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Review Article

Contemporary pathways in forensic psychology: A review of psychophysiological perspective of veracity versus deception detection

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Abstract

Forensic psychology, as a subfield of psychology, is relatively new and expanding its wings. It covers various spectrums of research, with one prominent one being the dynamics of lying behaviour. A uniform cognitive demand is created by people telling the truth, in contrast to liars, who might experience a high mental load during lying behaviour and post-lying as well, due to the false construction of reality. Suspects in crimes may manufacture and invent stories to find a narrow escape by diverting the investigation. The naked eye may also miss some truths. Hence, forensic psychologists use specific tools (such as eye blink count and duration) to detect deception without violating the civil rights of crime suspects. To evaluate the impact, efficacy and usefulness of these tools, measures or techniques, current research systematically reviewed the existing literature. The Google Scholar database was investigated in depth using several keywords like forensic psychology, polygraph, lie detection, eye blink count, eye blink duration, detection of deception and facial expressions to filter the entries and focus on relevant research. Temporally relevant research from the last 25 years was considered. Lie detection may not be an exact science. A significant variability in findings has been noted. Applicability may be contextualised. Some techniques involving diagnostic tools may enhance their application in modern times.

Keywords: Forensic psychology, Polygraph, Lie detection, Eye blink count and duration, Detection of deception, Facial expressions.

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1. Introduction

It is a good practice for society to be able to deal with lies, detection and crime. It has been four decades since forensic psychology was established as an applied discipline in India. One of the core areas of study under applied psychology is forensic psychology, with its primary theme being the detection of lies. During police interrogations, trials in court, and similar contexts, it can be difficult to decide whether a suspect is telling the truth or lying. In such cases, the role of a forensic psychologist becomes significant. Forensic psychologists employ various tools for lie detection such as observation, interview, verbal statements, non-verbal cues and analysing physiological responses. This field focuses on unearthing crime and then exploring intervention and rehabilitation techniques and possibilities with the victims of crime. Even the scope of application of forensic psychology has transformed over the years, from just lie detection to much more sophisticated tracking of the biopsychosocial parameters of the accused. There are several dependable and trustworthy hints to ascertain deception, especially via nonverbal aspects such as avoiding eye contact, rate and duration of eye blinks, extent of head shaking, emotional instability, mistakes in speech patterns and several verbal hints.[1] The present study focuses on the physiological parameters as indicators of deception.

Deception is a deliberate action to cultivate faith in other people that the deceiver thinks to be untrue. Deception is referred to as an intentional behaviour of making the other person believe something to be true that the deceiver knows is false.[2] In the phenomenon of lying, the deceiver usually

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keeps the deceived unaware that the truth has been hidden from them. The intention of not revealing the truth to others is there, and those others are kept uninformed that some information has not been completely shared with them. This deception may not be equated with the deceiving act of magicians, since the latter are expected to deceive in the play. Hence, lying behaviour is usually intentional and often occurs without any prior information.[3]

A forensic psychologist plays an important role in supporting the judiciary in collecting and stating facts at the crime scene. The key contributions of a forensic psychologist include undertaking detailed psychological assessments via interviews and other standardised tools and then submitting a comprehensive report about the accused in question. The court finally decides on the suspect based on this cognitive analysis and expert findings from other fields.

The experts may use polygraphs for testing. A polygraph is an instrument that taps alterations in a person's blood pressure, pulse rate, respiration rate and Galvanic skin response (GSR) simultaneously using a computer. Usually, a polygraph test is performed in two stages – pretest (to comprehend the items) and the stimulation test (actual answering of questions) phases.[3]

During lying, certain changes in emotions appear that signal deception, such as blaring speech, increased blinking and swallowing rates, dilation of pupils, mistakes and unwanted pauses in speech, and persistent swallowing.[4] This occurs because of the impact on the autonomic nervous system and disfigurement of the sympathetic and parasympathetic routes.

1.1. Cognitive demand, mental load and lie construction

Lying may be more demanding cognitively than simply telling the truth. It even increases the mental load involved for several reasons.[5]

1. Fabricating tales in such a way that they fit the plot
2. Remembering those stories and their details, if they need to be retold
3. Remembering what was told to whom
4. Try to sound genuine and honest to the lie detector
5. Monitoring the reactions of the interviewer to ensure that the interviewer is sounding convinced by the lie told
6. An extra mental load is experienced in rehearsing the lie told by the liars
7. While lying, it must be ensured that truthful statements are not touched upon
8. The lie must look natural and matter-of-fact, and not deliberate
9. An alibi may need to be created.

