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ORIGINAL ARTICLE

THE UTILITY OF POLYSOMNOGRAPHY(PSG) MACHINE AS A RELIABLE LIE DETECTOR IN AN EXPERIMENTALLY INDUCED MOCK THEFT SITUATION

Rajesh Kumar Ajagallay[1] | Gaukaran Janghel[2] | Vimal Chandra Bhagat[3*]

[1]Professor & Head of Department, Department of Psychiatry, Lakhiram Agrawal Memorial Govt. Medical College, Raigarh, Chhattisgarh, India

[2]Clinical Psychologist, Department of Psychiatry, Lakhiram Agrawal Memorial Govt. Medical College, Raigarh, Chhattisgarh, India

[3]Assistant Professor, Department of Psychiatry, Lakhiram Agrawal Memorial Govt. Medical College, Raigarh, Chhattisgarh, India

Abstract

Objective- To compare the various parameters in polysomnographic recordings of individuals who had indulged in experimentally induced theft situation with subjects who had not indulged in an experimentally induced theft situation.

Material and methods-The present study was conducted in the department of psychiatry, Sarojini Naidu Medical College (S.N.M.C.) Agra, between the periods, March 2010 and September 2011. The sample consisted of 102 medical students who had volunteered to participate in the study. These volunteers were selected on the following criteria's.

Result- The present study finding shows statistically significant difference on EEG amplitude, there are C_3-A_2 lead EEG amplitude were significant in group A and group C (control versus stolen, at baseline p-value = 0.0001; after 10^{th} minute p-value = 0.0007; and after 20^{th} minute p-value = 0.0129); EEG amplitude in O_1-A_2 lead were significant in control and stolen group (at baseline p-value = 0.0019 and after 10^{th} minute p-value = 0.0505); EEG amplitude in O_2-A_1 lead were found significant in control versus stolen group (at baseline p-value = 0.0002, after 10^{th} minute p-value = 0.0347, and 20^{th} minute p-value = 0.0262).

Conclusion- The changes observed in the amplitude of C3-A2 and O2-A1 leads along with C4-A1 (mv), O1-A2 (mv) leads could better identify the subjects who had stolen money, due to higher apprehension created for being caught during their PSG recordings while other leads which did not show significant changes in the PSG recordings could be considered as being not affected during deception.

Keywords: Polysomnography, Amplitude, Lie Detection

1 | INTRODUCTION

As deception and lying are common in day to day life situations, researchers have tried to define deception and lying but there is no universally accepted definition of lying to others. The Oxford English Dictionary (second edition, 1989) definition of lying is as follows: ”to make a false statement with the intention to deceive”. As obvious by the above definition, lying requires a person to make a statement but literature exists stating that lying differs from deception. According to Siegler (1966), it is possible for a person to sign expressions using American Sign Language, smoke signals, Morse code, semaphore flags, and so forth, as well as by making specific bodily gestures whose meanings have been established by convention. Hence, it is possible for a person to make statements by making smoke signals, or by nodding head in response to a question. Excluding the underlying controversies with the definition of lying and deception, this study concerns with lie detection.

The problem of detecting lies has always concerned humans; therefore, the history of the polygraph, also known as the lie detector, has very deep roots. In ancient China, dry rice was commonly utilized as a lie detector. The Chinese believed that salivation ceased at times of emotional anxiety such as a strong fear. An examiner had a suspect held a handful of dry rice in his mouth while he was asked a series of relevant questions. After questioning, the rice was examined. If it was dry, the suspect was declared to be a liar. This means of deception detection was more advanced than a subjective evaluation of a suspect by a tribe chief. As was assumed then and is currently supported by more recent evidence, the nervous tension created by lying slowed or blocked the flow of saliva (Boring, 1942). Generally speaking, the research on detecting lies from behaviour suggests that two broad families of behavioural clues are likely to occur when someone is lying, clues related to liar’s memory and thinking about what they are saying (cognitive clues), and clues related to liar’s feelings and feelings about deception (emotional clues) (Zuckerman,1981).

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Corresponding Author: *Vimal Chandra Bhagat*
Assistant Professor, Department of Psychiatry, Lakhiram Agrawal Memorial Govt. Medical College, Raigarh, Chhattisgarh, India
Email: bhagatgreat@gmail.com.

