A Cognitive Approach to Lie Detection: A Meta-Analysis

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Abstract

Introduction. This article provides a meta-analysis of a new, cognitive, approach to (non)verbal lie detection. This cognitive lie detection approach consists of three techniques, (i) imposing cognitive load, (ii) encouraging interviewees to say more and (iii) asking unexpected questions.

Method. A meta-analysis was carried out on studies using the cognitive approach, 14 of which directly compared the cognitive approach to a standard approach.

Results. The cognitive lie detection approach produced superior accuracy results in truth detection (67%), lie detection (67%) and total detection (truth and lie detection combined, 71%) compared to a traditional standard approach (truth detection: 57%; lie detection: 47%; total detection: 56%).

Conclusions. Practitioners may find it useful to use a cognitive lie detection approach in their daily practice.

A Cognitive Approach to Lie Detection: A Meta Analysis

This article provides a meta-analysis of a new, cognitive, approach to (non)verbal lie detection. The starting point of this approach is Zuckerman, DePaulo and Rosenthal's (1981) early observation that lying can be more mentally taxing than telling the truth. The new aspect is that investigators can *magnify* the difference in cognitive load that liars and truth tellers experience through specific interventions. The interviewing techniques discussed in this article focus on lie detection through observing someone's behaviour or listening to someone's speech when no other relevant background information is available. Such veracity judgements are frequently made and result in low accuracy rates (54% on average according to Bond and DePaulo's, 2006, meta-analysis). For verbal lie detection when background information is available, see the Strategic Use of Evidence technique (Granhag & Hartwig, 2008, 2015; Hartwig, Granhag, & Luke, 2014).

Reviews of the cognitive lie detection approach have been published before (Vrij, 2014, 2015; Vrij & Granhag, 2012; Vrij, Granhag, Mann, & Leal, 2011; Vrij, Granhag, & Porter, 2010; Vrij, Leal, Mann, Vernham, & Brankaert, 2015). The main difference between this article and the previous articles is that this article expands the literature by reporting a meta-analysis examining whether the cognitive lie detection approach facilitates lie detection. The focus of this article is entirely on the meta-analysis. Elsewhere we describe in detail 'theories about lying and cognition' (Vrij, 2014), why and when liars experience more cognitive load than truth tellers in interview settings (Vrij, 2015), and the empirical evidence that liars do often experience more cognitive loads than truth tellers in interview settings (Vrij, 2015).

Cognitive Lie Detection:

Enhancing the Differences in Cognitive Cues between Truth Tellers and Liars

The core of the cognitive lie detection approach is that investigators can *magnify* the differences in (non)verbal cues indicative of cognitive load displayed by truth tellers and liars through interventions based on cognitive principles that makes the liars' task even more cognitively demanding. If successful, those interventions should result in liars displaying more diagnostic cognitive cues to deception and thereby facilitating lie detection. The cognitive lie detection approach consists of three techniques that can differentiate truth tellers from liars: (i) Imposing cognitive load, (ii) encouraging interviewees to provide more information, and (iii) asking unexpected questions.

Imposing Cognitive Load

Imposing cognitive load is based on the well established empirical finding that in *interview settings* lying is typically more mentally taxing than truth telling (see for example fMRI research, Christ et al. 2009; Vrij & Ganis, 2014). Imposing cognitive load refers to investigators' interventions aimed at making the interview setting mentally more difficult. Liars, who often require more cognitive resources than truth tellers in interviews settings, will have fewer cognitive resources left over. If cognitive demand is further raised, which could be achieved by making additional requests, liars may be less able than truth tellers to cope with these additional requests.

Ways to impose cognitive load is by asking interviewees to tell their stories in reverse order (e.g., Evans, Meissner, Michael, & Brandon, 2013; Vrij, Leal, Mann, & Fisher, 2012; Vrij et al., 2008; Zimmerman et al., 2010); by instructing interviewees to maintain eye contact with the interviewer (Vrij, Mann, Leal, & Fisher, 2010); by asking interviewees to carry out two tasks simultaneously (e.g., story telling while gripping an

object, Debey, Verschuere, & Crombez, 2012; Visu-Petra, Varga, Miclea, & Visu-Petra, 2013); or through forced turn-taking which can be employed when two or more interviewees are interviewed together at the same time (Vernham, Vrij, Mann, Leal, & Hillman, 2014). In forced turn-taking, after asking the question, the investigator determines who starts answering a question. The investigator then interrupts that person after a short period of time and asks a second interviewee to continue with the story. After a short period of time, that person is interrupted and the third person (or the first person again in case of interviewing a pair) is asked to continue, etc.

Encouraging Interviewees to Provide More Information

The second technique that may differentiate truth tellers from liars is encouraging interviewees to provide more information. If truth tellers provide more information they are more likely to be believed, because the richer an account is perceived to be in detail, the more likely it is to be believed (Bell & Loftus, 1989; Johnson, 2006; Johnson, Foley, Suengas, & Raye, 1988). Moreover, the additional information truth tellers provide could provide leads to investigators to check. Liars may find it cognitively too difficult to add as many details as truth tellers do, or, if liars do add a sufficient amount of detail, the additional information may be of lesser quality or may sound less plausible. Also, liars may be reluctant to add more information out of fear that it will provide leads to investigators and, consequently, give their lies away. In other words, techniques that facilitate interviewees to say more may result in truth tellers in particular saying more. Research has supported this premise. Experimental research to date has revealed four ways to facilitate truth tellers to say more: by using a supportive interviewer (nodding head and smiling during an interview, Mann et al., 2013; Shaw, Vrij, Mann, Leal, &

