Neuro Signature Profiling of Traumatic v/s Non-traumatic Events

Parth Sharma[1] Dr. Priyanka Kacker[2]

[1]MA Criminology with specialisation in Forensic Psychology, National Forensic Sciences University
[2]Senior Assistant Professor, National Forensic Sciences University

ABSTRACT

A major concern in India currently is that of victim ignorance. Acknowledgement for victimization is limited to theoretical debates, candle light marches or protests. This results in either no or inadequate victim assistance. Compensation, which we find being granted in multiple cases, cannot be considered as a wholesome assistance to the victims and/or their families. Psychological and social assistance are equally important.

Trauma, being the reaction of an individual to a particular situation, is a crucial concept, especially in the criminal justice domain. General population and victims of crime and abuse of power have different types, intensities and timelines of trauma faced by them.

BEOS captures the electrical signals emitted by the brain. The signals are interpreted to reveal multiple information such as the experiences of the subject, the form of involvement of the subject in the stated event, the activation areas of the brain (frontal, temporal, etc.) and the intensity of remembrance in those activated areas. The process of triggering memories through probes and remembering details of events makes different areas of the brain active. The areas are activated with respect to the memory i.e., visual, motor, emotional and so on. The intensity of activation is displayed in the report through different shades of the colour Red.

The problem of not being able to scientifically analyse the intensity of trauma and eventually ignoring the victim can be mitigated through the neuro profiling process of victims. Administering BEOS on all victims of crime to scientifically evaluate their authenticity, impact of victimization and level of assistance needed can guide the investigation and victim support in the right direction.

Keywords: *BEOS, neuro profiling, trauma, victimization*

LIST OF ABBREVIATIONS

Abbreviations	Description
BEOS	Brain Electrical Oscillation Signature
CJS	Criminal Justice System
DSM	Diagnostic and Statistical Manual for mental disorder
EEG	Electroencephalogram
EK	Experiential Knowledge
ERP	Event Related Potential
GBV	Gender Based Violence
NGO	Non-Government Organization
NSS	Neuro Signature System
PCL-C	PTSD Check List - Civilian
PTSD	Post-Traumatic Stress Disorder
SPSS	Statistical Package for Social Sciences
SPU	Signal Processing Unit
VASP	Visual Auditory Stimulus Program

INTRODUCTION

The source of the term victim is the Latin word '*victima'*. Victim, in the most basic sense, is an individual who has suffered harm, pain, suffering or injury. An individual who has suffered a loss, i.e., financial, physical, psychological or social. The event causing such harm can be a criminal event, or a non-criminal event such as an accident or a medical illness. In any such circumstance, the victim experiences pain and suffering. The victim cannot feel and functioning normally in the society.

United Nations Declaration of Basic Principles of Justice for Victims of crime and Victims of Abuse of Power was adopted in November, 1985. It has specified, in Articles A and B, an exclusive definition of victim.

Article A states that, Victims mean those who, individually or collectively, have suffered harm including physical or mental injury, emotional suffering, economic loss or substantial impairment of their fundamental right, through acts or omissions that are in violation of criminal laws, operative within member states including those prescribing criminal abuse of power.

Under this declaration, considering an individual victim does not depend on whether the perpetrator is caught, identified or convicted by the court. It also does not depend on any form of familial relationship between the offender and the victim. The definition under the declaration is designed holistically to also include, wherever appropriate, immediate family members of the victims or dependants of the victim. It also does not leave out individuals who became victim while trying to intervene to assist other victims, possibly experiencing victimization, and/or to prevent further victimization. The definition does not exclude any individual from its ambit on the basis or sex, colour, race, religion, religious belief, political opinion, cultural set-ups or practices, property, financial, wealth, birth or family status, ethnic origins, social history, or any form of disability.

If we closely analyse the definition of victim, we see that, pain, loss, suffering is common. Therefore, the word victim becomes a synonym of pain and/or suffering. In such a case, it is

imperative to acknowledge the importance and concerns of victim in the society. A victim is not an individual who can be ignored. Victim has to be attended to at the earliest and all of his/her concerns should be addressed to ensure fair justice. Victim, who has already suffered due to any event, now requires attention, care and support from the society.

BEOS is a forensic investigative psychological instrument. The BEOS test was created and developed as an alternative to tests based on recognition evaluated by event related potential of P300 and polygraph-based lie-detection tests. BEOS tests the neurocognitive sign of the presence of memory taking place in the brain. The BEOS score of Experiential Knowledge (EK) is a reflection of numerous changes in the brain that are connected to memory that occur during retrieval.

When cues are given to an individual, memory of a previously experienced activity may be immediately triggered. It can only happen if someone took part in or saw an activity, as opposed to learning about the same activity from an outside source. When the test cannot be conducted, memory may be inhibited or destroyed due to crippling states like repression or the degenerative process of the brain. The process has undergone validation studies and has subsequently been employed regularly and successfully to aid forensic investigations. The method has been successfully used to investigate many hundreds of cases, aiding in our comprehension of the precise roles that each participant in each incident performed. The technology continually records the subject's scalp's multi-channel electrophysiological activity (EEG). The analyses are completed automatically by the system, which also generates a final report of the results.