All these actions exert some amount of cognitive load on the liar.

1.2. Relevance and theoretical background

Researchers have highlighted the use of new methodologies and technologies that may enhance neuropsychological assessments. Applications like virtual reality may also aid in intervention for forensic populations. However, there are gaps in understanding how these technologies can be integrated and individually customised.[6] Another relevant discussion in today's field of crime and forensics is about the dynamics of neuro-rights versus neuro-prediction and the drawbacks of lie detection parameters.[7] During forensic investigations, it is crucial to protect the cognitive mind from unnecessary damage by factoring in all technical advances. Thus, within forensic psychology, aspects like accuracy, customizability and fallibility of technologies need to be assessed and reviewed.

1.3. History of forensic psychology in the Indian context

The origin of forensic psychology in India dates to 1968 with the contribution of the Central Bureau of Investigation (CBI), where the first section of lie detection was established at its Central forensic science laboratory (CFSL).[8] This was a landmark development as no formal training spaces existed for professionals to specialise in lie detection till then. Until now, the primary source of learning was books and research articles from the Western context. Analogously, the Forensic science laboratory (FSL) based in Ahmedabad, Gujarat, designated regular posts for three psychologists between 1982 to 1984 to administer polygraph tests.[9] This was the first time when psychologists were employed full-time for the job of lie detection, and this practice spread this drift to other parts of India. The objective of polygraph testing teams was guided using scientific methodology to screen many suspects, while ensuring the protection of their rights at the same time. The next phase marked two major developments in the field of forensic psychology – combining the lie detection test with the interview technique and engaging visiting clinical psychologists in central prisons.

Dr. S.L. Vaya performed the first narcotics analysis in 1989 with permission from the court. Its drawback was that it was done without the subject's consent. Consequently, the Supreme Court of India passed a ruling in 2010 in favour of the subject, stating that informed consent is required for administering tests such as the Narcotics analysis, Lie detection and Brain Electrical Oscillation Signature. The observations obtained from these tests can then be submitted as proof in the court of law.

Today, standardised procedures are being laid down for forensic measurement, and this discipline exhibits tremendous growth prospects.

1.4. Rationale – India's worthy beneficence in the field of detection of crime

Classically, the landmark work on the detection of deception among psychiatric patients based on observing their faces was carried out by Ekman P in 1969.[10]

Professor C.R. Mukundan invented Brain electrical oscillation signature (BEOS) in 2003 to facilitate the application of neuroscience in crime detection. This method primarily focuses on the experiential memory of the suspect to ascertain his/her role in committing the crime.

Despite such landmark developments in the discipline, the methods of operation of criminals are undergoing a rapid change due to the advent of new technological advancements. Hence, there is an increasing need for forensic psychologists in the detection of crimes, especially in India.

Exploring the scope of polygraph testing in India is underway.[11] Lie detection via polygraph testing deals with measuring the biological parameters of suspects under investigation while they answer questions. Their physiological rhythms, such as pulse, heart rate, perspiration, blood pressure, and sweat rate, are monitored during interrogation to check if they are falsely responding to deceive investigators about their crime. The detection method works on the principle that if a suspect is lying, then the biological rhythmic values obtained will deviate from the standard levels. To detect deception through a modern mechanism, the first such apparatus was invented by physiologist John A Larson in 1921. This apparatus concurrently measured changes in heart rate, blood pressure and perspiration rate. Since then, research has been carried out to devise reliable ways of detecting deception in criminals, such as eye scanning, brain mapping and even the use of artificial intelligence to enhance accuracy in confirming the suspect to be a criminal.

2. Materials and Methods

The existing literature was thoroughly reviewed to analyse psychophysiological perspectives in the literature on deception detection. For systematically reviewing the literature, the Google Scholar database was investigated in depth. There were several keywords used to filter the entries and focus on relevant research. Keywords included words/phrases like forensic psychology, polygraph, lie detection, eye blink count and duration, detection of deception and Facial expressions (**Figure 1**). Only articles in English were considered; other inclusion criteria included only peer-reviewed journals and published research articles. The relevance of deception detection and psychophysiology is significant and has been evolving in recent times; hence, those studies have been included that are from 2000 onwards till date (the last 25 years). The template methodology-based approach[12] has been followed. Since eye-related response detection techniques like blink count and blink rate are non-intrusive and more humane,[13] they have gathered attention and thus have been evaluated separately (**Table 2**).