Hillman, 2013), by giving an example of a model answer (a very detailed answer, Bogaard, Meijer, & Vrij, 2014; Leal, Vrij, Warmelink, & Fisher, 2015), by using drawings (e.g., Vrij, Leal, et al., 2010; Vrij, Mann, Leal, & Fisher, 2012), and by using the Cognitive Interview technique (Ansarra et al., 2011; Bembibre & Higueras, 2011, 2012; Colwell, Hiscock, & Memon, 2002; Colwell, Hiscock-Anisman, Memon, Rachel, & Colwell, 2007; Colwell, Hiscock-Anisman, Memon, Taylor, & Prewett, 2007; Colwell, Hiscock-Anisman, Memon, Colwell, Taylor, & Woods, 2009; Geiselman, 2012; Hernandez-Fernaud & Alonso-Quecuty, 1997; Köhnken, Schimossek, Aschermann, & Höfer, 1995; Memon, Fraser, Colwell, Odinot, & Mastroberardino, 2010; Morgan, Colwell, Hazlett, 2011; Parker & Brown, 2000; Suckle-Nelson et al., 2010).

Asking Unexpected Questions

A consistent finding in the deception literature is that liars prepare themselves for anticipated interviews. They do so by preparing possible answers to questions they expect to be asked (Granhag, Andersson, Strömwall, & Hartwig, 2004; Granhag, Strömwall, & Jonsson, 2003; Hartwig, Granhag, & Strömwall, 2007; Vrij et al., 2009).

This strategy of preparing answers for possible questions makes sense. Planning makes lying easier -thereby combating, to some degree, the additional cognitive demand of lying- and planned lies typically contain fewer cues to deceit than spontaneous lies (DePaulo et al., 2003). However, preparing for answers has a limitation. It will be fruitful only if liars correctly anticipate which questions will be asked. Investigators can exploit this limitation by asking questions that liars do not anticipate. Though liars can refuse to answer unexpected questions by saying "I don't know" or "I can't remember", such responses will create suspicion if these questions are about central aspects of the target

event. A liar, therefore, has little option other than to fabricate a plausible answer on the spot, which is cognitively demanding. For liars, expected questions should be easier to answer than unexpected questions, because liars can give their planned and rehearsed answers to the expected questions but they need to fabricate answers to the unexpected questions. The difference liars experience in cognitive load while answering these two sets of questions should become evident in their verbal responses. In contrast, truth tellers experience similar levels of cognitive load while answering expected and unexpected questions, and they should produce more comparable answers to the expected and unexpected questions than liars.

To date, in the unexpected-questions technique, comparisons between truth tellers and liars have been made in three different manners, each of which examines a different outcome measure (e.g., dependent variable). In a first set of studies, small groups of truth tellers who went on a mission together and small groups of liars who had fabricated a story about going on a mission together were interviewed separately. In the interview they were asked a mixture of expected and unexpected questions (for example general opening questions versus spatial questions, Vrij et al., 2009), and the answers given by the different individuals belonging to a group were compared to one another (Roos af Hjelmsäter, Ohman, Granhag, & Vrij, 2014; Sooniste, Granhag, Strömwall, & Vrij, in press; Vrij et al., 2009).

In a second set of studies individual truth tellers and liars took part and were asked a mixture of expected and unexpected questions, for example about the execution (expected) or planning (unexpected) of intentions (Granhag & Knieps, 2011). Differences between truth tellers and liars in answering the two types of question were examined (Granhag &

Knieps, 2011; Knieps, Granhag, & Vrij, 2013a, b; Lancaster, Vrij, Hope, & Waller, 2012; Liu et al., 2010; Mac Giolla & Granhag, 2014; Shaw, Vrij, Mann, Leal, & Hillman, 2013; Sooniste, Granhag, Knieps, & Vrij, 2013; Vrij, Leal, Mann, & Granhag, 2011; Warmelink, Vrij, Mann, Jundi, & Granhag, 2012).

In a third set of studies individual truth tellers and liars were interviewed and were asked the same unexpected question twice, albeit in a different format (verbal recall vs sketching). The overlap in the two answers was examined (Leins, Fisher, Vrij, 2012; Leins, Fisher, Vrij, & Mann, 2011).

A Quantitative Review of the Cognitive Lie Detection Approach

Having introduced the cognitive lie detection approach above, the natural question to ask is: How effective is this approach compared to a standard lie detection approach? In this section, we present a meta-analysis of studies that compared the two approaches. We meta-analytically integrate accuracy rates and effect sizes and test the hypothesis that the cognitive load lie detection approach facilitates truth and lie detection. Moreover, data from additional studies that did not directly compare a standard with a cognitive lie detection approach but used the cognitive lie detection approach only will be used to precise the accuracy estimates from the direct comparison studies.

Method

Overview. We calculated effect sizes reflecting the difference in accuracy rates obtained with the standard and cognitive lie detection approaches and then integrated these effect sizes following standard meta-analytic methodology (Cooper & Hedges, 1994; Hedges & Olkin, 1985). We did this separately for truth detection accuracy, lie

detection accuracy and total accuracy (i.e., truth and lie detection combined), and using two different measures of effect size, odds ratios and Cohen's ds.[1] Initial analyses covered estimates and statistical significance of the population effect sizes, assessments of effect size heterogeneity and fail-safe N analyses (as a rough indicator of potential publication bias). For both the odds ratio-based and the d-based meta-analyses, we used a random effects approach as recommended in the meta-analytic literature (e.g. Borenstein, Hedges & Rothstein, 2007). This approach assumes that there is not necessarily one fixed, 'true' effect size in the population but that the population effect size may vary as a function of differences in study design, participants, materials or procedures (which are treated as random variations). Subsequent moderator analyses explored if the effectiveness of the cognitive lie detection approach depends (1) on whether veracity classifications are based on participants' judgments or on objective criteria and (2) on the type of cognitive lie detection manipulation (imposing load, encouraging interviewees to say more, asking unexpected questions). Participants' judgements may give us an idea how accurate observers are in truth – lie classifications when being exposed to interviews where the cognitive approach was implemented but such judgements create noise, for example when observers focus on non-diagnostic cues or interpret the diagnostic cues incorrectly. Objective criteria classifications give us a better idea of the potential of the cognitive lie detection approach.