Paying attention to one's own thoughts and feelings requires internal focus, and when recognition occurs, one may become aware of its familiarity or unfamiliarity. One may also recall more connected events that were either contemporaneous with or immediately after the remembered episode. Recognition or encoding of the memory is another aspect of remembrance through cued stimulus.

An Electro Encephalogram (EEG) cap with 30 electrodes cover the entire area of the scalp, thereby targeting each region of the brain. All the lobes, i.e., Frontal, Parietal, Occipital and Temporal are covered and captured by the EEG cap. The brain waves are oscillating in nature. They travel to-and-fro inside the brain. These waves are the response to the external and internal stimuli. Electrical activity from the brain consists primarily of rhythms. They are named according to their frequencies (Hz.) and their amplitude. These rhythms of brain waves differ as per the age of the individual and according to the level of activity or consciousness. For example, while sleeping the frequency of brain waves will be different as compared to while driving a two-wheeler.

The Beta brain wave (Fig.1) corresponds to normal consciousness of the individual. At this frequency, the individual is involved in active concentration on a subject matter. The wave has a smaller amplitude and multiple, varying and faster frequencies.

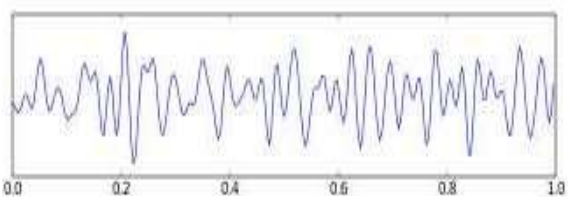

Fig.1 Beta Brain wave

The normal cognitive functioning happens at the Beta level. A relaxed state corresponds to the Alpha brain wave.

The Gamma brain wave (Fig. 2) functions at 35 Hz. and above. This means, the oscillations occur across different regions of the brain, instead of being limited to small regions, as in the case of Alpha brain waves. It shows a complete alert, wakeful consciousness of the individual with a high level of cognitive functioning.

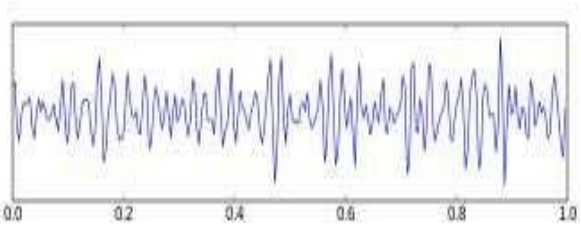

Fig. 2 Gamma Brain wave

Apart from the various technical aspects of BEOS involving EEG, NSS and Brain Waves, a crucial factor of the BEOS process is *Probes*.

Probes are statements pertaining to the event which are presented in an audio format to the subject, to trigger the relevant memories. The aim is to find out the kind of memory the subject has for any particular act, i.e., is the memory experiential or non-experiential. They are statements, which act as cued stimulus, since they trigger the specific memories in the subject's brain. They are presented in a sequence referring to the subject's participation in the event and are properly arranged to ensure effective retrieval of the original experience of the subject.

Probes are systematically divided into 4 types, namely Neutral, Control, Target A and Target B. Neutral are not expected to cue any remembrance, while Control are not related to the event. They serve as a validation of the test procedure by verifying certain episodes of the subject's life. Target A probes, as the name suggests, target at situations before, during and after the event and Target B probes are targeted at events stated by the subject. It is critical to design highly effective probes to ensure all the relevant memories are triggered which can further be differentiated on the basis of sensory recognition, attention, encoding, memory activation and so on.

The goal of accurately establishing the nature of involvement of the subject in the given event brings the concept, which is of utmost importance in BEOS – Experiential Knowledge or EK. Experiential knowledge tells us whether the subject has participated himself in the event, or is an eye witness to the event, or has heard about the event from someone. Experiential knowledge is comprised of all the components such as awareness, emotions, motor movements, sensory inputs. One important component assessed in the process of analysis EK is proprioception – the unconscious body movement registered by the brain of which there is no conscious acknowledgement by the individual.

Recall v/s Remembrance

In literal words, is the difference between something that the subject just knows and something that the subject has experienced. If there are sections in the event which the subject has not experienced, he or she will not have the required awareness, proprioception, motor or sensory memories for it. This will be a memory that the subject will be recalling. Remembrance deals with the autobiographical memory of the subject since there is the element of experiencing those elements of the event by the subject.

BEOS, through its identification of EK through remembrance is able to accurately establish the subject's involvement in the event. The Neuro Signature Profiling report generated by the NSS also presents individual brain scans for every single probe. These scans reveal the intensity of remembrance by the subject's brain, with respect to the probe presented, while also showing the area which is more activated as compared to the other areas of the brain.