A lie conceals, fabricates, or distorts information; this involves additional mental effort. The liar must think harder than a truth-teller to cover up, create events that have not happened or to describe events in a way to allow multiple interpretations. Additional mental effort is not solely the domain of the outright liar; however, a person who must tell an uncomfortable truth to another will also engage in the additional mental effort to come up with the proper phrasing while simultaneously reducing the potential negative emotional reaction of the other. This extra effort tends to manifest itself with longer speech latencies, increased speech disturbances, less plausible content, less verbal and vocal involvement, less talking time, more repeated words and phrases, and so forth (De Paulo et al., 2003). The researcher has also shown that some non-verbal behaviours change as a result of this mental effort. For example, illustrators-hand or head movements that accompany speech, and are considered by many to be a part of speech will decrease when lying compared to telling the truth (Ekman, 1972).

Another way in which cognition is involved in telling a lie is through the identification of naturalistic memory characteristics, this means experienced events have memory qualities that are apparent upon the description, those are different from the events, that have not been experienced (Undeutsch,1967). Events that were not actually experienced feature more ambivalence, have fewer details, a poorer logical structure, less plausibility, more negative statements, and are less embedded in context. Liars are also less likely to admit lack of memory and have less spontaneous corrections (Yuille,1989), and may use more negative words and fewer self and other references (Newman, M.et al., 2003). Mental effort clues seem to occur more in the delivery of the lie, whereas memory recall clues tend to rest more in the content of the lie.

Lies can also generate emotions, ranging from the excitement and pleasure of “pulling the wool over someone's eyes" to fear of getting caught to feelings of guilt (Ekman,1985). Darwin (1872/1998) first suggested that emotions tend to manifest themselves in the facial expressions, as well as in the voice tones and that these could be reliable enough to accurately identify emotional states. The researcher has shown that for some expressions- e.g. anger, contempt, disgust, fear, happiness, sadness/distress, or surprise, cultures throughout the planet recognize and express these emotions in both the face and voice similarly (Ekman, 2003).

To the extent that a lie features higher stakes for getting caught, we would expect to see more of these signs of emotion in liars compared to truth-tellers. If the lie is a polite lie that people tell often and effortlessly, there would be less emotion involved (DePaulo, 1996). Meta-analytic studies suggest that liars do appear more nervous than truth-tellers, with less facial pleasantness, higher vocal tension, higher vocal pitch, greater pupil dilation, and fidgeting (Lindsay, 2003). If the lie itself is about emotions- e.g. telling someone that one feels calm, when in fact one is nervous the research shows that signs of the truly felt emotion appear in the face and voice despite attempts to conceal, although these signs are often subtle and brief (Ekman,1988).

An important issue in measuring lie signs is to clarify the level of detail of measurement as well as to specify why that level of detail may or may not correlate with lying (Frank, 2005). Many meta-analyses of behavioural deception clues report insignificant effect sizes, but the variance among effect is not homogeneous (Zuckerman,1981). For example, some studies investigated behaviour at the most elemental physical units of measurement such as counting the movements in the hands, feet, arms, legs, torso, eye movements, eye blinks, pupil dilation, lip pressing, brow lowering or raising, lip corner puller (smiling), fundamental frequency, amplitude, pauses, filled pauses, response latency, speech rate, length of response, connector words, unique words, self-references, and so forth. Other studies investigated behaviour at the most elemental psychological meaning units of measurement. Some of these included manipulators which involve touching, rubbing, etc., various body parts which could be composed of several hands, finger, and arm movements, but which were scored for theoretical rather than merely descriptive reasons. Other psychologically meaningful units of measurement include illustrators, which accompany speech to help keep the rhythm of the speech, emphasize a word, show direction of thought, etc. or emblems, which are gestures that have a speech equivalent, such as a head nod meaning "yes", or a shrug meaning "I am not sure", or facial emblems such as winking (DePaulo, 2003).