Included studies. We searched for relevant studies in Psyclit, Psycinfo, Google Scholar and Web of Knowledge by using combinations of key words such as 'deception', 'lie', 'lying', 'detection', 'cognitive load', and 'interviewing'. We also contacted the leading scholars (Colwell, Granhag, and Meissner) who are heads of their research

groups and active in this research area, and checked the websites of journals that have published work in this area (Applied Cognitive Psychology, Journal of Applied Research in Memory and Cognition, Law and Human Behavior, Legal and Criminological Psychology, Psychology, Crime, & Law). Inclusion criteria were (1) that a study had to employ some form of cognitive lie detection manipulation (imposing cognitive load, encouraging interviewees to report more, or asking unexpected questions) and (2) that it reported some measure(s) of accuracy of lie detection (accuracy percentages for truth detection, lie detection, or combined truth/lie detection accuracy). This resulted in 26 experimental studies (reported in 24 papers, marked with asterisks in the reference list; two papers contained two experiments each), the details of which are summarized in Appendix 1. Fourteen of these studies explicitly contrasted lie detection in a cognitive lie detection approach condition with a standard approach condition (e.g., a condition that involved no cognitive lie detection manipulation as defined above), and were therefore included in our meta-analysis.

Effect sizes and study weights. Each of the 14 direct comparison studies contributed one or three effect sizes (depending on whether they reported truth, lie and total detection accuracy or only the latter) to both the odds ratio-based and the *d*-based meta-analysis. In the odds ratio-based meta-analysis (see Haddock et al., 1998, for an introduction), the odds ratios were derived directly from the accuracy rates in two conditions. To illustrate, Colwell et al. (2002) report 62% and 76% total accuracy in the standard and cognitive lie detection approach conditions, respectively, which translates into an odds ratio of 1.94 [76%/(100%-76%) divided by 62%/(100%-62%)] in favour of the cognitive approach – in other words, the odds of accurate detection were almost twice

as high with the cognitive approach. An odds ratio of 1.0 indicates no difference between conditions, and odds ratios of 3.0 or larger signals a strong effect. For the *d*-based meta-analysis, Cohen's *d* reflected the mean difference between the accuracy rates obtained with the cognitive vs. the standard approach, divided by the common standard deviation of these rates (a statistical compromise between the standard deviations within each approach). Although some studies used a within-participants manipulation of lie detection approach, we always computed Cohen's *d* as if it had been found in a between-participants design, following the generally accepted recommendation of Dunlap, Cortina, Vaslow, and Burke (1996).

In both the odds ratio-based and the *d*-based meta-analyses, the effect sizes were obtained for each study and then meta-analytically integrated by weighting them according to sample size, whereby effect sizes from larger studies receive larger weights, as they are more reliable (being based on more observations). This is standard practice, but in the particular context of lie detection studies the issue of what should be regarded as the sample size is more complex than usual and therefore requires comment. Specifically, in some studies participant-observers watch or listen to statements by liars and/or truth tellers and then make decisions about the veracity of these statements. In other studies, veracity classifications are not made by observers but are based on objective criteria (e.g., the amount of detail in a statement) and a cut-off criterion or decision rule. Hence, the relevant sample sizes are the numbers of participant-observers (in different conditions) in the former studies and the numbers of categorized statements in the latter studies.

Results

Lie detection accuracy. Table 1 summarizes the meta-analytic integration of the accuracy rates in the studies that directly compared the standard and cognitive approach, separately for total accuracy (14 studies) and for truth and lie detection accuracy (11 out of these 14 studies). The sample sizes and accuracy rates of the individual studies are documented in the Appendix (with one single exception for truth detection [Zimmerman et al., 2010], accuracy was always higher for the cognitive approach). Table 1 shows that the cognitive lie detection approach is superior to the standard approach for all three measures of detection accuracy (truth: 67% versus 57%, lie: 67% versus 47%, or combined: 71% versus 56% - note that the total accuracy rate differs from the average of the truth and lie accuracy rates because it is based on all 14 studies). It is noteworthy that the 56% (total) accuracy rate obtained with a standard approach very closely approximates the typical 54% accuracy rate typically found in deception research (Bond & DePaulo, 2006), $z = 1.08$, $p = .28$. By contrast, the 71% total accuracy rate obtained using the cognitive lie detection approach significantly exceeds this 54% accuracy benchmark, $z = 9.37$, $p < .001$.

These differences in accuracy rates translate into small (truth accuracy) to moderate (lie and total accuracy) effect sizes in both the odds ratio-based and the d-based meta-analysis. Generally the findings obtained with the two meta-analytic approaches mostly coincide: The rank order of the effect sizes is the same (lie detection accuracy largest, truth smallest, total in between), and also all effect sizes differ significantly from zero (see Table 1 for the full pattern of results). The fail-safe Ns – the numbers of file-drawer studies with zero effects sizes needed to render the effects non-significant (Rosenthal, 1979; Rosenberg, 2005) – were comparable as well, and they indicate that

publication bias is unlikely to be an issue here (certainly at the level of total accuracy).

The most important difference between the two approaches is that the d-based meta-analysis indicates more heterogeneity of effect sizes (particularly for total accuracy).