This is how that brain scan presented by NSS looks. The probe presented to the subject is "I apologized" (Fig.3). The shades of Red are showing a higher brain activation. There are markings identifying the lobes of brain such as Frontal, Parietal and so on. Hence, we can see that in the event being discussed here, this is how the subject is currently remembering the episode, especially when he apologized.

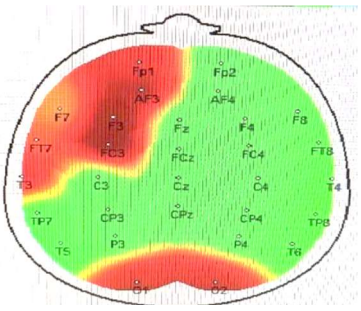

Fig. 3: Probe – "I apologized"

This image is for the probe (Fig.4) "We often had fights". These are the areas which are activated more intensely than the other areas. It can be seen that for the probe 'I apologized' there is an activation in the Occipital region of the brain – which involves visual memory and for the probe 'we often had fights' there is activation in the Temporal region of the brain which involves auditory memories. Therefore, the subject here can visualise the event of apologizing and can remember the verbal arguments or probable shouting at each other during the fights.

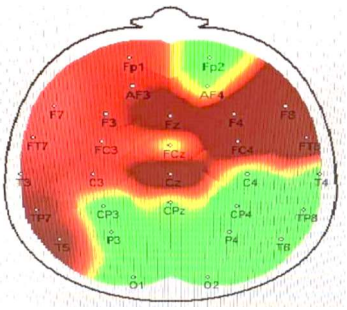

Fig. 4: Probe – "We often had fights"

To summarize, BEOS profiling involves describing an event in the form of probes, which are short statements, and presenting the statements in an audio format to the subject who is involved with the event. For every single probe (stimulus) a response is generated in the form of brain wave oscillation which is captured by EEG and integrated with NSS to derive a final report which presents all the elements (probes) that the subject has experienced.

This paper focuses on probes pertaining to a traumatic event. All probes, referring to a traumatic event, will trigger a traumatic experience. Upon a traumatic experience being triggered, the response, in the form of brain waves will be of remembering the traumatic experience.

In the Indian Criminal Justice System (CJS), not much importance is given to the victims. The entire CJS comes into function through the victim. Victim activates the CJS by reporting the crime to the police. The First Information Report (FIR) registered by the police, takes a detailed statement of the victim. But sadly, the role of victim ends there. The role of victim then decreases to a being a mere witness in the trial. The impact of victimization, the intensity of distress, the suffering or pain are never discussed or acknowledged by the society. Assistance to victims can be in the form of financial assistance, medical assistance, psychological assistance and/or social assistance. The United Nations Deceleration of Basic Principles of Justice for Victims of Crime and Abuse of power, 1985 states that victims should receive the necessary material, medical, psychological and social assistance through governmental, voluntary, community-based and indigenous means.

Victims, who have not been addressed with such assistance are not able to cope up with their traumatic experience. They either develop PTSD symptoms with varying intensities or more severe psychological disorders. From a criminal justice standpoint, some victims also develop revengeful feelings towards first the offender and second towards the society and become offenders themselves. A prominent example of this is the Kiranjeet Ahluwalia case. She was tortured and beaten by her husband for several years until finally she decided to kill him by burning him alive. While her husband was asleep, she poured inflammable material on and around the bed and lit up the entire area.

Review of Literature

A study named Previous Exposure to Trauma and PTSD Effects of Subsequent Trauma: Results from the Detroit Area Survey of Trauma conducted by Breslau and Chilcoat et. al. (1999) focussed on the association of experiencing a traumatic event in the past and its PTSD with experiencing subsequent traumas and their PTSD. The researchers interviewed 2181 individuals from southeast Michigan area to understand their traumatic experiences, in line with the criteria mentioned in DSM-IV. Researchers examined the influence of previous exposure to trauma on the risk of PTSD from a subsequent trauma in a large representative sample of the general population. They elicited a complete history of traumatic events, as specified in DSM-IV, and, in respondents who reported any exposure to trauma, they assessed PTSD symptoms that followed a randomly selected event from the list of events reported by each respondent. This was done to focus on PTSD resulting from a representative sample of traumatic events experienced in the community and avoid the bias of studies focusing on events designated by the respondents as their worst experiences so far.

The interview involved questions about the number of times any or multiple of these events had occurred and the respondent's age at each time. The analysis was conducted on 1,922 respondents whose traumatic event occurred after they attained the age of 5 years. The researchers found that a previous exposure to traumatic events was associated with a greater risk of PTSD from the subsequent traumas. Multiple previous events had a stronger influence on individuals than a single previous event. Upon examining several features of the previous traumatic event, the researchers found that subjects who experienced multiple events involving assaultive violence in childhood were more likely to experience PTSD from trauma in adulthood from the subsequent experiences. The researchers concluded that previous exposure to trauma signals a greater risk of PTSD from subsequent traumas probable in future.