The psychologically meaning of expression units might also include vocal tension, speech disturbances, negative statements, contextual embedding, unusual details, logical structure, unexpected complications, superfluous details, self-doubt, and so forth. Finally, other studies investigated behaviour at the most interpretative/impressionistic unit level, which is further unarticulated composites of the physical and the psychological meaning units described earlier. Some of these impressionistic variables of the behaviour include fidgeting, body animation, posture, facial pleasantness, expressiveness, vocal immediacy and involvement; and spoken uncertainty; plausibility; and cognitive complexity (DePaulo, et al., 2003). The problem, of course, is that as one moves from physical to impressionistic measures, it would seem to become harder to make those judgments reliably. Although research works suggested that people can be more accurate when they employ indirect inferences to deception (e.g. does the person have to think hard? (Vrij, 2001). This suggests that we must be cautious about clues at the impressionistic level and that it may be more productive to study them at their psychological level where they might be more meaningful to understanding deception.

Lie detection experts (Reid & Inbau, 1953) point out that a polygraph examination should not be conducted during certain transient states of an individual, such as, for example: Excessive fatigue, Prolonged interrogation, Physical abuse, extreme nervous tension, evidence of drugs, especially tranquilizers and stimulants, shock or adrenal exhaustion, fear of detection of some other offense not related to this interrogation. A similar restraint applies when long-term physical or psychological disorders are present: Excessively high or low blood pressure, Heart diseases, Respiratory disorders, Hyperthyroidism, Mental abnormalities, Psychoses, and Psychopathic personality. Any of these conditions preclude an effective examination because it introduces into the record response characteristics which are not the result of the examination itself. The professional integrity of the examiner would require him to refuse to examine Individuals in whom such conditions are known to be present because an adequate examination could not be conducted.

In the early 90s, a machine called Polysomnography (PSG) was developed to detect various sleep disorders. Polysomnography (PSG), also known as a sleep study, is a multi-parametric test used in the study of sleep and as a diagnostic tool in sleep medicine (Hjorth, 1970). The test result is called a polysomnogram, also abbreviated PSG. The name is derived from Greek and Latin roots: The Greek 'Poly' for multi-channel (many), the Latin 'somnus' (sleep) and the Greek 'graphein' (to write). Polysomnography is a comprehensive recording of the biophysiological changes that occur during sleep. It is usually performed at night, when most people sleep, though some labs can accommodate shift workers and people with circadian rhythm sleep disorders and to the test at other times of the day. The PSG monitors many body functions including brain (EEG), eye movements (ECG), muscle activity or skeletal muscle activation (EMG) and heart rhythm (ECG) during sleep. After the identification of the sleep disorder sleep apnea in the 1970s, the breathing functions respiratory airflow and respiratory effort indicators were added along with peripheral pulse oximetry.

Objectives-

The main objective of the current study was to compare the various parameters in polysomnographic recordings of individuals who had indulged in experimentally induced theft situation with subjects who had not indulged in an experimentally induced theft situation.

2 | MATERIAL AND METHODS

The present study was conducted in the department of psychiatry, Sarojini Naidu Medical College (S.N.M.C.) Agra, between the periods, March 2010 and September 2011. The sample consisted of 102 medical students who had volunteered to participate in the study. These volunteers were selected on the following criteria's.

Inclusion criteria-

Students of 2^{nd}, $3^{rd,}$ Final Professionals, Internship and Post Graduates studying in S.N. Medical College, Agra were included in the study.

Exclusion criteria

Students with a history of epilepsy, history of any psychiatric disorder, history of head injury, history of stress in past six months assessed by presumptive stressful life event scale (Singh et al., 1983).

Procedure-

The volunteers were assessed with following after taking informed consent: sociodemographic variables, general and systemic physical examination, detailed history of substance use, detailed clinical history of any medical/psychiatric illnesses, history of head injury, polysomnographic (PSG) recording after exposure to a mock theft.

Research lab settings

The volunteers fulfilling the above-mentioned criteria were chosen for recording of polysomnography. The assessment was done in the research laboratory of the department, which was situated in a separate block, away from the main building of the department, and in a kind of silent zone. This research laboratory is fully air-conditioned and well-spaced room.

After taking informed consent from all the students participating in the study, they were explained regarding the study design and purpose of the study and out of these 102 participants, 30 were assigned to act as control group **(Group-A)** and their polysomnography (PSG) recording of 30 minutes was done to obtain their baseline recordings.