Moderator analyses. Despite some non-significant heterogeneity of some of the effect sizes (see Table 1), we decided to proceed with our planned moderator analyses, as they are theoretically interesting and also sometimes moderator effects emerge in spite of statistical homogeneity of effect sizes. Our two moderator analyses checked whether the accuracy results reported in Table 1 (i) depended on how the accuracy judgements were made (by human judges or based on objective criteria, using e.g. a discriminant analysis algorithm) and (ii) if any of the cognitive lie detection techniques introduced earlier (imposing load, encouraging interviewees to say more, or asking unexpected questions) were more effective than others in terms of detection accuracy. The outcome of these moderator analyses (conducted on the basis of both odds ratios and Cohen's ds) are summarised in Tables 2 and 3.

How the veracity decisions were made (by humans or based on objective criteria) did not matter very much for *total* accuracy, $Q_B(1) = 0.85$, $p = .36$. This picture changed at the level of truth and lie accuracy (see Table 2). The weighted accuracy rates and the moderator effects (based on both odds ratios and Cohen's ds[2]) show the same basic picture. For truth detection, the cognitive lie detection approach works best when veracity decisions are based on objective criteria, but there is little advantage over the standard approach for human observers. The opposite pattern emerged for lie detection, where the human observers profited more from the cognitive lie detection approach than criteria-based lie detection. A possible explanation for these findings is that humans typically

obtain poor lie accuracy, due to having a truth bias (the inclination to think that a target

person is telling the truth, Vrij, 2008). In that respect, there is for humans more room for

improvement in increasing their lie accuracy than their truth accuracy.

Our second moderator analysis explored if the effectiveness of the cognitive

approach depended on the particular technique employed (imposing load, encouraging

interviewees to say more, asking unexpected questions). As before, there was no

significant moderator effect for total accuracy, $Q_B(2) = 1.48$, $p = .48$, but this was again

owed to opposite moderator effects for truth and lie detection (see Table 3).[3] For truth

detection, the most effective technique was *encouraging interviewees to say more*,

followed by *asking unexpected questions* and *imposing load*. An opposite pattern

emerged for lie accuracy. The most effective lie detection technique was *imposing load*,

followed by *asking unexpected questions* and *encouraging interviewees to say more*. This

pattern nicely reflects the theoretical rationale given for the techniques. We argued that

encouraging interviewees to say more would particularly encourage truth tellers to say

more. Therefore, following this reasoning, truth tellers would differ most between

standard and cognitive lie detection technique, which facilitates truth detection in

particular. We also argued that liars in particular would face difficulties with coping with

imposing cognitive load. Therefore, following this reasoning, liars would differ most

between standard and cognitive lie detection conditions in this technique, which

facilitates lie detection.

A potential concern with these two moderator analyses is that there was

considerable overlap between the moderators – all studies that imposed load involved

human observers making the veracity decisions, and all studies that encouraged

interviewees to say more used criteria-based decisions (studies using unexpected questions were one each); this is why the patterns of effects are so similar. As a consequence, it is difficult to say which moderator is the substantial one that drives the differences in detection accuracy rates. Future meta-analyses, including more studies, may provide the answer.

   Cognitive lie detection approach findings based on all 26 studies. In addition to the studies reviewed above, which directly compared the cognitive lie detection approach to a standard approach, twelve further studies (see Appendix) had been conducted using the cognitive lie detection approach but without a standard approach comparison condition. These additional studies do not provide information about the effect of the cognitive approach (the topic of investigation in this article) but still gives some indication about the detection rates that can be expected from the cognitive lie detection approach. Combining these 12 additional studies with the 14 direct comparison studies discussed above amounted to 26 cognitive lie detection approach studies reporting total accuracy rates, 20 of which further reported truth and lie detection accuracy rates. The total accuracy weighted average based on 26 studies was 74% (95% CI = 71%, 76%); the truth detection accuracy, based on 20 studies, was 69% (66%, 73%) and the lie detection accuracy, also based on 20 studies, was 70% (66%, 73%).

   Finally, we were interested in correlations between truth and lie accuracy as a function of the lie detection approach. Interestingly, the correlation between the truth and lie accuracy rates across the 11 standard approach studies was negative, $r = -.29$, but strongly *positive* across the 20 cognitive approach studies, $r = .52$. The difference between these two correlations was significant, $z = 2.04$, $p = .04$. The lack of a truth bias

and the correlational findings, taken together, suggest that the cognitive lie detection approach not only boosts detection rates overall but boosts truth and lie detection in such a way that the typical truth bias is eliminated.

Summary of the meta-analytic findings on truth and lie detection accuracy. In sum, the meta-analytic findings confirmed the superiority of the cognitive lie detection approach. Specifically, the cognitive lie detection approach led to better total detection accuracy (71% versus 56%) and also into more accurate classifications of truth tellers (67% versus 57%) and liars (67% versus 47%), when compared directly to a standard approach. Additional studies using the cognitive lie detection approach only led to somewhat higher detection rates (74% overall, and 69% and 70% for truth and lie detection, respectively).

Two moderator analyses indicated that (1) human observers mostly profited from the cognitive lie detection approach in terms of lie detection, whereas criterion-based detection benefited mostly in terms of truth detection, and (2) that different cognitive techniques had different strengths in terms of truth and lie detection. Encouraging interviewees to say more facilitates truth detection in particular and imposing cognitive load facilitates lie detection in particular. Finally, descriptive and correlational findings suggested that the cognitive approach may effectively overcome the typical truth bias in veracity judgements.

