DISCUSSION

The study has three major parts, which are (1) comparison of the BEOS profiles two Experimental groups for determining if the Perpetrator Group (PG) can be differentiated from the Witness group (WG), (2) Comparison of the BEOS Profile of the PG and WG groups with Polygraph measures, (3) effect of negative probes on the BEOS profile, and (4) determining the sensitivity and specificity of the BEOS profiles of PG and WG groups in comparison with a Control group. The BEOS profiles produced by probes with motor imageries and visual imageries were compared between the PG and WG groups for determining if the two groups could be differentiated. A comparison of the deception scores on the Polygraph with the BEOS profiles scores helped to determine the second effect. A set of negative probes in which each probe stated that the individual did not either carry out an act or witness a scene were used to determine the probes could still elicit Experiential Knowledge. The number of subjects in whom total EK scores more equal to, greater than a cutoff score (Mean + 2 Standard Deviation) of the control group were analyzed for determining the Sensitivity and Specificity of the BEOS test in the two experimental groups.

1. **Comparison of PG and WG**

Probes, which elicited need to extract EEG with either motor or visual imageries. The presence of motor imagery was specified by a significant
increase in the EEG Coherence values compared to preprobe base line Coherence values between any two Frontal and Central electrodes (AF1, F3, F7 and FC3, C3 or AF2, F4, F8 and FC4, C4 electrodes) for the probes, which elicited EK scores to probes requiring movements and actions. Similar significant increase in Coherence values between any two of the Frontal and Posterior electrodes (AF1, F3, F7 and CP3, P3, O1 or AF2, F4, F8 and CP4, P4, O2) electrodes for the probes, which required the individual only to see an object or action during the simulation study. Coherence in the phase of Gamma ranges (35 – 85 Hz) of EEG activities were determined in the response segment (3.5 + 3.5 Sec) time locked to the initiation of the probe presentation and statistically compared with the coherence in the preprobe baseline (3sec) in the specific pair of electrodes mentioned. The coherence values range from +1 to -1.

The scores of mean score of EK coherence results of probes with motor imageries are given in the Table 8 in between the two groups (PG and WG). Results of statistical analysis of these sores in the PG and WG groups are shown in Table 8.1. EK scores in the PG group were statistically compared with that of the WG group. The finding clearly indicates that only an individual who had indulged in an act can have the motor imagery of the same act during its remembrance. One who has only witnessed the act will not have the motor imagery of the act.
witnessed by him. The differentiation can be done with 95% accuracy by the BEOS test. EK response is indicated only if the presence of the imagery as required in the probe identification code is present during the EEG analysis. A few of the control group subjects also have shown EK to some of these probes. This indicates that the probes did elicit some motor imagery in a control subjects also. This could be because the probe facilitated remembrance of some other act, which did have an action component. The probes presented are indeed irrelevant to the Control participants, as they have not engaged in the activities in the simulation study. However, some of the probes may have triggered remembrance of similar activities they might have engaged in some other occasion. This has caused isolated probes to trigger remembrance and EK.

The probes, which have elicited EK with motor imageries are those common ones related to movement within the study room, when the WG volunteer was to move around with the PG volunteer. Significantly, lesser number of WG volunteers have produced EK to the probe, which are related to personal actions. The simulation video showed some of them engaging in conversation with the PG volunteer. The videos of have shown a few of WG volunteers trying to help the PG volunteer. These are the volunteers, who have produced EK responses to a few probes referring to actions. Further, the simulation activities were not criminal in nature. They were described by the volunteers as ordinary.
activities, which they normally indulge in, except they felt rather strange doing these in the Forensic Institute and under surveillance.

With regard to visual imageries, the PG and WG volunteers produced highly comparable number of probes EK responses with visual imageries. The comparison of mean coherence scores of EK, in between PG and WG groups shows significant difference in between both the groups with \( P<0.001 \) (Table 9 and 9.1). The mean and SD values of EK scores on visual probes are given in Table 10, and the statistical analysis of the difference between the means clearly indicates this that the two groups are significantly different with \( P<0.034 \) (Table 10.1). This finding is indeed as per the hypothesis that both the groups will produce comparable EK profiles. The findings related to motor and visual imageries clearly indicate that only the perpetrator of an act will have motor imageries during remembrance. Neuroimaging studies shown that remembrance of imageries is an important indicator of a person truly engaging in the said activity and its absence may indicate false witnessing as in the case of child sex abuse and PTSD patients. Descriptive narration and associated emotional effects may be part of confabulation (Fiorio et al. 2006; Kosslyn et al 2005, 1999,1997; Lacourse et al. 2005;Pineda 2005;Kelin et al.2004, 2001; Ganis et al. 2004;Sparing et al.2002;Dettmers et al.2001;Maruno et al. 2000), which is considered a frontal phenomenon. That EK associated changes are identified in each
Anjali Yadav, GFSU, Gandhinagar, Gujarat