Remaining 72 participants, who constituted the experimental group, were divided into 10 groups, each group containing six subjects. Each group of these 6 students was sent to the research laboratory where a closed room was prepared for artificial theft situation and a closed-circuit camera was installed and the monitor was kept out of the knowledge of interviewer as well as a sealed box was placed inside the room with paper and pen beside the box and all students were instructed that only one student will enter inside the room at a time to attempt mock crime and write down what he had done in the paper provided and put this paper in the sealed box which would be opened only after the completion of our study and at the time of assessment of results, so that the interviewer would remain blinded regarding their act. After that, each group of six students was sent for mock theft consequently inside a room where 6 piggybanks were placed on a platform and out of which 3 piggybanks had money with at least one coin inside them while remaining 3 were empty. These students were also informed that it's their choice to pick up either a piggybank having money or the piggybank having no money and then they had to break it and take money out of it or put the money inside the closed box if they had picked up piggybank having money and then to write down on a piece of paper what they actually did. Though the fact whether they had stolen or not was known to the member of the team keeping the track on video recording, the subjects were asked to write down on a piece of paper, telling them that this piece of paper would be opened only after the completion of the study. This strategy was adopted merely to make the experimental situation resemble a real theft situation, in which the subject would be always apprehensive about what he had done. These subjects were not aware that their action was being watched on closed-circuit TV.

As the study was double-blind, the faculty member of the department who was keeping the track on the CCTV, stopped the experiment when an equal number of 30 subjects could be assigned to either stealing the money or not stealing the money. Once a target of 30 subjects had been reached in one group, the extra subjects falling in the same group were not included for assessment. Thus an equal number of 30 subjects each in the group who stole the money and who did not comprise the study material. The rest 12 subjects were excluded from the study assessment. After completion of the required task, the volunteers were assessed on Polysomnograph recording for 30 minutes within 24 hours of mock theft. After first 10 minutes of baseline recording, they were asked twice for two minutes, at 10^{th} and 20^{th} minutes of recording, about whether they had stolen the money from piggybank or not and irrespective of the fact whether they had stolen the money or not, they had to deny, that is, they had to say 'NO' to the question, meaning by that they had not stolen the money.

Assessment

The sixty subjects, who underwent mock theft situation, were grouped into two groups based on their CCTV records into those who had not stolen money as the **(GROUP-B)** and those who stole money as the **(GROUP-C)**. In our study comparisons were made between the PSG recordings of the two groups i.e. stolen group **(GROUP-C)** and the control group **(GROUP-A),** as the not stolen group was taken into another study in the department which was aimed to compare the not stolen group with the control group. The data obtained were analyzed to find out if any correlation existed between the theft committed and their various changes in PSG variables viz. EEG (frequency & amplitude), EMG (frequency & amplitude), EOG, and ECG, Heart rate, SPO2, Respiratory rate.

STATISTICAL ANALYSES-

The data of all volunteers were collected. The mean and standard deviation were calculated for both groups. Further statistical tests (unpaired t-test) and chi-square (χ^2) tests were applied to compare the data in both the groups by the help of computer software graph pad instate, version 3.0 and p value<0.05 was taken to be significant.

3 | RESULT

Result of the present study was showing in the below table-

Table 1 shows the distribution of subjects according to age group. Mean age of subjects belonging to the stolen group was 22.8±2.496 years while the mean age of the not stolen group was 23.63 ±3.508 years. As evident from the above table, both groups were

TABLE 1: AGEWISE DISTRIBUTION OF SUBJECTS INCLUDED IN THE STUDY(Group ``A'' comprising of control subjects and Group ``C'' comprising of subjects who had stolen money): (CHI-SQUARE (χ^2) TEST FOR INDEPENDENCE)

AGE (years)	GROUP-A	GROUP-C	TOTAL	$\chi2$	p-value
<20	3 (10.0%)	5 (16.7%)	8 (13.3%)		
20-22	11 (36.7%)	11 (36.7%)	22 (36.7%)	2.183	0.7022
22-24	6 (20.0%)	8 (26.7%)	14 (23.3%)		
24-26	5 (16.7%)	4 (13.3%)	9 (15.0%)		
>26	5 (16.7%)	2 (6.7%)	7(11.7%)		
TOTAL	30(100%)	30(100%)	60(100%)		

analyzed on the chi-square test for independence and they came out to be insignificant (p-value 0.7022).