The study on what is post-traumatic stress disorder by Andreasen in 2022 mentions the impact of traumatic events in one's life. The researcher also tested the impact of trauma on the subject's brain through EEG scans. Coping mechanisms, long term issues and symptoms – acute or chronic were all studied by the researcher for people with PTSD. The study highlights how PTSD is a significant domain in the psychological state of people who have experienced trauma. Experiences and memories are strong enough to impact one's normal day to day functioning. The researcher also contributed to the DSM manuals in terms of describing PTSD and inclusion of various symptoms of PTSD.

A study focussing on the process of remembrance, done by Mukundan and Chetan in 2017 aimed at establishing the process of Brain Oscillation Signature Profiling (BEOS). The process of remembrance through triggering relevant experiences or memories is done by presenting probes in a sequential manner. If the subject has participated in an activity or has witnessed it, the remembrance will be different as compared to recalling something about which the subject has knowledge from some external source. The study explains the entire process of BEOS involving all elements such as the electrodes, the EEG cap, reference electrodes, probes and so on. BEOS has been used on multiple cases and research projects which scientifically validate the accuracy of BEOS in automatically triggering the memories through cued stimulus (probes) and analysing each response to ascertain the kind of involvement of the subject in the act.

Another study on experiential knowledge of positive and negative experiences on remembrance and neural response using neuro signature system done by Kacker in 2018 aimed at identifying the difference in intensity of remembrance between a negative event and a positive event. The hypothesis was that an individual is able to remember a negative event with much more ease as compared to a positive event. A sample of 20 individuals was taken between the age group

of 20-25 and the individuals were interviewed regarding positive and negative experiences of their life. Probes were prepared as per their life events and the subjects were administered BEOS individually. NSS recordings of each subject were analysed to ascertain if there are a greater number of EKs in case of negative experience than in case of positive experiences. The researcher found out that though the remembrance was elaborate for negative experiences, there was not much difference in the number of EKs derived for both experiences, i.e., positive and negative. The researcher concluded that subjects were able to conceptualize more of positive events when compared with negative events. The elements such as Encoding and Encoding ++ also reveal the individual's ease in associating with positive events more. It can also be concluded that BEOS is effective in identifying EKs based on the emotions attached with an experience and the NSS report can be analysed in terms of the feelings associated with an experience.

A study named Remembrance of Recent Vs. Remote Memory of an Event: A Key to Investigation of Cold Cases performed by Pendse and Kacker (2020) focussed on analysing the difference in remembrance between a recent memory and a remote memory, memory of an event that has happened long ago. The remembrance intensity was tested with respect to BEOS, i.e., whether there is a difference in BEOS recording of individuals with recent memory of an event and individuals with remote memory of an event. A sample of 10 subjects was taken who were in the age group of 20-29. Each individual was asked to provide one recent memory and one remote memory, both memories being similar in nature, i.e., involving similar emotions or general themes. Recent memory was considered not more than six months old, while remote memory was considered at least 6 years old. Equal number of probes (70) were prepared for each of the memory accounts narrated by the subjects. This was done to ensure that the subjects are provided with equal opportunities to remember the respective event, thereby getting equal opportunities for EKs in each set of probes. The number of EKs derived for recent memory and remote memory were close (around 80 for both). This proved that BEOS is effective in generating EKs even for an event which had occurred 6-7 years ago. The practical application of this concept was tested in the case of Kamal Singla, Ganesh Kumar v/s Delhi. Administering BEOS in DFS Gandhinagar on the suspects showed EKs for the crime they had committed 8 years ago. Therefore, it can be concluded that no matter how old the event is, BEOS can be used to generate responses through the memory of that event by presenting specific probes.

Khemchandani and Kacker researched about the experience of post-traumatic stress disorder and domestic violence. Their research was aimed at identifying the areas of brain that are greatly affected by the experience of PTSD, through the traumatic event of Domestic Violence. The sample of domestic violence victims was interviewed regarding their domestic violence events to prepare the set of probes to be administered to the participants of the study. Majorly all researchers focussing on PTSD, its intensity, occurrence and therapies needed are on war veterans. This research aimed at taking victims of domestic violence and analysing the effects of the traumatic event on them with respect to their PTSD symptoms. The researchers concluded that BEOS can be used to generate Neuro Signature Profiles of victims with PTSD which can eventually assist with appropriate counselling interventions, psychiatric help and social support. NSS report can also be used to scientifically understand the experience of the victim of a traumatic event and make informed decisions regarding the assistance such victims need.

A study on women empowerment to reduce crime against women was done by Sanger and Kacker in 2020. This study aimed at the fact that women empowerment – being a globally discussed term – was not a strengthened concept in India. Policies, implementation of law and attitude of society towards women victims or victims of Gender Based Violence (GBV) are yet

to improve. The researchers brought out misconceptions associated with the term women empowerment such as:

- Women empowerment will make women superior in society
- Women empowerment is a theory of the west – not relevant for India
- Locus of women empowerment is not limited to specific domains, but includes all areas such as family, workplace, education, society and politics.

