbal memory. Several neuroimaging studies on normal subjects have documented evidence for a “*hemispheric encoding/retrieval asymmetry (HERA)*” [13,30-33]. A theory of memory system with multiple memory traces representing different episodic memories acquired by the individual over the lifetime. The model “*Multiple Memory Trace*” theory distinguished between episodic and semantic memories, which were not done in the traditional memory postulations [34].

Factors that contribute to autobiographical recall and its association with the areas activated using event related fMRI. They used a measure of recollective quality using measures of

details recalled, their emotional or personal significance, and regency. There are several studies, which have been differentiated knowing from remembering. The difference between knowing and remembrance was first proposed by Mandler [2]. Dorsolateral prefrontal cortex, activation was obtained during remembrance. Studies by Tulving [13], Le Page et al. [35,36], Henson et al. [37,38], and Fletcher and Henson [39] have shown anterior prefrontal cortex activation in mental tasks involving remembrance. Similar findings have been reported in recall of autographical information in the recent studies by Giloba et al. [8], Cabeza et al. [7] and Umeda et al. [5]. Autographical remembrance is a recall of experiences, which may be composed of awareness of experiences consisting of sensations, proprioceptive, sensations, emotions, and visual and other forms mental imageries. Examples of autobiographical recall of individuals that we have examined in a study, which were also independently verified from sources other than the subject past events in their life, followed by inquiry into what they truly remember, which make them think the remembrance was true [23]. Accuracy of remembrance depends on several factors and awareness of the time of experiencing is one of them, which help to support the veracity of the experience. Time estimation is one of them, which help to support the veracity of the experience. Time estimation is one of them, which help to support the veracity of the experience [23].

Objectives

- The objective of the research was to explore the positive and negative experience of an individual through the BEOS System.
- To study which emotions have more impact on remembrance; the negative or the positive event of an individual.

Method and Materials

Sample

Total 20 samples were selected through purposive random sampling that were willing to share their positive and negative experiences of their life and were ready for N.S.S. recording. The samples were between 20-25 years of age.

Inclusion criteria

1. Individuals who are above 19 years and below 26 years old.
2. Individuals who were willing to share positive and negative experiences.
3. Individuals who gave consent to sit for N.S.S. recording.

Exclusion criteria

1. Individuals who do not have negative and positive experience in detail.
2. Individuals below 18 years old and above 26 years of age.

Hypothesis

1. Negative-event based experiences will elicit more EK as compared to positive-event based experiences.
2. Negative-event based experiences will be having more impact of remembrance as compared to positive event-based experiences.

Instrument

Brain Electrical Oscillations Signature (Profiling) Instrument version 6.2 was used for recording developed by Prof. C. R. Mukundan.

Procedure

The objective of the study was to find out whether the positive and negative experiences of an individual shall produce Experiential Knowledge and whether negative events have more impact as compared to positive events in terms of remembrance and showing EKs using Neuro Signature System. The procedure was divided into 3 phases which are described below:

Phase-I

Data collection: Total 20 samples were selected through purposive random sampling that were willing to share their positive and negative experiences of their life and were ready for N.S.S. recording. The samples were between 20-25 years of age. Consent of each participant was taken then they were given a form where they had to write one positive and negative experience of their life in detail and then the forms were collected.

Phase-II

Designing and recording of probes: Once the forms were being collected, a set of probes were designed. It consisted of 60 minimum and 250 maximum probes of each subjects and recording were designed in sequence along with respective event markers. The set was uploaded into the VASP. Then auditory probes were recorded, based on the gender.

In order to form connection, after audio recording is done, the file was in the Visual Auditory Stimulus Programming (VASP). After the successful auditory recording, trimming was carried out to remove the excessive silence and to avoid any further error.

Phase-III

BEOS recording: After almost 7 days the subjects called for recording, according to the convenience of the subject. Following instructions were given to the subject. At the very first the subject will be asked to seat comfortably in the chair. Prior to the recording the temperature of the room the room was maintained. It was ensured that the temperature of the room was not hot and it was also ensured that the subject has removed his/her watches or any other metallic things. The

subject was seated comfortably in a wooden chair. Then the subject will be put the head cap with 32 electrodes and then gel will be placed in each of the electrodes with the help the needle along with the reference in one of the ears along with the harness. Once everything is made ready, the subject will be asked to close the eyes where baseline is taken with eyes closed for 5 minutes. Then after baseline is taken the subject will be asked to again close the eyes and then the probes will be presented to the subject. Each probe presentation consists of 10 sec of EEG, 3 sec for pre-probe stage and the next 7 sec consists of probe presentation stage and post-presentation together. The beginning and the end of the probe were marked with red markers and each probe will be presented after a gap of 6 sec.