TABLE 2: CHANGES OBSERVED IN EEG FREQUENCY (Hz) IN C_3-A_2 LEAD

GROUP	MEAN± SD	T-VALUE	P-VALUE
Control versus stolen at baseline			
GROUP- A	9.33±1.845	1.3998	0.1669
GROUP- C	8.67±1.807		
Control versus stolen after 10th minute			
GROUP- A	9.33±1.845	0.9581	0.3420
GROUP- C	8.83±2.183		
Control versus stolen after 20th minute			
GROUP- A	9.33±1.845	0.4409	0.6609
GROUP- C	9.07±2.651		

The above table compares the mean values of changes in frequency (Hz) of EEG in the left central leads (C3-A2) at three different intervals in both groups and shows increase in mean values in the stolen group throughout three different intervals. The comparison gives P values more than 0.05, which denotes that the difference between the values is not significant at three different intervals in both groups.

The above table 3 compares the mean values of changes in frequency (Hz) of EEG in the right central

TABLE 3: CHANGES OBSERVED IN EEG FREQUENCY (Hz) IN C_4-A_1 LEAD

GROUP	MEAN± SD	T-VALUE	P-VALUE
Control versus stolen at baseline			
GROUP- A	8.93±1.680	0.5690	0.5716
GROUP- C	8.70±1.442		
Control versus stolen after 10th minute			
GROUP- A	8.93±1.680	0.0000	1.0000
GROUP- C	8.93±1.982		
Control versus stolen after 20th minute			
GROUP- A	8.93±1.680	0.0780	0.9381
GROUP- C	8.97±2.251		

leads (C4-A1) at three different intervals in both groups. As shown in the table the mean values increase with the passage of time in the stolen group while it remains the same at three different intervals. The comparison gives P values more than 0.05, which denotes that the difference between the values is not significant at three different intervals in both groups.

TABLE 4: CHANGES OBSERVED IN EEG FREQUENCY (Hz) IN O_1-A_2 LEAD

GROUP	MEAN± SD	T-VALUE	P-VALUE
Control versus stolen at baseline			
GROUP- A	9.33±2.368	0.4770	0.6351
GROUP- C	9.07±1.818		
Control versus stolen after 10th minute			
GROUP- A	9.33±2.368	0.4134	0.6808
GROUP- C	9.10±1.918		
Control versus stolen after 20th minute			
GROUP- A	9.33±2.368	0.3603	0.7199
GROUP- C	9.53±1.907		

The above table compares the mean values of changes in frequency (Hz) of EEG in the left occipital leads (O1-A2) at three different intervals in both groups and shows that the mean values increase in the stolen group while remains same in the control group. The comparison gives P values more than 0.05, which denotes that the difference between the values is not significant in three different intervals in both groups.

The above table compares the mean values of changes in frequency (Hz) of EEG in the right occip-

TABLE 5: CHANGES OBSERVED IN EEG FREQUENCY (Hz) IN O_2-A_1 LEAD

GROUP	MEAN± SD	T-VALUE	P-VALUE
Control versus stolen at baseline			
GROUP- A	9.07±2.116	0.5382	0.5925
GROUP- C	9.40±2.608		
Control versus stolen after 10th minute			
GROUP- A	9.07±2.116	1.4623	0.1490
GROUP- C	10.00±2.767		
Control versus stolen after 20th minute			
GROUP- A	9.07±2.116	1.6343	0.1076
GROUP- C	10.07±2.599		

ital leads (O2-A1) at three different intervals in both groups and there was an increase in the mean values in the stolen group at three different intervals. The comparison gives P values more than 0.05, which denotes that the difference between the values is not significant in three different intervals in both groups.

TABLE 6: CHANGES OBSERVED IN EEG AMPLITUDE (microvolts) IN C_3-A_2 LEAD

GROUP	MEAN± SD	T-VALUE	P-VALUE
Control versus stolen at baseline			
GROUP- A	18.67±4.245	4.9665	0.0001
GROUP- C	28.00±9.373		
Control versus stolen after 10th minute			
GROUP- A	18.67±4.245	3.5946	0.0007 ***
GROUP- C	25.67±9.785		
Control versus stolen after 20th minute			
GROUP- A	18.67±4.245	2.5649	0.0129**
GROUP- C	23.10±8.454		

The above table compares the mean values of changes in amplitude (microvolt) of EEG in the left central leads (C3-A2) at three different intervals in both groups and shows decrease in the mean value after 10^{th} and 15^{th}-minute intervals. The comparison gives P values less than 0.05 at baseline and after tenth minutes, which denotes that the difference between the values is highly significant whereas p-value after the fifteenth minute is not significant.

