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Capper No Cap: Cognitive Load Approach in the Context of Deception Stakes, Age, and Forensic Settings

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Abstract: Deception detection is a crucial yet formidable process within the criminal justice system. The cognitive load approach is a novel methodology for deception detection, which draws upon the cognitive theory emphasising that lying imposes a greater mental tax than truth-telling. This approach has garnered significant attention and is currently undergoing rigorous laboratory testing. Nevertheless, most researchers who advocate for the effectiveness of the cognitive load approach tend to overlook the potential impact of specific contexts that might undermine the accuracy of employing this approach. This review paper addresses three types of contexts that may impact the effectiveness of the cognitive load approach: a) the stakes of deceptions, b) the age of candidates, and c) the authenticity of interviews. In general, the cognitive load approach exhibits more reliability and a higher likelihood of enhancing the deception detection rate in high-stakes contexts than in low-stakes contexts. In comparison with adolescents or adults, this approach appears to be less predictable or consistent when used among young children. Moreover, the cognitive load approach in legal systems seems less viable in real-life applications than in controlled laboratory settings.

Keywords: deception detection, Cognitive load approach, deception stakes

1. Introduction

In the age before cameras, painters relied solely on brushes as their primary tool to “record” crime scenes. Perhaps, the first documented deceptive behaviours in criminal history could date back to the eighteenth century when the painter, Jacques-Louis David, deliberately removed the assassin, Charlotte Corday, from his famous painting of the crime scene, dubbed *The Death of Marat*. In contemporary society, where people produce around two lies per day on average [1, 2], deceptions continue to be difficult for trained law enforcement professionals to discern during interrogation if lacking additional technologies such as DNA testing. Until 2012, 53% of cases involving deception were only exonerated later by biometric tests [3]. Difficulties in deception detection may result in the incarceration of the innocent and even the acquittal of the perpetrator. Therefore, deception detection must be enhanced in light of these detrimental legal ramifications so that lies can be uncovered to assist investigation during the first rounds of interrogation.

In a forensic context, deception or deceptive behaviours can be defined to include at least one of the characteristics as follows: a) the objective forgery of the statement, b) the sender’s belief in forgery, and c) the sender’s deliberate intention to deceive the receiver [4]. Although deception may result in unfavourable outcomes within the criminal justice system, such as miscarriages of justice, humans' ability to detect deceptions without employing specific strategies is similar with flipping a coin, with a worrying accuracy rate of 54% [5]. This holds true even for law enforcement officers who have received professional training [5]. For example, in the study conducted by Hartwig et al. [6], 30 police officers who were not trained in deception detection failed to detect deception in more than half of the trials, irrespective of the interrogation methods employed (e.g., self-preferred interrogation methods or video examination). Additionally, regardless of their deception detection expertise, law enforcement workers and university students encounter formidable obstacles when attempting to distinguish between truth and deception. Without a specific strategy, customs officers were no more accurate than college students in spotting lying children [7].

Numerous approaches have been devised to identify cues of deception to enhance the chance of successful deception detection. A recent cognitive load approach, for example, has emerged and derived deception detection methods such as the Time-Restricted Integrity Confirmation (Tri-Con) [8] and Cognitive Interview for Suspects (CIS) [9]. Researchers have extensively discussed this approach in terms of its applicability in countering deceptions within the law enforcement process. In essence, the cognitive load approach to deception detection is an umbrella term that encompasses a collective of techniques and strategies [10], which are designed to increase interviewee's cognitive load (i.e., the amount of workload required to perform a specific task) [11]. In contrast to conventional deception detection frameworks, the cognitive load approach is grounded in the cognitive load theory, which posits that lying is more mentally taxing and cognitively demanding than truth-telling (e.g., liars need to suppress truth and exhibit while remembering fabricated facts) [12]. The cognitive load approach has been devised to amplify such differences to facilitate assertions' verification. Under the guidance of this approach, Vrij et al. [11, 13] proposed a taxonomy of finer-gained techniques in three categories: a) imposing cognitive load approach, b) eliciting more information, and c) utilizing unexpected questioning. The imposing cognitive load approach seeks to amplify the observable behavioural difference between liars and truth-tellers by increasing the cognitive burden of lying. An example of this technique could be presenting statements in reverse chronical order [14]. The eliciting more information technique is designed to elicit additional information to obtain inconsistent information from deceptive individuals. An experiment in which a provision of interviewee's hand-drawing followed by their verbal accounts allowed interviewers to achieve an accuracy of 70% for truth and deception detection, considerably higher than what would be expected by chance [15]. In addition, the strategic questioning technique, also known as the unexpected questioning, encompasses the use of unanticipated evidence or inquiries that require interviewees to shift their temporal or spatial perspective [16-19].