electrode only when various other ranges of frequency domain and time domain changes in the EEG occur significantly, along with the significant increase in the coherence values. The actual values of coherence are not used for analysis. The results are taken from the BEOS analysis screen and the fact that a probe with ID code for motor or visual imagery has elicited the EK response. The BEOS program does not identify an EK response if significant increases in coherence across the front-central or fronto-posterior electrodes were not present. The program does not look for coherence values and their statistical comparisons if the respective ID for imagery is not included in the probe, which is to be stored along with the probe before they are presented to a subject.

In a forensic investigation, these differences may provide vital information regarding the involvement of a person in a criminal activity. (Puranik et al., XX all India Forensic Science Conference, 815-822., Sunny et al., XX all India Forensic Science Conference, 803-813) have shown that they could differentiate the different roles suspects in a criminal case using BEOS results, which were later supported by evidences elicited by the investigators. Further, the need to include brain changes associated with action significantly increases the specificity of the findings compared detection of only recognition of a crime related item is included in identifying a suspect as the perpetrator, as in the case of P300 methods, which is only a measure of recognition. Such
Imageries occur mainly because cueing of remembrance of a specific experience is triggered through simple sentences presented in auditory mode. A criminal act essential has motor component, whether it is carried out impulsively or intentionally. Impulsive act may fail to produce imageries of the actual act, which we would call the criminal act, but the test gives scope for testing the remembrance of experiences preceding and following a said criminal act. The available data from the presentation of BEOS findings in several cases show the presence of this specific situation in several cases (state of Gujarat Vs Jivanbhai Rajabhai Bhardwaj, State of Maharashtra Vs Aditi Baldev Sharma, State of Jharkhand Vs Ajey Kumar Pal). The specific components of criminal actions may be forgotten or repressed because of their traumatic effect on the individual. However, this requires further investigation using BEOS and other neuroimaging techniques.

As per the published literature available on BEOS (Mukundan, Vaya, 2004; Mukundan 2005, Mukundan 2007a, 2007b, TIFAC-DFS Report – 2008; Mukundan 2008a, 2008b, Wagh et al. 2009; Vaya et al. 2009a, b) and the screen display of analyzing the results, the analysis constitutes a series of independent statistical comparison of the computed signals (integrated FFT values of different ranges of frequencies) across time in a segmental and sequential manner. EEG of 250 milliseconds constitutes each segment and hence there are 40 such segments in a 10
search epoch of each probe. Significant increase or decrease is looked for in each segment in the different frequency ranges. Significant serial decrease in low and middle alpha are consider indicators of desynchronization or sensory registration of the probes. Significant sequential increase in high alpha and beta 1 and beta 2, and either in low or both low and high gamma frequency ranges are considered indicators of semantic processing or encoding. The author of the test has taken significant increases in the power of theta and delta bands of EEG as indicators of accessing hippocampus for autobiographic memory and inward direction of attention during remembrance. These changes are also detected in a sequential manner across segments. The program identifies these changes as indicative of EK responses only when occur within the first 3.5 Sec of the probe epoch. The power spectrum changes were seen to start occurring from 250 ms until the end of the probe, which is 3 Sec or less. Three seconds is the permissible maximum duration of a probe, as the program, looks for significant changes only until 3.5 Sec. The minimum duration of the significant increase or decrease is 500 ms One cannot be certain that the minimum duration of semantic processing or remembrance must be 500 ms However, if it is lesser than this duration, the change is not taken to indicate the presence of EK. On the other hand, the time domain change or the positive response may occur any time during the 7 Sec response epoch. It is
considered that it may occur even later than this period, but it is not included for analysis, especially because the next probe occurs 10 seconds after the end of the response epoch (7sec or 10 Sec including preprobe baseline). As the program looks for the morphological format of the positive waveform, it can be easily seen that the program avoids detection of other movement artifacts or eye opening responses as the positive response. This was easily seen in the video of the face, which is continuously and embedded in the EEG record. Late positivity occurring after the probe, were frequently seen.

2. **BEOS and Polygraph Findings**

In this particular study, the design used is GKT and the expected response from the subjects was to say ‘No’ for each and every option provided. The Guilty Knowledge test did not differentiate between the WG and Control groups, as all the participants in the two experimental groups were aware of the activities in the experimental room. The Control Group subjects were provided with all the information and asked to give a deceptive response, deception was seen significantly present in the control group also. This has resulted in all the three groups showing merely an equally significant deception.
In polygraph, denial of mere knowledge can affect deception response, whereas in BEOS, only the presence of experiential knowledge can produce EK. The mean comparison of all three groups, PG, WG and Control group shows that PG can be significantly differentiated (table 14.3), however WG can not be differentiated from Control group. The statistical analysis clearly indicates that PG can be compared to both truthful and deceptive responses with that of the control group with P <0.001 (table 14.4 and 14.6), but WG shows no difference, neither on deceptive response nor on truthful responses (table 14.5 and 14.7).