The above table compares the mean values of changes in amplitude (microvolt) of EEG in the right central leads (C4-A1) at three different intervals in both groups. There is a decrease in the mean values in the stolen group from the baseline after 10^{th} and 15^{th}-minute intervals. The comparison gives P values less than 0.05 at baseline indicating significant change while no significant change after 10^{th} and 15^{th}-minute intervals.

TABLE 7: CHANGES OBSERVED IN EEG AMPLITUDE (microvolts) IN C_4-A_1 LEAD

GROUP	MEAN± SD	T-VALUE	P-VALUE
Control versus stolen at baseline			
GROUP- A	21.47±6.611	2.3858	0.0203**
GROUP- C	26.13±8.411		
Control versus stolen after 10th minute			
GROUP- A	21.47±6.611	1.2903	0.2021
GROUP- C	24.27±11.876		
Control versus stolen after 20th minute			
GROUP- A	21.47±6.611	1.1283	0.2638
GROUP- C	24.27±11.876		

TABLE 8: CHANGES OBSERVED IN EEG AMPLITUDE (microvolts) IN O_1-A_2 LEAD

GROUP	MEAN± SD	T-VALUE	P-VALUE
Control versus stolen at baseline			
GROUP- A	20.53±7.999	3.2601	0.0019
GROUP- C	27.30±8.086		
Control versus stolen after 10th minute			
GROUP- A	20.53±7.999	1.9973	0.0505*
GROUP- C	25.20±10.001		
Control versus stolen after 20th minute			
GROUP- A	20.53±7.999	1.0956	0.2778
GROUP- C	22.63±6.800		

The above table compares the mean values of changes in amplitude (microvolt) of EEG in the left occipital leads (O1-A2) at three different intervals in both groups. The comparison gives P value less than 0.05 at the baseline record, which denotes that the difference between the values is highly significant whereas, after tenth and fifteenth minutes, p values obtained are not significant.

The above table compares the mean values of changes in amplitude (microvolt) of EEG in the right occipital leads (O2-A1) at three different intervals in both groups. The comparison gives P values less than 0.05 at three different intervals, which denotes that the difference between the values is statistically

TABLE 9: CHANGES OBSERVED IN EEG AMPLITUDE (microvolts) IN O_2-A_1 LEAD

GROUP	MEAN± SD	T-VALUE	P-VALUE
Control versus stolen at baseline			
GROUP- A	18.67±4.978	3.9211	0.0002
GROUP- C	27.77±11.696		
Control versus stolen after 10th minute			
GROUP- A	18.67±4.978	2.1631	0.0347**
GROUP- C	23.80±11.998		
Control versus stolen after 20th minute			
GROUP- A	18.67±4.978	2.2812	0.0262**
GROUP- C	24.03±11.868		

significant.

TABLE 10: SHOW THE FREQUENCY(HZ) IN LEFT SIDE OF THE BRAIN AN EMG LEADS

GROUP	MEAN± SD	T-VALUE	P-VALUE
Control versus stolen at baseline			
GROUP- A	9.13±4.066	1.3408	0.1852
GROUP- C	7.90±2.952		
Control versus stolen after 10th minute			
GROUP- A	9.13±4.066	0.3248	0.7465
GROUP- C	8.80±3.800		
Control versus stolen after 20th minute			
GROUP- A	9.13±4.066	0.6918	0.4918
GROUP- C	8.43±3.766		

The above table compares the mean values of changes in frequency (Hz) of left EMG leads at three different intervals in both groups. The comparison gives P values more than 0.05, which denotes that the difference between the values is not significant in three different intervals in both groups.

The above table compares the mean values of changes in frequency (Hz) of the right EMG leads at three different intervals in both groups. The comparison gives P values more than 0.05, which denotes that the difference between the values is not significant in three different intervals in both groups.

The above table compares the mean values of changes in amplitude (microvolts) of left EMG leads at three different intervals in both groups. The comparison gives P values more than 0.05, which denotes that the difference between the values is not significant in three different intervals in both groups.