Researchers have provided mixed empirical evidence regarding the implementation of deception detection techniques under the cognitive load framework over the past decades. Most research indicates that individuals who tell lies would indeed experience more mental straggling than those who "tell it like it happens". Matching with its theoretical prediction, the cognitive load approach accentuates the distinction between truthful and deceptive statements [11, 20]. An illustration of this can be seen in the findings of Vrij et al. [11], who conducted a meta-analysis of 26 empirical studies that utilized at least one type of techniques under the cognitive load approach. They concluded that the cognitive load approach could increase the detection rate of both deception and truth (71%) compared to traditional approaches (56%). Nonetheless, some studies contend that the cognitive load approach does not guarantee the growth of the deception detection rate. For instance, the cognitive load approach might not effectively enhance the likelihood of detecting low-stakes lies, in which the deceivers face a less severe consequence for their actions [21]. Furthermore, researchers argue that age also influences the effectiveness of the cognitive load approach. In particular, the cognitive load approach appears incapable of explaining children's deceptive behaviours and encounters challenges

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in detecting them [22]. Although the cognitive load approach may seem effective in general, it becomes compromised when examined in the context of specific factors such as the stakes of lying and age.

Nevertheless, some argue that the accuracy and effectiveness of the cognitive load approach could be further deducted when applied to real-life deception detection [23]. More specifically, deception seems less detectable with the cognitive load approach in real-life forensic settings [24]. This, certainly, has raised apprehensions regarding the practicality of the cognitive load approach [25, 26]. As an example, in contrast to techniques such as unexpected questioning and eliciting more information, which is well-substantiated by both empirical and practical evidence, the imposing cognitive load approach has garnered significant support in the field of deception detection research but has exhibited suboptimal performance when applied to real-life contexts [27].

Despite being aware that the cognitive load approach to deception detection is susceptible to contextual variables, many of the researchers choose not to investigate the issue further [23, 28]. According to Vrij [29], investigators often conclude a deception detection approach is effective too soon without taking situational or contextual aspects into account. However, disregarding the influence of situational factors may result in fundamental attribution errors, given that the same person's behaviours vary in different contexts [29, 30]. In the realm of deception detection, an investigator who did not take context into account may mistakenly attribute the success of deception detection to the effect of the cognitive load approach and not the effect of the scenarios. Therefore, there is a need for research to compile disparate findings on the effectiveness of the cognitive load approach in varied contexts and to provide guidance for its applicability. By conducting a comparative analysis of the cognitive load approach to deception detection across various scenarios, this review can contribute a more comprehensive understanding on its ecological validity and applicability in real forensic cases involving suspects at varying ages, telling lies with severe consequences, and questioned by interrogators who may have either experience or lack thereof.

2. Current study

This review paper will discuss the importance of three types of contexts regarding the accuracy of the cognitive load approach to deception detection in forensic settings: a) deceptions in high-stakes vs. low-stakes (stakes of deception); b) deceptions in young vs. older child interviewees (age of interviewees); c) deceptions in laboratories vs. real-life cases (authenticity of interview). In a nutshell, the accuracy of deception detection using the cognitive load approach is significantly influenced by the stakes of the deception, of which high-stakes deceptions are more prone to exposure than low-stakes deceptions. The effectiveness of the cognitive load approach is contingent upon the candidate's age, to the extent that children frequently contest this approach's validity. When implemented in real-life legal systems, the cognitive load approach can barely preserve the accuracy of deception detection under simulated laboratory conditions.

3. Effects of stakes of deception

According to DePaulo et al. [1], deception can be characterized as high-stakes and low-stakes regarding the associated consequences. Low-stakes deception, which is prevalent in everyday life, often leads to less adverse consequences for the deceiver (e.g., criticism and impaired reputation) [31]. In contrast, high-stakes deception, which is prevalent within the legal system, often results in substantial and adverse consequences for the deceiver upon apprehension (e.g., longer sentencing and incarceration). In the present paper, high-stakes deceptions are defined as lying behaviours intended to conceal a criminal act, while low-stakes deceptions are defined as lying behaviours that do not pertain to criminal acts or have legal consequences.