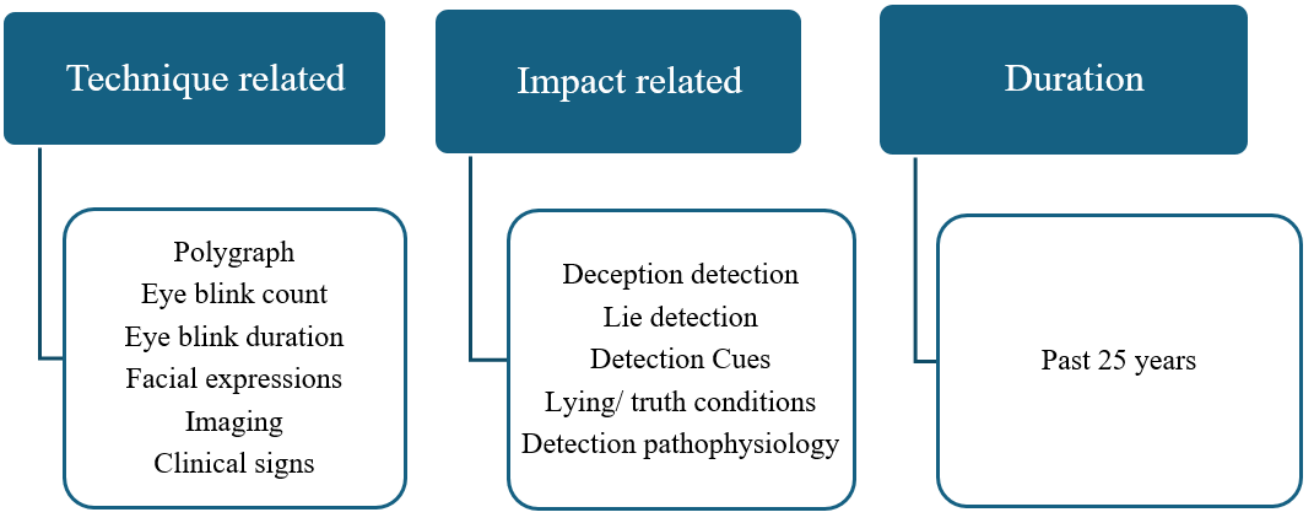

Figure 1: Search words and phrases used to capture relevant research

3. Discussion

As discussed in **Table 1**, several parameters may be assessed by forensic psychologists while undertaking polygraph testing – anxiety levels, breathing rates and facial expressions. The rate at which an individual blinks their eyes could be an indicator of lying behaviour or deception. The research on eye blink count and eye blink duration has been compiled in **Table 2**.

Table 1: Studies on keywords related to "polygraph, facial expressions, imaging, clinical signs" PLUS "deception detection, lie detection, detection cues, lying/ truth conditions, detection pathophysiology"

Study	Sample size	Observation	Remarks
The effects of first and second languages on lie detection ability[14]	135 undergraduate and 4 postgraduate students from Hong Kong.	The connection between facial expressions and language while lying was studied. A two-by-two between-subjects design was used.	Non-verbal cues are equally important in detecting deception, along with verbal information.
Cues to deception as a function of police interview styles[15]	120 undergraduate students at a British University.	Half of the participants were placed in the truth-telling condition and the other half in the lying condition.	The information-gathering style of the interview method yielded the maximum number of deception cues.
Personality and lie detection[16]	81 undergraduate American students.	Short videos were shown to the respondents to assess their personality types.	Respondents high in extraversion, intuitive thinking and perceiving were found to be better at lie detection as shown in videos.
Thermal imaging as a lie detection tool at airports[17]	51 travellers (UK, USA) at the departure terminal of an international airport.	An interview was conducted, and their body temperature was measured using thermal imaging.	The skin temperature of respondents speaking the truth remained stable, whereas that of liars increased. This implies that thermal imaging may be used for the detection of deception at airports.
Lie detection during high-stakes[18]	57 undergraduate student volunteers from America's Southeastern University.	Video recordings depicting participants telling the truth or lying were shown to them.	No significant difference was found between the two conditions.
Deception detection in age and sex[19]	84 college students and 77 elderly people from New York.	All participants were exposed to three conditions of cues for detecting deception: audio, visual, and audiovisual.	The college students could detect lies more efficiently than the elderly. Moreover, both these age group participants succeeded in lie detection with the audiovisual cues rather than just the audio or visual cues.
Single-trial lie detection using a combined fNIRS–polygraph system[20]	16 South Korean males agreed to participate in this study.	In addition to the polygraph, functional near-infrared spectroscopy (fNIRS) was used to measure neural activity and blood flow in the prefrontal cortex during deception.	A significant difference was observed between truth and lying conditions on the mentioned parameters.
Voice analysis for the detection of deception[21]	Voice recordings during questioning available at the police station of 12 Indians (10 men and 2 women) were analysed. These people had been suspected of theft, domestic violence and similar crimes.	Jitteriness in the voice while lying was being analysed.	Fewer jitters were recorded under reduced stress conditions. Phonic parameters during stress in the human voice could indicate deception.