TABLE 11: SHOW THE FREQUENCY(HZ) OF RIGHT SIDE OF BRAIN AN EMG LEADS (HZ)

GROUP	MEAN± SD	T-VALUE	P-VALUE
Control versus stolen at baseline			
GROUP- A	8.73±2.586	1.7709	0.0818
GROUP- C	7.57±2.487		
Control versus stolen after 10th minute			
GROUP- A	8.73±2.586	0.4508	0.6538
GROUP- C	8.43±2.569		
Control versus stolen after 20th minute			
GROUP- A	8.73±2.586	0.6045	0.5479
GROUP- C	8.27±3.269		

TABLE 12: CHANGES OBSERVED IN AMPLITUDE IN LEFT SIDE EMG LEADS (microvolt)

GROUP	MEAN± SD	T-VALUE	P-VALUE
Control versus stolen at baseline			
GROUP-A	190.00±208.608	0.2261	0.8219
GROUP-C	200.00±123.176		
Control versus stolen after 10th minute			
GROUP-A	190.00±208.608	0.3156	0.7534
GROUP-C	203.33±99.943		
Control versus stolen after 20th minute			
GROUP-A	190.00±208.608	0.3225	0.7483
GROUP-C	203.33±88.018		

The above table compares the mean values of changes in amplitude (microvolts) of right EMG leads at three different intervals in both groups. The comparison gives P values more than 0.05, which denotes that the difference between the values is not significant in three different intervals in both groups.

4 | DISCUSSION

The present study was done to find out the differences, if there exist any on polysomnograph machine recordings, between the subjects who had stolen the

TABLE 13: CHANGES OBSERVED IN AMPLITUDE IN RIGHT SIDE EMG LEADS (microvolt)

GROUP	MEAN± SD	T-VALUE	P-VALUE
Control versus stolen at baseline			
GROUP-A	156.67±188.338	1.0846	0.2826
GROUP-C	200.00±111.417		
Control versus stolen after 10th minute			
GROUP-A	156.67±188.338	1.1504	0.2547
GROUP-C	205.00±132.190		
Control versus stolen after 20th minute			
GROUP-A	156.67±188.338	1.6699	0.1003
GROUP-C	228.33±140.616		

money and those who did not steal money, after exposing the subjects into a mock theft situation. Since the advent of various lie detectors which had utilized multiple physiological parameters, studies have been conducted to find a validated and reliable lie detector, but none has been proven conclusive. Polysomnograph has been a well-known tool which is capable of recording various physiological parameters simultaneously and has been widely utilized in sleep studies, however, till date no studies or only a few have been done to utilize this instrument's capability as a reliable lie detector, keeping a fact in the mind that this instrument is easily available, is economical and not much manpower training is required for the interpretation of this instrument's parameters. Hence this study was conducted to find if polysomnograph could be used as a lie detector.

In our study, a total number of 102 subjects were included and out of those 102 subjects, thirty were taken as a control group and rest were exposed to a mock theft. On the basis of CCTV recordings subjects who had stolen money were grouped as stolen group while those who did not steal money were taken as not stolen group. An equal number of 30 subjects who fulfilled the criteria for any group, out of the total of 102 subjects were selected for the assessment. Then a statistical comparison of physiological parameters obtained on PSG recordings of the stolen group from those of the control group was done to find if there was any significant difference present in their respective records of PSG.

Several investigators have reported blocking or reduction in the alpha activity of the electroencephalogram (EEG) with stimulation of an emotion-producing sort (Lindsley, 1951; Thiesen, 1943; Williams, 1939). The only known study employing the EEG in the detection of deception was conducted by Obermann (1939), with two separate experiments reported, one involving neutral stimuli (numbered cards) and the other involving knowledge of the details of a fictitious crime. Monopolar recordings from a left occipital placement were obtained with the eyes closed, and judges were asked to rank the records on the basis of their likelihood of being indicative of deception, using as a criterion any disturbance in the record. Although the statistical treatment of the data makes them difficult to interpret in terms of the discrimination achieved, the detection of deception with EEG criteria seems possible. Interestingly enough, more objective measures of amplitude or percentage of alpha activity did not prove as efficient as did the subjective judgment.