The paper highlighted the importance of women empowerment in crime reduction. Awareness and increased confidence among women will enable them to not become prey of crimes such as trafficking, forced prostitution, sexual slavery and forced pregnancy. A higher crime statistic for these crimes is a result of women not knowing how to seek help and retaliate towards such atrocities. The research study lists various suggestions regarding steps that can be taken towards empowering women. The steps are:

- Awareness about rights
- Awareness about execution of rights
- Awareness about helpline numbers
- Awareness about technology

The last suggestion, "awareness about technology" is the focus area for this research. Technology such as BEOS, can definitely be helpful in scientifically evaluating the suffering and impact of a criminal event over a victim and appropriate assistance can further be provided.

Another research on public attitude towards rape crime and the treatment of its victims in Delhi city conducted by Hetu in 2020 aimed at focussing the public attitude towards rape victims. The aim was to explore whether the movements of social change and social development were instrumental in bringing about any change in the attitudes, thoughts and actions of the society towards rape victims. The researcher interviewed close to 130 rape victims and their family members and found out that the society was highly insensitive towards the victims. There was an increased domination and control over the families of rape victims. Young girls were asked to leave the schools, families were asked to vacate the houses and leave the society. Such experiences and continued victimization have a detrimental effect on the victims. Scientific evaluations and constructive assistance for rape victims is the need of the hour today.

RESEARCH METHODOLOGY

Aim is to evaluate if there is a difference between the brain activity (Beta and Gamma waves) for post-traumatic subjects. It is based on the Research Hypothesis that there will be a difference between the brain activity of subjects who have faced trauma. The research began with a pilot study to identify the traumas experienced by subjects. Responses from the Google form helped in identifying the traumas experienced by the research population. A hierarchy of traumas, based on the number of subjects who have experienced them was prepared. A total of 113 responses in the form assisted with,

- Preparing the list of traumas to be considered for the BEOS script (probes). The list is based on the number of subjects identifying with the stated traumatic event.
- The descriptions of the traumatic event helped in identifying the common aspects among the experiences. Common details from the experiences were noted separately.

PROCEDURE

Each subject was individually contacted to discuss more about their traumatic event, to ensure no important detail is missed. This was done to ensure that the probes for BEOS are specific and efficient. Vague probes generate vague responses, which reduce the accuracy of the

research. 40 in-depth interviews were conducted to understand the traumatic experiences of the respondents in detail. This provided the relevant information to design specific probes, both regarding experiencing the event and experiencing the traumatic emotions. Each of the 40 subjects provided their written consent for the entire process and also filled a PTSD checklist.

The PCL-C (Civilian) is a self-reporting scale to measure PTSD. It comprises of 17 items which correspond to the symptoms of PTSD. This scale is administered on general public for any traumatic event a person has experienced. Filling the scale, with respect to traumatic event experienced, the intensity of PTSD can be measured. The respondents were asked to fill the scale with respect to the traumatic event mentioned by them in the Google form and discussed in detail in the personal interview. The 17-item scale then provides with a score, which represents the intensity of PTSD for that respondent corresponding to the traumatic event experienced by him/her. The threshold of the PCL-C PTSD checklist is 34. Therefore, respondents scoring above 34 are categorized as individuals with positive symptoms of PTSD and those scoring below 34 are categorized as individuals with negative symptoms of PTSD.

The checklist was filled by each of the 40 subjects interviewed. After the interviews, the standard script of BEOS was prepared. The script contains multiple traumas. Each subject went through the entire script. The trauma faced by a particular subject showed Experiential Knowledge (EK) for probes pertaining to the traumatic event. For the other events, it did not show EK, if the subject has not experienced either the event or trauma for that event.

This is the first research on the difference of significance levels of Beta and Gamma waves with respect to remembering traumatic events. The difference in the significance levels, while remembering a traumatic past, which is triggered by a traumatic probe, connects the domain of Beta and Gamma brain waves and impact of trauma. This is a unique scientific work which scientifically tests the impact of victimization or the suffering of an individual, which has not been carried out till date, to the best of our knowledge.

The probes included four kinds of traumas, i.e.,

- Relationship trauma
- Sexual trauma
- Accident through two-wheeler
- Conflict with parents

The four traumas were decided through the Google form filled by 113 students. The most common traumas in descending order were selected. The 30 participants filled the PCL-C checklist (PTSD scale) for their respective trauma. The PTSD scale helped in identifying the right sample for the research. The personal interviews with each subject, helped with designing accurate probes for the research. Inaccurate, vague or irrelevant probes would not have yielded the right results. The probe had to be specific enough to trigger the traumatic memories and experiences of the subjects, to eventually get accurate readings from their brain waves.

Since all the probes are traumatic probes in the entire BEOS script, subject could identify with some corresponding with their personal experiences and could not identify with some probes. The intensity of remembrance is measured through the difference between the Beta and Gamma brain waves for the probes which the subjects have experienced, i.e., Experiential Knowledge (EK).