The effectiveness of Probes can be stated in the negative presentation of probes, as the probes states that the participant (or a suspect) has not done a certain activity and hence the probes do not pose any threat to the participants (or the suspects) listening to them. This is equivalent to the GKT response of ‘No’ to each question. However, no significant correlation was found between the scores in Polygraph and BEOS.

3. **Denial Probes**

The last phase of the BEOS test consisted presentation of probes, which denied either carrying out an act or witnessing an object or act done by another person. These are presented separately in the tables (13 to 13.5) as they are grouped as probes requiring to elicit motor imagery or visual
imagery. The initial analysis consists of a combined analysis of all the
denial probes with motor and visual imageries. The analysis of combined
EK responses for the Denial probes show that the PG and WG groups
have significantly (P<0.01) increased mean EK responses compared to
the control group. Statistical comparisons of the regular probes referring
to the same experiential component denied in the Denial Probes also
show similar significant differences in the PG (P<0.01) and WG
(P<0.05) groups, as shown in the Tables 13 to 13.3. However, there is
statistically significant difference in the mean scores of the PG and WG
groups on the total EK response scores.

The significant outcome of the results of the Denial probes is the
substantiation that Experiential Knowledge is remembered only by the
cueing effect of the probe and not its literal semantic meaning. The
Cueing effect may be achieved by part of the probe or a word in the probe
and it may cue any associated autobiographic memory in a person.
However, as the probes are closely and sequentially linked to an event
under investigation, they are unlikely to cue remembrance of an
independent or unassociated event. This may happen if the person tested
is not at all associated with the event and a certain probe happens to
trigger an independent episode in life. If the probes are relevance wise
and sequentially are not adequately linked to the event that really
occurred or was experienced by a person or suspect, the probes may fail
to linked EK responses and isolated EK response may appear. It further shows the experience and competence needed by the examiner in formulating the episodes and defining the probes, which could trigger the remembrance of the components of the original episode.

Denial probe has a more positive effect on a suspect than a regular probe, in which the statement is in first person and it refers to the person carrying out an act or meeting an individual or witnessing an object or an action. Suspects do generally feel uncomfortable by the probe, which must be taken care of by the examiner. Further, as the test allows to inclusion of probes, which substantiates a suspect’s version of his involvement or its absence, it becomes possible to explain to the suspect that the test is only examine if he has really taken part in the action or episode investigated. As the suspect has been already examined and interrogated by the investigators, the presentation of probes, which indicate involvement in the episode investigated, is not difficult. The negative or denial probes make it very comfortable to the suspect, as the probes mean that he was not involved in the action. However, the cueing effect of the probe to trigger the remembrance is not affected by the negative or denial statement.
Independent analysis of the Denial probes with motor and visual imageries, on the other hand, shows the emergence of a different pattern. Denial probes do not show any significant difference in PG and WG with a control group on motor imageries. This is because the mean scores of the two groups are less than one in the two groups. However, on visual imageries, the difference is statistically significant in PG (P<0.01) and in WG (<0.05) as shown in table 13.4 and 13.5.

4. Sensitivity and Specificity

Though the main objective of the study was to determine if BEOS profile could differentiate a perpetrator from a witness, the issues of sensitivity and specificity of the BEOS test was considered as the study involved a simulated test and a sample of control participants. The first issue to be considered in this respect is that the participants in the PG and WG groups did not have the same engagements. The WG participants only witnessed what the PG participant was carried out in the simulation study. The total EK scores of each group EK responses elicited by probes with motor and visual components, which is fully applicable only to the PG participants. The number of participants who scored EK scores greater than the cutoff score of ‘Mean + 2 SD’ (EK=3) of the control group are shown in Table 12.2. In the PG group, 16 out of 20 participants
has scores greater 3 whereas in the WG group, there are 14 out of 21 participants fall above the cut off limit. The sensitivity and specificity values of the BEOS test are given in Table 12.3. Sensitivity of BEOS profiling test is found to be 0.8, which would mean that 80 out of 100 individuals who have really carried out an act can be picked up by the test as perpetrators and the specificity of the test is 1.0, which would mean that no innocent person would be wrongly identified as a perpetrator. On the other hand, if we are to use the test with the same probes, its sensitivity falls to 0.66.