Wang et al (2015), Seth, Inversen, Edelman (2006) & Kim, Jung, Lee (2012) reported the response time was found to be marginally negatively correlated with the clustering coefficient of the secondary auditory cortex (42L) in the NE-IL condition and negatively correlated with the clustering coefficient of the somatosensory association cortex (5L, R) in the NE-IT condition. Therefore, these results provide complementary and intuitive evidence for the differences between the IL and IT conditions in SDP for two types of deception tasks, thus elucidating the electrophysiological mechanisms underlying SDP of deception from regional, inter-regional, network, and inter-network scale analyses. the modulation effect of deception on the EEG power spectrum has been observed on the scalp level in previous studies, specific EEG frequency band (i.e. alpha) was associated with lying, demonstrating that risk monitoring/expectation and increased cognitive load play important roles in deception.

Another similar study Turnip et al () find that the extracted signals were classified with adaptive neuro-fuzzy inference system method. The results show that a huge spike of the EEG-P300 amplitude on a lying subject corresponds to the appeared stimuli is achieved. The findings of these experiments have been promising in testing the validity of using an EEG-P300 as a lie detector.

Recently some study was reported that the EEG studies in deception detection have primarily focused on the topography and time-domain analyses of the P300 component. However, there is still disagreement about the features that may best discriminate between deceptive and truthful responses (Wang et al,2013). Another conceptual study indicated that EEG is feasible to identify the basic lie detection. EEG signals will be used for the lie detection because this is no-invasive, cheap, and are the direct results of the electric activity inside the brain (Khandelwall et al, 2016).

These findings support the common-sense assumption that subjects should be more responsive to personally relevant stimuli reinforced by the context than to previously neutral stimuli made relevant only within the experimental context. Even before any experimental manipulation, the subject's own name or date of birth should evoke a physiological response.

In this study, it was seen that there was statistically extremely significant difference in both groups at all the three intervals in leads C3-A2 (table-6) and leads O2-A1 (table-9) whereas, significant differences were found at the baseline recordings in leads C4-A1 (table-7).

Finally, we conclude that the various physiological parameters measured on polysomnograph in a mock theft situation reveals changes among them and due to lack of previous studies on polysomnograph as a lie detector, no comparisons could be sorted out.

Strength of the present study-

Polysomnograph machines and the Sleep Laboratories are available more or less in each medical college and that too in many departments of the hospital, for example: Pulmonary Medicine, Neurology, ENT, Psychiatry, Physiology, ICU and others and that way number of trained professionals is much higher as compared to people getting training on Polygraph. If the findings of PSG in real theft situation could be ascertained, the decoding of theft files will become much easier than what is available today to the law-enforcing authorities and the department of justice. This will also help in giving justice in time which will help decrease the workload on the judiciary as well as shall also be helpful to the society in general and will improve the social standards of the society, for; justice delayed is a kind of injustice in itself.

Another positive finding of the PSG machine as compared to Polygraph is its advantage in having more number of variables, like EEG, EOG, and EMG. Thereby a subject is assessed on more variables as compared to Polygraph. This will help provide more accurate data and will save innocent people and catch hold of guilty more scientifically.

Limitations of the present study-

A certain factor may limit the credibility and generalization of the findings of the present study: The Sample size of the study is small, for the reason that this was a pioneer study and the aim was to find out if PSG could be employed as a tool for lie detection. But because theft situations form a behavioural variable which affects the society as a whole, before generalizing the findings of the present study to the real-life situation, more studies and on a more number of subjects, who represent the true sample size of the society statistically, should be contemplated.

The present study has not compared with the group who had not stolen the money. However, this fact is the part of another study being done in the department and hence the observations of that part have not been included in the present work.

5 | CONCLUSION

We concluded that the changes observed in the amplitude of C3-A2 and O2-A1 lead along with C4-A1 (mv), O1-A2 (mv) leads could better identify the subjects who had stolen money, due to higher apprehension created for being caught during their PSG recordings while other leads which did not show significant changes in the PSG recordings could be considered as being not affected during deception.

Because this study was conducted on a small number of subjects belonging to the common group i.e. medical students and of the same gender, it is recommended that further studies are required in this area so that subjects could be taken from various backgrounds to get an increased number of significant results.

Conflict of interest- Authors are declaring that no conflict interested.

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