Table 1 Continued….			
The role of age and emotions in lie detection accuracy[22]	196 Volunteers between 16 and 67 years old for the research to be carried out at a Northwest England University were selected.	In an experiment conducted online to check the accuracy of the detection of deception, there were two conditions: cues to deception and no cues to deception. The participants had to differentiate a genuine appealer from a liar.	It was found that deception was better predicted when the participants made use of emotional cues. Faked / masked emotions conveyed deception. Another interesting observation was that the accuracy of detecting deception was higher in the older age group participants.
Detection of deception using facial expressions[23]	43 respondents (20 men, 23 women) in the 18-25 age group from Iraq.	In this simulated set-up, a machine-based deception detection system (DDS) was used to analyse facial expressions while lying. This software works on the Facial Action Coding System (FACS), wherein each Action Unit (AU) corresponds to a particular facial muscle and its expression.	This technology is not only economical but also portable. Eight Action Units were found to align with facial feedback: AUs 5, 6, 7, 10, 12, 14, 23, and 28. Four types of algorithms were found to be effective in detecting facial features – MLP, SVM, VG-RAM, and KNN, with the last two being the most effective performers. This technology-packed DDS proved fruitful in giving a new perspective to lie detection.
EEG feature extraction for lie identification[24]	10 volunteers from the Goan region were taken.	A simulated crime scene was created, and 16 electrodes were placed on each participant's head to record readings.	The wavelet paradigm was found to be more effective, and 92.4% accuracy in lie detection was observed. These days, lie detection using EEG is favoured more than polygraphs since there is limited intervention at the human level in the former.
Facial psychophysiology in forensic investigation[3]	14 Indian respondents from Gujarat for polygraph testing.	The electromyography (EMG) technique was used.	EMG could detect deception using Galvanic Skin Response (GSR). Thus, EMG may be added to the tools for lie detection.
Investigating offenders' abilities in the context of deception detection[25]	76 males from Germany – 33 offenders and 43 students.	Prison inmates were examined on the Dark Triad traits of narcissism, psychopathy and Machiavellianism.	No prominent difference was noted between the two groups.
Cross-cultural verbal cues to deception in first and second language interview contexts[26]	88 South Asian bilinguals (with Hindi as their first language or English as their second language) and 48 British monolinguals well-conversant in English.	Verbal responses of the respondents were noted using the interview method.	Similarities across cultures were found in that verbal responses of liars were less convincing than those of truth-speaking respondents.
Exploring the effects of a wearable biocueing app in forensic psychiatric outpatients[27]	Of the 25 forensic outpatients in the Netherlands, 92% of the participants were predominantly male.	Quasi-experimental design with pre- and post-test measures was used.	A prominent reduction in aggression was noted.

Exploring the added value of DEEP (Diaphragmatic Exploration and Exercise Program) in forensic psychiatric inpatient care[28]	2 Dutch forensic institutes dealing with mental healthcare focused upon 13 forensic psychiatric inpatients.	Semi-structured interviews were undertaken using a qualitative research methodology. DEEP – a biofeedback game based on virtual reality that focuses on breathing based on control of the diaphragm- was exposed to all the participants.	DEEP proved useful for the participants in their anger management.
Factors influencing chatbots in juvenile offenders' risk assessment training[29]	112 undergraduate students studying criminology in Canada.	Tailor-made chatbots were made for data collection to complete questionnaires online on juvenile offenders' risk assessment.	Trust and acceptance of chatbots depend on varied factors such as the design of chatbot software and, more importantly, on user features (personality traits, anxiety levels and learning curves).