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It has been argued that the stakes of deception impact the effectiveness of deception detection. As an illustration, O'Sullivan et al. [32] found that police officers detected high-stakes deceptions more accurately than low-stakes ones. In contrast, a confession from high-stakes deceivers requires more time and effort to be obtained than the confession from low-stakes deceivers [33]. As suggested by the cognitive load theory, people aware of high-stakes scenarios are hypothesized to encounter greater cognitive load and frequently display disrupted verbal expressions or excessive nonverbal behaviours that signify deception [34, 35]. Contrary to initial expectations, this trend only finds empirical support in high-stakes scenarios where predictions remain consistent, but is less well-supported by evidence in low-stakes scenarios where predictions lose validity.

3.1. High-stakes scenarios

The effectiveness of the cognitive load approach in enhancing the precision of high-stakes deception detection has been consistently demonstrated in the literature [36]. To construct a high-stakes scenario, Walczyk et al. [37] presented participants with two videos depicting actual theft crimes in which participants were then required to act one of two roles: a) witness (truth-teller) who wants the perpetrator incarcerated, or b) perpetrator familiars (liars) who want to cover the crime for the perpetrator. Later, interviewers utilized the imposing cognitive load approach, specifically the Tri-Con technique, to judge whether the participants were lying. It was found that the Tri-Con technique yielded an accuracy of 67% and 69% in distinguishing high-stakes liars from truth-tellers who testified to two crimes of their intimates, respectively. Furthermore, when considering the target of receiving consequences, a more thoughtful study could establish a more life-like high-stakes condition where deceivers tell lies to cover a crime and evade legal consequences for themselves rather than for their familiars. When mock suspects lied about committing a thieving offence, the reverse chronical order technique, another type of the imposing cognitive load approach, may still classify guilty suspects from innocent suspects with a 60% accuracy rate [38]. Similarly, Leins et al. [15] imposed cognitive load by employing a sketch drawing technique and achieved a minimum classification accuracy of 70% among mock suspects accused of stealing £5. Moreover, the cognitive load approach has demonstrated an exceptional accuracy rate of up to 80% regarding high-stakes deception detection [36]. Despite a wide span of accuracy achieved, the cognitive load approach outperforms random chance by a substantial margin when distinguishing high-stakes deceivers from truth-tellers.

3.2. Low-stakes scenarios

Contrary to the consistent findings observed in low-stakes scenarios, the research that employs the cognitive load approach to detect low-stakes deception yielded rather inconsistent results. When a non-legal consequence is associated with deception behaviour in scenarios with moderately low stakes, specific cognitive load techniques remain effective. An example of this can be seen in the effective implementation of the strategic questioning technique, which increases the deception detection rate of participants from 44.1% to 68% when tasked with distinguishing low-stakes liars from truth-tellers in terms of their cheating behaviour in a trivia game experience [19]. Similarly, implementing the recurrent questioning strategy yields a higher degree of accuracy in detecting deceptions in low-stakes autobiographical events compared to control groups that were only questioned once [39].

However, in extremely low-stakes scenarios where deception behaviour is not readily associated with any consequence, cognitive load techniques that appear to be effective in high-stakes scenarios may be rendered ineffective. While the reverse order technique has been shown to improve the detection rate of high-stakes deceptions (e.g., [38]), Fenn et al. [21] found the same technique fails to

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amply the behavioural differences between truth-tellers and liars when the latter lie about future attempts with little or no immediate consequences. Similarly, neither the unexpected inquiry nor the reverse order technique achieved the chance level of deception detection among children recounting a game experience with no specified consequence [40]. In conclusion, the cognitive load approach to low-stakes deceptions may be effective under conditions of moderately low-stakes condition, but it may fail under conditions of extremely low-stakes in which the lying consequence is not foreseen.