After the recording of probes the data analysis was done. Data analysis is a software-based analysis done by the Neuro Signature System itself. The analysed data was then used to measure the number of EKs produced by the subjects in positive and negative based experiences.

Result and Analysis

The objective of the research was to explore the positive and negative experience of an individual through Neuro Signature System (N.S.S.) and to study which emotion have more impact on remembrance; the negative or the positive event of an individual.

After recording the response of 20 participants on their one positive and one negative events based experiences. Total 40 recordings were done. The analysis of the data was done using N.S.S. version 6.2 automated software to measure the Encoding, Encoding++ and Experiential Knowledge responses by each individual.

- **Encoding:** Activity related to semantic processing of the probe detected.
- **Encoding++:** Activity related to higher order of processing.
- **Experiential knowledge:** Activity related to remembrance of the experience triggered by the probe present.

The Table 1 explains that in positive experiences, the total number of probes with Encoding is more as compared to negative events, which shows that the individuals were able to conceptualize more the positive events as compared to negative events. In encoding++ again, the positive is more which shows better conceptualization of positive events as compared to negative events. Lastly, from the EK table it can be concluded that though positive events are better conceptualized, Experiential Knowledge in terms of remembrance is almost equal. In this study, the participants elicited more number of positive encoding and encoding++ responses than negative responses. The findings of BEOS results can be interpreted as, encoding and encoding++ indicate a person having conceptual knowledge about the positive experiences.

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Table 1: Table showing summary of encoding, encoding++ and experiential knowledge of the participants on positive and negative experiences based events.

Subject	Encoding		Encoding++		Experiential Knowledge (EK)	
	Positive	Negative	Positive	Negative	Positive	Negative
1.	9	10	82	26	1	0
2.	16	7	44	37	0	0
3.	7	2	30	22	3	1
4.	5	10	43	29	1	0
5.	11	3	29	13	0	1
6.	4	4	7	14	0	0
7.	15	12	25	20	2	0
8.	9	8	29	22	7	5
9.	10	9	26	23	0	1
10.	3	1	30	22	0	1
11.	7	1	25	15	0	1
12.	14	11	50	22	0	0
13.	20	15	6	3	2	1
14.	15	10	5	2	1	1
15.	13	12	3	7	0	1
16.	9	7	30	22	0	1
17.	18	12	43	29	0	0
18.	12	10	29	13	1	1
19.	7	6	20	11	0	1
20.	16	17	15	10	2	1
Total	220	167	571	362	20	17

Therefore, it can be interpreted as, when probes of negative and positive experiences were presented to the participants, they were able to conceptualize more of the positive events. But the probes were not up to the mark that the participants could remember the specific experiences. One+ response is indicative of accessing source memory and the other + indicates the probe eliciting significant intentional response.

In this study the hypothesis was Individual will elicit most EK for negative experience as compared to positive experience and this very hypothesis was rejected as more EK was generated in positive experience. The participant has conceptualized the positive experience more as compared to negative experience.

The above results allow us infer that the participant has conceptualized more in positive experiences as compared to the negative experiences. The participant has generated EK more in positively encoded events than negatively encoded ones. It can be understood that the participant's positive experience has a greater impact on her than the negative experiences. Thus, it can be said that the positive experiences

have a greater influence on the individual rather than the negative events. While analysing the results it has been found that number of encoding++ has been generated more in positive experiences than in negative experiences. Even while designing the probes it has been found that participants elaborate the positive experiences better than the negative experiences. In encoding as well, number of responses for the probes elicited is more than negative experiences. Though experiential knowledge (EK) was generated in few of the probes but it can be said that the participants were able to process it strongly but EK was not generated much.

Conclusion

It is easy to remember and elaborate the negative experiences as compared to positive experiences. However the results of the study concluded that though the negative experiences were remembered and often elaborated in detail, individual's brain gives equal weightage to both types of experiences in terms of remembrance. The participants elicited almost equal number of

experiential knowledge (EKs) in both of their positive and negative events of their life.

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