Table 2: Studies on keywords related to "eye blink count, eye blink duration, blink pattern, pupil size, shape" PLUS "deception detection, lie detection, detection cues, lying/ truth conditions, detection pathophysiology"

Study	Sample size	Observation	Remarks
Eye blinks as new indices in the detection of deception[13]	10 female volunteers in the first experiment and 11 volunteers (5 females and 6 males) in the second experiment from Japan.	The research was conducted in two phases. The first experiment involved a guilty knowledge test, and the second experiment included a dual-modality attention task. Both experiments measured the time duration of eye blinks using an automated system.	The eye blink count and duration were indicated to be related to selective attention and deception ratios.
Blinking during and after lying[30]	Thirteen liars and thirteen truth tellers were among the British sample in the 18- to 41-year-old age group.	An interview method was employed for data collection. Blink rates were recorded using software.	The eye blink pattern was found to be different for liars compared to truth tellers. Moreover, eye blinks were reduced for liars during the interrogation period, and after the interrogation was over, they increased.
Identifying concealed emotions in universal facial expressions[31]	41 respondents in Halifax.	The expression of emotions was analysed for eye blinking rate.	Liars displayed a reduced eye blink rate for neutral emotions and an enhanced blink rate for masked emotions.
Identifying the behavioural consequences of extremely high-stakes interpersonal deception[32]	78 (out of which 35 were deceptive) participants from British Columbia.	Videotaped behaviours were observed.	Emotional falsification was observed, and eye blinking was recorded more frequently among deceptive participants compared to truth-tellers.
Detecting false intent using eye blink measures[33]	54 participants from Montana State University.	The ocular data of the difference in blink count, number of blinks and duration of blink were noted.	No significant differences were observed in age or gender. However, the false intent condition participants demonstrated a lesser difference in blink count as compared to the truthful intent participants. This implies eye blinks are a good indicator for detecting deception towards past actions in individuals.

Table 2 Continued…			
Combining blink, pupil and response time measures in a concealed knowledge test[34]	University of California, Santa Cruz, 60 college undergraduate students, the majority of whom were females.	A Concealed Knowledge Test that calculates time to generate a reaction was used.	Ocular indices were reported to provide more information on deception when pupil size, slope and blink rate were computed together.
Detecting deception via eyeblink frequency modulation[35]	32 Confederates – 17 to act as liars and 15 to state the truth at Philadelphia.	Blink frequency was measured; electromyography and interview techniques were employed.	The participants telling the truth showed a heightened frequency of eye blinks, whereas an inhibited frequency of eye blinks was noted for liars. Hence, deception could be detected via the eye blink frequency method.
Eye blinking as cues to deception[36]	A total of 59 American volunteers were recruited, comprising 27 for the interview method and 32 for the computer method.	A two-by-two within-subjects design was followed. Respondents answered the same statements either truthfully or deceptively – either in an interview or on the computer.	It was noted that the eye blink rate changes in the lying situation. Moreover, the eye blink rate was reduced while lying in the computer mode condition.
Eye blink count and eye blink duration analysis for the detection of deception[37]	Responses from 50 participants (15 females and 35 males) between 18 to 35 years were analysed for truth or lie in the Manipal region in India.	A psychological experiment was conducted with 10 questions serving as a control. An interview technique was further used. A camera with high speed to capture eye blinks was employed.	Facial expressions Action Unit (AU) 45 was used to measure eye blinks. Both blink duration and blink count were reported as higher while lying as compared to when telling the truth.

4. Conclusion

As society evolved, deception became one of the fallouts of societal communications. In such a scenario, lying behaviour came under the lens of research to tackle and safeguard mankind against deceit and deception. Even though the face is the mirror of one's soul, humans have learnt to mask their expressions to conceal the truth.

Lie detection may not be an exact science. There is significant variability in findings. Applicability may be contextualised. Some techniques involving diagnostic tools may enhance their application in modern times. For a forensic psychologist, it is an evolving field. Greater measurement of psychophysiological parameters within the jurisdiction of law and without the infringement of the civil rights of crime suspects may help in further progress of this discipline. Lie detection could find its application across various spheres – criminal justice, deceptive pleas claiming innocence, and corporate recruitment to distinguish between a genuine candidate and a candidate full of pretence. The research findings in **Table 1** and **Table 2** strengthen our understanding of deception cues and indicate that eye blink rate changes while lying.

Recently, there has been a growing need to apply knowledge from forensic sciences to criminal law, forensic psychiatry, and the like. Thus, the need of the hour is to work on the neuro rights of individuals, so that there may be a seamless application of principles into practice. Moreover, the application of virtual reality in intervention programs is quite new and may be explored further, especially in enhancing motivation and reducing the stress of clients. These intervention strategies may be specifically designed to meet the individual needs of clients and patients. Neuromodulation and neurofeedback techniques also may be investigated. The futuristic perspective may be customised to incorporate more technology-based strategies to cater to forensic populations more effectively.

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6. Conflict of Interest

None.

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