3.3. Issues in high-stakes and low-stakes deception detection

However, before discussing the effectiveness of the cognitive load approach, it is imperative to address several issues regarding the study of high-stakes and low-stakes deceptions in the existing literature. To begin with, the researchers' constructed condition of high-stakes deception may still not represent real-life high-stakes situations. In practice, it is challenging to manipulate cognitive load with actual suspects who are telling high-stakes lies; therefore, research on the cognitive load approach concerning high-stakes deception detection often employs mock interrogations to evaluate their effectiveness. However, while suspects may copy the process of committing a crime, the cognitive load imposed on them is not equivalent to that of an actual perpetrator due to real-life legal implications [41]. Thus, laboratory-built high-stakes deceptions may not be representative of those occurring in the real world, which may contribute to the paucity of research on high-stakes.

Second, there is a lack of consistent operational definitions of "high-stakes" and "low-stakes" deception. While the present study establishes the distinction between high- and low-stakes deceptions according to the presence of legal repercussions, additional criteria may be employed by other researchers, including personal relevance or substantial reward for successful lying [32]. For instance, the current paper defines lying in mock crime interrogations as high-stakes deceptive behaviours, whereas Camara et al. [42] who regard role-playing to be an exclusion criterion for high-stakes might consider lying behaviours in mock interrogation as low-stakes deceptions. That is, the dearth of research on the cognitive load approach regarding the context of deception stakes may be attributed to the inability to construct deception with real-world consequences and the divergent definitions of high-stakes and low-stakes deception.

4. Age influence in the cognitive load approach

There is a consensus among the majority of studies that interviewers' demographic backgrounds, such as age and gender, have little effect on deception detection rate [43-45]. The age of the interviewee, on the other hand, does influence on deception detection. For example, older adults' lying behaviours were shown to be more difficult to detect than younger adults' [46]. However, the reversed detection pattern was demonstrated among adolescents and younger as interview candidates. For instance, deception detection among 14- or 15-year-olds is simpler than that among adults but more challenging than among children between five to six [47]. Given that children's cognitive capacity and deceitful ability both develop with age [48], it is plausible that the cognitive load approach developed with adults may be challenged by this demographic with restricted cognitive abilities.

4.1. Cognitive load approach with children

Although children have a higher propensity to divulge incriminating details, the accuracy of deception detection has yet been reported to improve with assistance of the cognitive load approach. For example, research with children aged 10 to 11 revealed that interviewers did not demonstrate any difference in performance when detecting deceptive children, despite the fact that they tended to answer more unexpected questions than truth-tellers [22]. This suggests that the unexpected questioning technique may not enhance deception detection accuracy in children. On the other hand,

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Saykaly et al. [40] found that the reverse order technique affects school-aged children's ability to maintain their genuine or deceptive statements relevant to the testification they provided a week before. Specifically, 97.8% of children were able to preserve their true reports, whereas only 79.6% of children were able to maintain their false reports in reverse temporal order. However, in terms of deception detection rate, subsequent research revealed neither the reverse order technique nor the asking unexpected question technique was able to improve the deception detection accuracy when interviewees were preschoolers aged nine to twelve [49]. Therefore, the cognitive load approach has encountered practical difficulties when applied to children, notwithstanding the consistency between the deceitful behavioural patterns observed in children and the predictions put forth by the cognitive load theory. The prospective causes for this inconsistency will be examined in the subsequent section.

4.2. Potential explanations of children's deceptive behaviour

From children's perspective, their limited cognitive ability and executive functions, including the working memory system affect them in producing lies or speaking the truth [50]. A systematic review conducted by Jones and Pipe [51] pointed out that children who were asked open-ended questions exhibited experienced short-term amnesia or rapid forgetting shortly after the event. For genuine children (truth-tellers), rapid forgetting is a disadvantage as it might lead to inconsistencies within claims. Particularly, children who have provided claims on two separate occasions may yield inconsistent claims on account of their rapid forgetting. Since inconsistency is frequently interpreted as an indication of deception (e.g., [15, 52, 53]), it would diminish the credibility and trustworthiness of truth-tellers by rendering them more sceptical; and this is detrimental to veracity judgement. Moreover, child deceivers may benefit from the durability of false reports, as research indicates that children's false reports are more durable than true reports [54]. Arguably, the durability of deceptive statements contributes to greater consistency across repeated interviews, which is advantageous for children to play the role of deceivers. For these reasons, the cognitive load approach can hardly help adopters identify deceptions for young children with limited cognitive abilities. Taking the study by Saykaly et al. [49] as an example, their study failed to improve deception detection among children using the reverse order technique most likely because: a) children in the truth-telling condition may have provided less consistent claims due to rapid forgetting and were therefore perceived as more sceptical, and b) children in the deception condition may have provided more consistent claims due to the greater sustainability of deceptive reports and were perceived as more honest. The limited cognitive capacity, particularly of the memory capability, renders truth-tellers more deceptive and liars more genuine, thereby impeding the potential effectiveness of the cognitive load approach to detect deceit among young-aged deceivers.