Discussion

We finish this article with some concluding thoughts about the cognitive lie detection approach. We will briefly discuss the applicability of the approach by discussing interviewees' willingness to answer questions (a requirement in each lie

detection tool that is based on the analyses of speech) and the settings in which the various techniques can be employed. We will also discuss the practical utility of the findings presented in this meta-analysis, provide an explanation as to why the increased accuracy rates occurred, and define unexpected questions.

The Applicability of the Cognitive Lie Detection Approach

The cognitive lie detection approach is predominantly based on the analyses of verbal responses. Of course, verbal analyses can take place only if interviewees talk. To encourage interviewees to talk the cognitive lie detection approach utilises an information-gathering interview style which is, amongst other aspects, characterised by providing opportunities for uninterrupted recall (Meissner, 2011; Meissner et al., 2014). The stereotypical view, often addressed in police manuals (e.g., Inbau et al., 2013), is that suspects are reluctant to talk and that investigators need to use an accusatory approach to get them to talk, characterised by confrontation, and the use of minimisation and maximisation techniques (Kelly, Miller, Redlich, & Kleinman, 2013; Meissner, 2011; Meissner et al., 2014). The view that an accusatory approach is required is by no means shared by all practitioners. For example, Soufan (2011), an experienced and successful American FBI interrogator who gathered valuable information from al-Qaeda suspects, did not use an accusatory approach when interviewing them. Instead he used an information-gathering approach characterised by rapport building, truth seeking and listening. He also reported in his book the benefit of asking spatial questions for lie detection purposes. In addition, Tedeschini (2012), a Canadian police trainer, also advocates the information-gathering approach.

Research has shown that the idea that suspects in police interviews are unwilling to talk in information-gathering interviews is a myth rather than fact. A systematic analysis of more than 1,067 such police interviews in the UK has shown that only 5% of the suspects remained silent (Moston, Stephenson, & Williamson, 1993). In addition, in his analysis of 600 information-gathering police interviews, Baldwin (1993) found that 80% of the suspects were thoroughly cooperative and answered police questions of significance. Furthermore, a recent meta-analysis of field and laboratory studies about the influence of the interview/interrogation method on confession outcomes revealed that information-gathering approaches significantly increased the likelihood of true confessions and significantly decreased the likelihood of false confessions compared to accusatory approaches (Meissner, 2011; Meissner et al., 2014). In addition, accusatory approaches significantly increased both true and false confessions compared to control conditions. Moreover, information-gathering approaches elicited significantly more relevant information and significantly more diagnostic cues to deceit than accusatorial methods. In summary, research findings do not back up the idea that suspects are reluctant to talk and that accusatory techniques are needed to yield success in interviews. On the contrary, an information-gathering approach yields better results in obtaining relevant information, obtaining confessions and eliciting cues to deceit.

The lie detection techniques that we have discussed can be employed in various settings. The techniques can be employed to determine the veracity of statements about past activities and future activities (intentions). It has been shown that the unexpected-questions technique can be employed to identify deceit in both individuals and groups of liars. Future research should examine whether the techniques are sensitive to

countermeasures, that is, liars' attempts to fool investigators. The unexpected-questions technique should be immune to this, as its method is to ask questions that a liar has not anticipated and therefore not prepared answers for. The number of unexpected questions that can be asked about core elements of the event is vast, which reduces the risk that the unexpected questions become anticipated after some time. However, investigators should be aware that after some time suspects will know which questions are asked, and should change the questions regularly to keep them unexpected. Due to individual differences in people's responses, within-subjects lie detection techniques are preferable because they control for such individual differences. Some of the unexpected-questions techniques are within-subjects techniques.

It is important to note that in the cognitive lie detection studies in which observers made veracity judgements, the observers were never coached about which cues to pay attention to. In other words, it appears that observers pick up these cues naturally and a training program about such cues does not seem to be necessary. Of course, this does not rule out that observers will perform even better if they receive guidance about what to look for. Indeed, Colwell et al. (2009) found that trained observers obtained a significantly higher total accuracy (77%) than untrained observers (57%).

Practical Utility of the Findings

The findings showed that the cognitive lie detection approach produced superior total accuracy rates both with human observers and through an analysis of objective criteria. The finding that human observers also improved their ability to discriminate between truth tellers and liars is important as it demonstrates the potential applicability of the cognitive lie detection approach in real life as practitioners in the field will make

human-based rather than criteria-based decisions. However, in the lie detection studies included in this meta-analysis -as well as in lie detection studies in general- relative judgements rather than absolute judgements were made. In other words, the results of the meta-analysis indicate that by using the cognitive lie detection technique, 71% of truth tellers and liars were classified correctly but the findings do not tell us about the accuracy of these techniques in classifying correctly each given individual. However, we can conclude that using the cognitive lie detection approach increases the chance of classifying an individual correctly as being a truth teller or liar. The results also tell us that if practitioners use a cognitive lie detection technique, they will correctly classify more individuals than when they use a standard technique. Or to give an example in a different context, for a professional gambler it would certainly pay off if s/he knew the chances of winning a hand in the long run, despite not being able to be certain about the outcome in any individual game.

Of course, accuracy rates around the 70% are still quite modest which has implications for real life, for example for clinical use or for mass screening at border controls, where the error rate should be much lower for a lie detection technique to be useful. This point of criticism does not just apply to the cognitive lie detection technique, every veracity assessment tool developed to date encounters this problem (Vrij, 2008).

An Explanation of the Increased Accuracy Rates

A plausible explanation as to why the cognitive lie detection approach resulted in superior accuracy rates than a standard approach is that the cognitive lie detection approach elicits more and/or stronger (non)verbal cues to deceit. An analysis of the number of cues elicited by a cognitive lie detection or standard technique was not the

topic of investigation in this meta-analysis. In fact, these 'cues data' are not entirely suitable for a meta-analytic approach. The problem is that different researchers examine different cues, and that, if they use the same cues, they operationalise them sometimes somewhat differently. This makes it difficult to compare the studies with each other. For this reason Vrij, Fisher, Blank, Leal, & Mann (in press), who reviewed the cues data, presented only a basic documentation and descriptive analyses on the elicited cues to deception. The results showed that cues to deceit were twice as likely to occur when a cognitive lie detection technique was employed compared to a standard technique.