Once the interviews were done, the final sample of 30 subjects was formalized. Each subject was briefed about the BEOS procedure. Each administration was carried out with the standard set of probes.

DISCUSSION

The objective of the research was to find out if the intensity of trauma can be scientifically evaluated through BEOS. The significance levels of Beta and Gamma brain waves and the significance levels of the Odd and Even markings all correspond to the intensity of remembrance which is scientific evidence of the intensity of remembrance.

The values for level of significance for Beta and Gamma waves is given for every single probe in BEOS. For the purpose of this research, the values for EK probes were noted. Hence, individual values for 32 electrodes, on all EK probes, for each subject were noted down. Total of significance values for both Beta and Gamma waves were done for each subject and a grand total was obtained. Total of Odd and Even marking of electrodes was also done for each subject and grand total was obtained. This provided with the significance values for the Left and Right hemisphere of the brain. The individual totals for Beta and Gamma waves of all 30 subjects were compared for a One Sample T-test. The same was done between the Odd and Even values.

One sample T-test was conducted on two aspects derived from the results, i.e., Beta and Gamma brain waves figures of individual subjects and Odd and Even markings of individual subjects. Since the comparison is between different components of the same sample, the One sample t-test is done. The test provides with the level of significance (P value) to check the chances of error in the experiment conducted.

The level of significance for both the comparisons is $P = 0.000$ which shows there is a significant difference between the Beta and Gamma waves and the Odd and Even hemispheres. The test was conducted through Statistical Package for Social Sciences (SPSS) version 26.

A significant difference between the Gamma waves and Beta waves shows a higher level of significance and intensity of remembrance of a traumatic event. Gamma waves function at 35 Hz. and above, therefore, the activity of remembering a traumatic event is functioning at 35 Hz. and above. This means that a traumatic experience, when triggered through any stimulus, impacts the normal cognition of an individual. The remembrance is high enough for the normal functioning of the brain to be impacted.

The Odd and Even markings represent the hemispheres of the brain. The Odd markings are aligned towards the left hemisphere of the brain, while the Even markings are aligned towards the right hemisphere. The two hemispheres of the brain are responsible for different functions of the brain. The left hemisphere performs functions such as, sequencing, linear thinking, reasoning and so on. It deals with everything related to Logic. The right hemisphere is responsible for imagination, intuition, holistic thinking and so on, i.e., everything to do with Arts. A significant difference between the odd and even markings show a significant difference between the intensity of remembrance of the two hemispheres. Since there is a higher level of intensity in the left hemisphere, it shows that remembering a traumatic experience hampers the logical thinking domain of the individual.

A study conducted on Emotions and Brain Waves by Sisode (2016) mentions multiple researches that have proved that change in emotional status affects the different brain waves.

Du and Jong (2014) conducted an experiment wherein they selected 10 young college students to volunteer for the stimulus experiment. The experiment involved viewing different stimulus

to trigger change in emotions, while measuring the activity through the EEG cap. The researchers found that Alpha, Beta and Gamma brain waves changed significantly.

If an experience is remembered with high intensity, it means, there is a high involvement of different regions of brain in remembering that event. The brain is strongly involved in the remembrance process as there are multiple related memories, such as, motor memory, visual memory, emotions and so on, which constitute to a holistic experience of the stated event.

Therefore, if the event is a traumatic event, remembering the experience will signify reliving the trauma again. A high intensity of remembrance in multiple memories such as visual, memory, emotions and so on, confirms a strong impact of the experience of the event.

Remembering the traumatic event with a high intensity of remembrance, irrespective of the number of years that have passed after experiencing the event, is a clear indication of the impact of the experience being strong for the individual. Such impactful memories, when triggered, take the individual back during the time when the event was experienced. The same emotions, such as fear, anxiety, nervousness etc. are felt. In a lot of cases, individuals also feel the same physical pain that they had felt during experiencing the traumatic event. For example, a trauma due to an accident on a two-wheeler impairs the person's ability to drive a two-wheeler confidently again. Subjects in this research reported feeling shivering of hands, feeling frightened upon seeing a dog, constantly feeling nervous and anxious while driving in traffic and so on.

As can be seen in the images, both the probes; i.e., '*I had nervous breakdowns' (Fig.5)* and '*I was extremely hurt' (Fig.6)* have triggered multiple experiences and memories for the subject. Since the remembrance is functioning at the Gamma brain wave, the activation areas are not limited to a small region in the brain. The dark shade of colour Red is a proof that the intensity of remembrance is also high.