From an interviewer's perspective, interviewers may not capitalise on the behavioural cues elicited by the cognitive load approach to deception detection in children due to the truth-bias towards children. Past research has established a tendency that interviewers are more prone to believe children as truthtellers than liars [55, 56]. To clarify, the reason why children are perceived as less likely to lie is not because they possess advanced cognitive abilities to fabricate elaborate deceptions [57]. Instead, they benefit from an adult-biased perception that they are more naïve, credible, and incapable of lying because of their limited cognitive capabilities [58]. Hence, interviewers' potential oversight of the distinction between truth-tellers and liars may have resulted from the implicit bias towards children when employing the cognitive load approach.

In conclusion, age affects both interviewees' lying behaviours and how interviewers evaluate them with bias. While the cognitive load theory can reliably forecast deceitful behaviours, interviewers' implicit truth bias towards very young children may cause them to be overlooked. In theory, the cognitive load approach effectively distinguishes between truthful individuals and those who are dishonest. Nonetheless, additional factors that impede the approach's ability to exhibit effects may

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influence its effectiveness. As previously stated, these variables may encompass the propensity for children to forget rapidly and retain deceitful memories for an extended period, both of which moderate the disparity in consistency between those who tell the truth and those who deceive. Another potential factor is the interviewer's subjective truth bias towards younger children, which may cause them to disregard additional cues emphasised more significantly by the cognitive load approach. Because children often serve as crucial witnesses in legal proceedings [59], understanding how deception detection functions with children is essential. Therefore, more research should be conducted to examine whether the cognitive load approach can productively help identify child liars in order to combat miscarriages of justice in legal systems most effectively.

5. The practicality of the cognitive load approach in real-life forensic interviews

Many scholars have addressed the concerns regarding the practical applicability of deception detection methods [25, 26]. For practical reasons, most empirical studies on the cognitive load approach are conducted with role-plays in mock interrogations (e.g., [15, 37, 38]). However, mock interrogations differ significantly from interrogations in the forensic context [60]. For example, the majority of interviewees in research settings are college students or members of the general public who tell low-stakes lies (e.g., [21, 32 39, 41]). Conversely, the interviewees in forensic settings consist primarily of suspects who tell high-stakes lies. Given that the stakes of deception have been discussed to influence the cognitive load approach, it is reasonable to expect that the approach would exhibit distinct performance when evaluating felony offenders compared to the general public. Moreover, interviewers' identities also change from researchers working in laboratories or non-professional law enforcement personnel to federal personnel involved in the forensic interrogation process. As the identities of interrogators and interrogatees involved in the cognitive load approach evolve, it is worthwhile to debate whether this method continues to be viable in a forensic interrogation process.

5.1. Cognitive load approach in a real-life forensic context

The cognitive interview for suspects (CIS), a cognitive load approach to deception detection, demonstrated inconsistent accuracy of veracity judgements when implemented by law enforcement officers and college students. The CIS, developed by Geiselman [9], is an improved version of the eliciting more information technique that incorporates the imposing cognitive load (e.g., reverse order) technique. This technique aims to increase the cognitive load of suspects by acquiring more information from suspects through eight steps. In Geiselman’s [9] study, the CIS was first tested by college students who had been trained in CIS and then conducted an interview with truth-tellers or liars concerning a recent or fabricated event. CIS-trained students demonstrated the ability to distinguish truths from deceptions, with their proficiency advancing in tier-based formats throughout the eight stages as the CIS progresses. In other words, trained interviewers exhibited chance-level accuracy in detecting deception in suspects' narratives when relying on intuition alone, yet they were able to generate higher accuracy with the engagement of the CIS. Likewise, additional studies have found that the CIS can a) amplify the disparity in nonverbal cues between truth-tellers and liars, b) enhance the accuracy of veracity judgements among CIS-trained college students beyond what would be expected by chance [61], and c) even facilitate the precision of other cognitive load approach methods (e.g., reality monitoring) [62]. Nevertheless, the precision of CIS diminished when evaluated in a forensic context. In a recent study, Noc et al. [63] examined the effectiveness of a CIS training program for law enforcement agents and college students, respectively. While the programme utilized by customs officers collected substantially more information than the control group and college students, CIS-trained custom agents did not outperform those who did not receive CIS-training