Characteristics of an Unexpected Question

An important question is how to define an 'unexpected question'. The experiments to date have shown that spatial questions are unexpected, and so are temporal questions and questions about planning. No doubt, many more types of unexpected questions will emerge in future research. Truth tellers and liars will find unexpected questions equally unexpected. The difference between truth tellers and liars emerges in how difficult such questions are for them to answer. Truth tellers should be able to rely on their memory of the event when answering these questions and, if their memory is clear and vivid, will not find the questions too difficult to answer. Liars, however, will not have ready-made answers prepared for these unexpected questions and will find them much more difficult to answer. Furthermore, if liars must create an ad-hoc answer to an unexpected question, they may also have difficulty remembering the answer for the purpose of providing the same answer (consistency) on a later interview.

The key for the unexpected questions technique to work is that truth tellers will know the answer to both expected and unexpected questions. For that to happen, all

questions should be about central rather than peripheral parts of the event. In that respect,

the unexpected-questions technique differs from Levine et al.'s 'strategic questioning'

technique (Levine, Shaw, & Shulman, 2010). In their experiment, some participants

cheated on a test and had to deny this in a subsequent interview (liars), whereas other

participants did not cheat (truth tellers). 'Strategic' questions about the cheating ('Did

any cheating occur?') were compared with 'non-strategic' questions that were unrelated

to cheating ('How much experience have you had with doing teamwork activities?').

Observers were better able to detect deceit in the strategic questioning condition. This is

probably unsurprising as the non-strategic questions had nothing to do with cheating, and

were therefore not about the central part of the event. The question asked in the strategic

questioning condition 'Did cheating occur?' was most likely expected by the

interviewees, and therefore perhaps not the best question to ask to distinguish between

truth tellers and liars.

Conclusion

All available theories and models about deception acknowledge that lying could

be mentally more taxing than truth telling. The new aspect of the cognitive lie detection

approach that we propose here is that investigators can magnify the differences in

cognitive load experienced between liars and truth tellers, and thereby enhance their

ability to detect deception. We hope that this article will stimulate research in this area

and will motivate practitioners to employ a cognitive lie detection approach.

References

References marked with an asterisk refer to studies included in the meta-analysis.

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Footnotes

[1] We opted for using two different effect sizes because one of the reviewers and the third author of this paper could not agree on their relative merits in the context of this meta-analysis. Odds ratios are the recommended type of effect size for categorical data (Fleiss, 1994; Haddock Rindskopf, & Shadish, et al., 1998), with which we are dealing here (i.e. statements being judged as true or false). Meta-analyses based on odds ratios are very common in the medical sciences, for instance (see Egger, Smith, & Phillips, 1997; or the *Cochrane Handbook*, Higgins & Green, 2011). A weakness of odds ratios is that they do not take dependencies between judgements into account (if the same person makes multiple judgements, for example).

Cohen's *d* is a more popular and well-known effect size in psychology, but has its weaknesses as well. Specifically, measures of effect size for continuous data (such as Cohen's *d*) are suboptimal for the analysis of accuracy data that are based on categorical veracity judgments (true vs. false; Dixon, 2008). Moreover, Cohen's *d* is inflated if averages are computed across repeated trials within conditions (Brand, Bradley, Best & Stoica, 2011; Wiedermann, Gula, Czech & Muschik, 2011), as is the case in some lie detection studies where participants make multiple veracity judgments.

Readers will have their own opinions regarding which approach they find more convincing. To pragmatically resolve the issue here, we use both approaches (as other authors have done, e.g. Bond & DePaulo, 2006, in their meta-analysis of lie detection accuracy) and present both sets of results. A positive potential effect of this dual approach is that we may have more confidence in the results if the findings obtained with both approaches agree.

[2] The two approaches differ in one respect: The odds ratio-based analysis shows only a marginal moderator effect for lie detection, whereas this effect is highly significant in the d-based analysis. This difference is a consequence of the larger indicated heterogeneity of the lie detection effect sizes in the d-based analysis, which is turn a consequence of the fact that one study (Evans et al., 2013) is an extreme outlier in the d-based analysis but only a mild outlier in the odds ratio-based approach (which is why we decided to retain it).

[3] Again, the weighted accuracy rates and the moderator analyses showed the same general pattern of results, except for the statistical significance of the moderator effect for lie detection accuracy (see Footnote 2 for an explanation).

Table 1

Meta-Analytic Results for Total, Truth and Lie Detection Accuracy Using the Standard

(Sta) vs. Cognitive (Cog) Approach

	Type of Detection (Number of Included Studies)		
	Total (14)	Truth (11)	Lie (11)
Detection Accuracy (% correct, [95% CI])[1]	Sta: 56 [52, 60] Cog: 71 [68, 75]	Sta: 57 [52, 63] Cog: 67 [62, 73]	Sta: 47 [41, 53] Cog: 67 [62, 72]
Odds ratio-based approach			
Effect size [95% CI]	1.97 [1.53, 2.52]	1.53 [1.09, 2.15]	2.38 [1.38, 4.11]
Heterogeneity	$Q(13) = 9.56$ (ns)	$Q(10) = 9.23$ (ns)	$Q(10) = 23.15$ *
z (Cog > Sta)	5.33 ***	2.47 **	3.11 ***
Fail-safe N^2	134	14	29
Cohen's d-based approach			
Effect size [95% CI]	0.42 [0.26, 0.58]	0.24 [0.08, 0.40]	0.53 [0.17, 0.88]
Heterogeneity	$Q(13) = 25.33$ *	$Q(10) = 8.37$ (ns)	$Q(10) = 44.76$ ***
z (Cog > Sta)	5.04 ***	2.93 **	2.92*
Fail-safe N^2	118	24	24

[1] Sample size-weighted averages. [2] The number of studies with zero effect sizes needed to

render the meta-analytic effect non-significant; calculated after Rosenberg (2005) on the

basis of the weighted effect sizes, assuming heterogeneity of effect sizes.

* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 2

Moderator Analyses of the Impact of Type of Decision-Making (by Human Observers or based on Objective Criteria) on the Effectiveness of Lie Detection Using the Standard (Sta) vs. Cognitive (Cog) Approach

	Truth Detection	Lie Detection
Detection accuracy (% correct, [95% CI])[1]		
Human Observers (N = 6)	Sta: 57 [50, 63] Cog: 60 [53, 67]	Sta: 37 [30, 44] Cog: 64 [57, 71]
Objective Criteria (N = 5)	Sta: 58 [49, 68] Cog: 80 [73, 88]	Sta: 66 [57, 75] Cog: 73 [65, 81]
Odds ratio-based approach		
Moderator effect	$Q_B(1) = 5.35$ *	$Q_B(1) = 3.25$ [(*)]
Human Observers (N = 6)	1.18 [0.79, 1.77] [2]	3.49 [1.45, 8.37]
Objective Criteria (N = 5)	2.82 [1.52, 5.23]	1.46 [0.81, 2.64]
Cohen's d-based approach		
Moderator effect	$Q_B(1) = 4.13$ *	$Q_B(1) = 11.02$ ***
Human Observers (N = 6)	0.12 [-0.08, 0.32]	0.83 [0.28, 1.38]
Objective Criteria (N = 5)	0.47 [0.20, 0.74]	0.16 [-0.11, 0.43]

[(*)] $p < .10$, * $p < .05$, *** $p < .001$. Q_B = heterogeneity between factor levels. [1] Sample size-weighted averages. [2] Effect size [95% confidence interval].

Table 3

Moderator Analyses of the Impact of Detection Technique (Imposing Load, Encouraging
Interviewees to Say More, Asking Unexpected Questions) on the Effectiveness of Lie
Detection Using the Standard (Sta) vs. Cognitive (Cog) Approach

	Truth Detection	Lie Detection
Detection accuracy (% correct, [95% CI])[1]		
Imposing Load (N = 5)	Sta: 56 [48, 64] Cog: 58 [51, 66]	Sta: 34 [26, 41] Cog: 63 [56, 71]
Encouraging Interviewees (N = 4)	Sta: 57 [46, 68] Cog: 81 [72, 89]	Sta: 69 [59, 79] Cog: 74 [66, 83]
Unexpected Questions (N = 2)	Sta: 61 [48, 74] Cog: 74 [62, 86]	Sta: 53 [39, 66] Cog: 67 [54, 80]
Odds ratio-based approach		
Moderator effect	$Q_B(2) = 6.05$ *	$Q_B(2) = 4.15$ (ns)
Imposing Load (N = 5)	1.10 [0.71, 1.71] [2]	4.04 [1.38, 11.81]
Encouraging Interviewees (N = 4)	3.00 [1.51, 5.95]	1.40 [0.72, 2.74]
Unexpected questions (N = 2)	1.85 [0.81, 4.24]	1.79 [0.82, 3.93]
Cohen's d-based approach		
Moderator effect	$Q_B(2) = 4.65$ (ns)	$Q_B(2) = 14.79$ ***
Imposing Load (N = 5)	0.09 [-0.13, 0.31]	0.94 [0.29, 1.59]
Encouraging Interviewees (N = 4)	0.50 [0.19, 0.80]	0.14 [-0.16, 0.43]
Unexpected questions (N = 2)	0.29 [-0.09, 0.67]	0.29 [-0.09, 0.67]

* $p < .05$, *** $p < .001$. Q_B = heterogeneity between factor levels. [1] Sample size-weighted
averages. [2] Effect size [95% confidence interval].

Appendix 1. *Cognitive Lie Detection Studies: Accuracy Rates*

		Sample size		Accuracy based on	Lie Detection Approach					
					Standard			Imposing Cognitive Load		
	Studies	Standard	Cognitive		Truth	Lie	Total	Truth	Lie	Total
(1)	Evans et al. (2013), Study 1	46	46	Obs	55	18	37	59	75	67
(2)	Vrij et al. (2008)	24	31	Obs	50	42	46	56	60	58
(3)	Vrij, Mann et al. (2010)	52	54	Obs	55	49	52	56	51	54
(4)	Vrij et al. (2012)	62	62	Cri	--	--	71	--	--	87
(5)	Vernham et al. (2014)	30	30	Obs	53	40	47	73	80	77
(6)	Zimmerman et al. (2010)	47	47	Obs	67	18	43	54	63	59
					Standard			Encouraging Interviewees to Say More		
(7)	Ansarra et al. (2011)			Cri				67	63	65
(8)	Colwell et al. (2002)	50	75	Cri	67	58	62	84	68	76
(9)	Colwell et al. (2007a), Exp. 1		58	Cri						69
(10)	Colwell et al. (2007a), Exp. 2		131	Cri						75
(11)	Colwell et al. (2009)		30	Obs						67
(12)	Colwell et al. (2007b)		38	Cri				68	89	79
(13)	Köhnken et al. (1995)	30	29	Cri			60			86
(14)	Leal et al. (2015), Exp 2	43	40	Cri	52	73	63	85	75	80
(15)	Mann et al. (2013)	42	42	Cri	53	65	59	71	75	73
(16)	Morgan et al. (2011)		34	Cri				81	85	83
(17)	Parker & Brown (2000)		28	Cri				88	92	89
(18)	Suckle-Nelson et al. (2010)		83	Cri				75	86	80
(19)	Vrij, Leal et al. (2010)	31	31	Cri	53	88	71	80	88	84
					Standard			Asking		