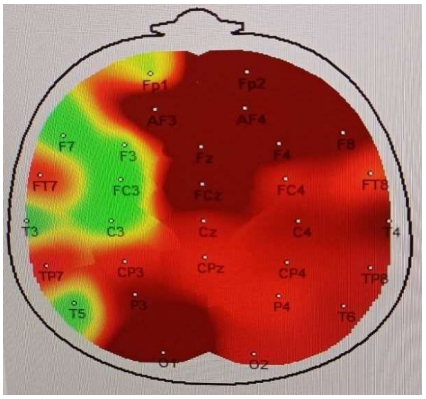

Fig. 5: Probe – "I had nervous breakdowns"

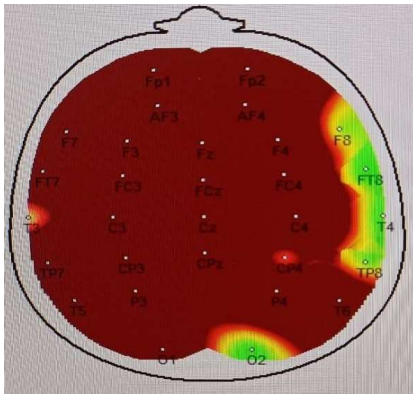

Fig. 6: Probe – "I was extremely hurt"

We can clearly see that one experience, which turned into a traumatic experience, has affected the normal functioning of the individual. Traumatic events are encoded in the autobiographical memory and in most cases need external support for the individual to either come to terms with the experience or repress the memory. It is important to address the concern of trauma to ensure that the person is able to manage the traumatic emotions and responses and is slowly able to function in the same way as he/she used to. This research has focussed on the aspects of suffering and pain and integrated them with the neurological functioning of the victim. Along

with the areas of the brain highlighted in the brain scan images, a neurological assessment can also be done regarding the regions of the brain that are more impacted due to the traumatic experience. EK probes in a script which has only traumatic probes confirms that the particular content mentioned in the probe is the subject's experience. And a significant difference between the Gamma brain waves and the Beta brain waves proves scientifically that BEOS can be used as a diagnostic tool to measure the intensity of suffering of a victim of trauma. Any individual who has experienced a traumatic event can undergo a BEOS administration to scientifically evaluate the intensity of suffering of that individual.

Also, the experience of any victim of any criminal event is a traumatic experience for many and unpleasant for all. Administering BEOS on all such victims can provide with crucial information such as,

- Important facts about the case, evidences, involvement of victim, interactions and experiences with the offender.
- Intensity of victimization of the victim.

Through these two domains, a BEOS administration on the victim of the crime can provide with the information necessary to navigate the investigation in the right direction. This can lead to speedy and error-free investigations. Second it can provide with the level of victimization and suffering of the victim through which an appropriate assistance can be ascertained for the victim. Counselling, therapy, medication, social assistance, etc. are some domains which impact the mental health of the victim immensely. A concrete scientific information regarding these aspects will ensure efficient recovery of the victims and their smooth integration in the society. It is imperative to acknowledge the victims in the society. Appropriate assistance ensuring a healthy mental condition of the victims also contributes towards reduction in crime by decreasing the number of victims seeking revenge from their offenders. For a victim to trust the criminal justice processes patiently, it is highly important to work on restoring the normal mental health of the victim.

CONCLUSION

This research confirms that BEOS can be used as both a Forensic Investigative Instrument and as a Diagnostic Instrument since it can provide with crucial details pertaining to the criminal case and victim's personal sufferings. BEOS is non-invasive in nature, it protects the right to remain silent of the individual, does not allow the individual to respond in any form, thereby eliminating chances of manipulation from the subject and presents the experience of the individual in a comprehensive and holistic neurological report.

With such important aspects being covered by the instrument, it can be concluded that BEOS should be used on all victims of crime. Through this, we can step towards addressing, the concerns regarding ineffective and inaccurate investigations, faulty acquittals, crimes due to revenge taken by victims, injustice, poor mental health of victims, scientifically evaluating victimization. Most important among all, through this an integration between forensic and diagnosis can be achieved. This will certainly strengthen the criminal justice system, which should not be limited to convictions and acquittals, but also acknowledge the most crucial entity of the entire criminal justice delivery process – the Victim.

REFERENCES

[1] *Ajitprasad, A., Kacker, P., (2020). Experiential knowledge on confabulated and real experiences using neuro-signature system: a pathway to criminal justice. GAP Interdisciplinarities, 3(3).*

[2] *https://www.gapinterdisciplinarities.org/res/articles/(3036)%20EXPERIENTIAL%20KNOWLEDGE%20ON%20CONFABULATED%20AND%20REAL%20EXPERIENCES%20USING%20NEURO- SIGNATURE%20SYSTEM%20A%20PATHWAY%20TO%20CRIMINAL%20JUSTICE.pdf*

[3] *Ashtaputre, A., (2016). Emotions and Brain Waves. The International Journal of Indian Psychology, 3(2).*

[4] *https://books.google.co.in/books?hl=en&lr=&id=XniVCwAAQBAJ&oi=fnd&pg=PA14&dq =beta+and+gamma+brain+waves+&ots=NjyWSOEWZ_&sig=469ts3r33dsEY5eZMeyc9Kk 2fu8&redir_esc=y#v=onepage&q=beta%20and%20gamma%20brain%20waves&f=false*