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courses in terms of accuracy in veracity judgements. The application of CIS increases the deception detection rate in a laboratory setting when the interviewers are college students, but this result cannot be extrapolated to forensic settings when the interviewers become law enforcement officers.

Other cognitive load approach such as the strategic interview is consistently effective in laboratory environments but encounters obstacles in real-life implementation. Similar to the CIS, the strategic interview is a recently developed cognitive load approach designed by Masip et al. [53] that integrates the unexpected questioning technique with the imposing cognitive load technique. Strategic interview has been found to be considerably more accurate when implanted into computers than when conducted by human [53]. In particular, computer programs can distinguish deceptions from truths with an accuracy ranging from 60% to over 90% based on two types of deceptive clues (i.e., inconsistency and aversive answers). In contrast, human performance with the same deceptive clues only yielded an accuracy of 54%, which is, again, statistically equivalent to chance. However, it would be premature to conclude that the cognitive load approach is ineffective for deception detection in real-life interrogation conducted by humans, mostly police officers. Instead, this can be elucidated in several ways. First, human deception detection is likely less accurate than that of AI owing to a lack of automated statistical abilities, which restricts the impact of human-operated strategic interviews. Additionally, humans may not be as cognisant of all captured clues as computers, making the deception judgements more complex and less accurate. Indeed, follow-up studies demonstrated that when humans were trained to code the deceptive cues using computers' coding system and when they were informed of every cue as computers used to be coded (i.e., hold awareness of all possible deceptive cues), police officers and lay respondents achieved a 90% accuracy rate in detecting deception, comparable to what computers could achieve using the cognitive load approach [64]. Arguably, the cognitive load approach to detecting deception is practically viable; but only when implemented directly on computers or by humans with technical assistance, rather than when administered only by human interviewers.

In summary, techniques tested in laboratories under the framework of the cognitive load approach (e.g., strategic interview and cognitive interview techniques) both succeeded in amplifying the differences between truth-tellers and liars, as evidenced by a higher proportion of correct information in the CIS and more aversive responses accompanied by inconsistency in the strategic interview. In real-life contexts, however, the cognitive load approach loses its advantages in enhancing deception detection. Such an approach may be hampered by some constraints, such that humans working in legal systems who do not have access to computers would fail to duplicate the deception detection accuracy when computers are available. Overall, when applied to real-life forensic scenarios, the cognitive load approach, applied by police officers in real-life forensic scenarios struggles to maintain its deception detection accuracy obtained from lab interviews conducted by non-professionals or machine-learning technologies.

6. Conclusion

Past literature on deception detection emphasized the effectiveness of the cognitive load approach in laboratory settings. However, the cognitive load approach to deception detection is susceptible to contextual or situational variation. This article shed light on three contexts that may influence the effectiveness of this approach through a review of recent research on the cognitive load approach: a) the stakes of deception, b) the age of the interviewee, and c) the authenticity of the interview. Specifically, the cognitive load approach is found to be more reliable in high-stakes scenarios and less stable in low-stakes scenarios, as it fails to detect a greater number of instances of low-stakes deceptions. In addition, the cognitive load approach appears to be challenged by a specific age group of children, most likely owing to the effect of external factors such as different lying behaviours due to limitations on children's cognitive ability and the interviewer’s truth bias. Moreover, the cognitive load approach delivers lower deception detection accuracy in real-life forensic contexts than in controlled laboratory environments. This discrepancy may be rectifiable with additional technical support when employed by humans. Still, systematic reviews on the contexts examined in this paper are still scarce. Therefore, more research is needed to print a fuller picture of how the cognitive load approach performs in deception detection in varied situations. Only with an understanding of the impacts of contexts, the cognitive load approach will become more generalizable and applicable to assist the deception detection process in a variety of scenarios, thereby facilitating the most effective defence against detrimental consequences in the legal system.

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