[5] *Andreasan, C., (2022) What is post-traumatic stress disorder? Dialogues in Clinical Neuroscience, (13), 240-243. https://www.tandfonline.com/doi/full/10.31887/DCNS.2011.13.2/nandreasen.html*

[6] *Bremner. NCBI-National Library of Medicine. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3181836/*

[7] *Denial: Why It Happens and How to Overcome It. APC Bham. https://apcbham.org/2019/10/01/denial-why-it-happens-and-how-to-overcome-it/html*

[8] *Hetu, V., (2020). Public Attitude Towards Rape Crime and the Treatment of Its Victims in Delhi City. The Emrald Handbook of Feminism, Criminology and Social Change, 137-155.https://www.emerald.com/insight/content/doi/10.1108/978-1-78769-955-720201013/full/html*

[9] *Kacker, P., (2018). Experiential knowledge of positive and negative experiences on remembrance and neural response using neuro signature system. J Clin Psychiatry Cog Psychol, 2(1), 19-25.*

[10] *https://www.researchgate.net/profile/PriyankaKacker/publication/334764817_Experiential_knowledge_of_positive_and_negative_experiences_on_remembrance_and_neural_response_using_neuro_signature_system/links/5e71f7014585152cdbfabaef/Experiential-knowledge-of-positive-and-negative-experiences-onremembrance-and-neural-response-using-neuro-signature-system.pdf*

[11] *Khemchandani, R., Kacker, P., (2020). THE EXPERIENCE OF POST-TRAUMATIC STRESS DISORDER AND DOMESTIC VIOLENCE. GAP INDIAN JOURNAL, 1(1). https://www.gapijfbs.org/res/articles/1-4%20THE%20EXPERIENCE%20OF%20POSTTRAUMATIC%20STRESS%20DISORDER%20AND%20DOMESTIC%20VIOLENCE.pdf NCBI – Frontiers in Psychiatry (2019).*

[12] *Https://Www.Ncbi.Nlm.Nih.Gov/Pmc/Articles/PMC6603306/. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6603306*

[13] *NCBI- National Library of Medicine. https://www.ncbi.nlm.nih.gov/books/NBK207191/html*

[14] *Mukundan, C., (2016). Brain Electrical Oscillations Signature Profiling (BEOS) for Measuring the Process of Remembrance. Journal of Psychology & Clinical Psychiatry, 6(6). Mukundan/Publication/315873736_Neurocognitive_Processing_Steps_during_ Remembrance/Links/5c20a1c5299bf12be395f9df/Neurocognitive-Processing-Steps-during-Remembrance.Pdf*

[15] *https://www.researchgate.net/profile/C-R-Mukundan/publication/315873736_ Neurocognitive_Processing_Steps_during_Remembrance/links/5c20a1c5299bf12be395f9 df/Neurocognitive-Processing-Steps during Remembrance.pdf*

[16] *Pendse, A., Kacker, P., (2020). Remembrance of Recent Vs. Remote Memory of an Event: A Key to Investigation of Cold Cases. Indian Police Journal, (67), 89-95. https://bprd.nic.in/WriteReadData/News/IPJ%20V-67%20No.%201%20Jan-Mar2020.pdf#page=95*

[17] *Posttraumatic Stress Disorder (PTSD). (2003). WebMD. https://www.webmd.com/mentalhealth/post-traumatic-stress-disorder*

[18] *Post-Traumatic Stress Disorder. National Institute of Mental Health (NIMH). https://www.nimh.nih.gov/health/topics/post-traumatic-stress-disorder-ptsd*

[19] *Psychiatry Online (1999). The American Journal of Psychiatry. https://ajp.psychiatryonline.org/action/cookieAbsent*

[20] *Robinson, L. (2022). Emotional and Psychological Trauma. HelpGuideOrg. https://www.helpguide.org/articles/ptsd-trauma/coping-with-emotional-and-psychologicaltrauma.html*

[21] *Sanger, S., Kacker, P., (2020). Women empowerment to reduce crime against women. Women empowerment – Awakening of a new era, 59-66. https://www.researchgate.net/profile/Sudeep-Chandramana/publication/356666392_Achieving_Sustainable_Development_through_Wo me n_Empowerment/links/61a74faa85c5ea51abc2843d/Achieving-Sustainable-Developmentthrough-Women-Empowerment.pdf#page=68*

[22] *The 6 Types of Basic Emotions and Their Effect on Human Behavior. (2021). Very well Mind. https://www.verywellmind.com/an-overview-of-the-types-of-emotions-4163976*

[23] *What Is Trauma? - Definition, Symptoms, Responses, Types & Therapy. Integrated Listening. https://integratedlistening.com/what-is-trauma/*

[24] *What Is Shame? (2021). Verywell Mind. https://www.verywellmind.com/what-is-shame-5115076#:%7E:text=Shame%20can%20be%20defined%20as,our%20survival%20as%20a%20species.*