								Unexpected Questions		
(20)	Lancaster et al. (2013)		80	Cri				78	83	80
(21)	Leins et al. (2011), Exp. 1		80	Cri				80	70	75
(22)	Leins et al. (2011), Exp. 2		34	Cri				100	77	89
(23)	Liu et al. (2010)	46	46	Obs			57			59
(24)	Vrij et al. (2009)	40	40	Cri	64	53	58	79	65	72
(25)	Vrij et al. (2011)	35	32	Obs	59	53	56	71	68	69
(26)	Warmelink et al. (2012)		86	Cri				69	75	72

Note. This appendix includes studies comparing the standard and cognitive lie detection approaches as well as studies that use the cognitive lie detection approach only (these studies do not have entries in the 'Standard' columns). Also, where particular experimental conditions within studies have been combined (see notes to individual studies below), the means and effects sizes have been re-calculated, using the raw data where possible. The sample sizes are total sample sizes (i.e. aggregated across truth and lie detection conditions; further breakdowns are available from the authors upon request). Obs = Human observers, Cri = Criteria-based veracity classification.

Individual studies: (1) Evans, Michael, Meissner, & Brandon (2013). In Study 1, students watched four video clips (of 2 liars and 2 truth tellers). Study 2 was not included because cognitive load was not manipulated but inferred from language proficiency. (2) Vrij, Mann, Fisher, Leal, Milne, & Bull (2008). Observers (in Exp. 2; British police officers) watched 12 video clips (6 liars and 6 truth tellers from Exp. 1). (3) Vrij, Mann, Leal, & Fisher (2010). Observers (in Exp. 2) watched/listened to video/audiotapes (showing 8 liars and 8 truth tellers each from Exp. 1). The 'video and audio' and 'audio' conditions are combined. (4) Vrij, Leal, Mann, & Fisher (2012). Pairwise veracity

classifications based on the amount of detail elicited for 2 statements (1 true, 1 false) by the same interviewee, using either chronological order (= standard) or reverse order (= cognitive) questions. (5) Vernham, Vrij, Mann, Leal, & Hillman (2014). Observers in Exp. 2 read one transcript each (from 1 liar or 1 truth teller in Exp. 1); comparison between non-turn taking condition (condition 1) and turn-taking condition examining the turn-taking cues (condition 3). (6) Zimmerman, Veinott, Meissner, Fallon, & Mueller (2010). Interviewers made veracity judgements based on standard approach and cognitive approach interviews. (7) Ansarra, Colwell, Hiscock-Anisman, Hines, Fleck, Cole, & Belarde (2011). Reality Interview. (8) Colwell, Hiscock, & Memon (2002). Criteria-based veracity classification, cognitive and inferential interviews combined (using the results reported in their Table 4; classified cases only). (9) Colwell, Hiscock-Anisman, Memon, Rachel, & Colwell (2007) Experiment 1. Cognitive Interview. (10) Colwell, Hiscock-Anisman, Memon, Rachel, & Colwell (2007), Experiment 2. Cognitive Interview. (11) Colwell, Hiscock-Anisman, Memon, Colwell, Taylor, & Woods (2009). Cognitive interview, observers read transcripts, untrained and trained judges combined. (12) Colwell, Hiscock-Anisman, Memon, Taylor, & Prewett (2007). Reality Interview, initial recall and follow up questions combined. (13) Köhnken, Schimossek, Aschermann, & Höfer, (1995). Standard interview versus cognitive interview, CBCA-based classification results only (see Table 5 in Köhnken et al., 1995). (14) Leal, Vrij, Warmelink, Vernham & Fisher (2015). Standard interview versus model response interview (Exp. 2). (15) Mann, Vrij, Shaw, Leal, Ewens, Hillman, Granhag, & Fisher (2013). Neutral interviewer (= standard approach) vs. supportive interviewer (= cognitive lie detection approach) conditions; suspicious interviewer condition excluded. Objective and subjective detail scores combined for veracity classification. (16) Morgan, Colwell, & Hazlett (2011). First and second account combined. (17) Parker & Brown (2000). CBCA results only, unsubstantiated cases (i.e. neither clearly true nor false) excluded. (18) Suckle- Nelson, Colwell, Hiscock-Anisman,

Florence, Youschak, & Duarte (2010). Initial recall and follow up questions combined. (19) Vrij,

Leal, Mann, Warmelink, Granhag, & Fisher (2010). Veracity classification based on whether agent

was included in text (= standard approach) or drawing (= cognitive lie detection approach). (20)

Lancaster, Vrij, Hope, & Waller (2013). (21) Leins, Fisher, Vrij, Leal, & Mann (2011), Experiment

1. (22) Leins, Fisher, Vrij, Leal, & Mann (2011), Experiment 2. (23) Liu, Granhag, Landström, Roos

af Hjelmsäter, Strömwall, & Vrij (2010). Students in Exp. 2 watched video clips of children's (true or

false) statement from Exp. 1. The children had been asked anticipated (= standard) versus

unanticipated (= cognitive lie detection) questions. (24) Vrij, Leal, Granhag, Mann, Fisher, Hillman, &

Sperry (2009). Results collapsed across delay variable. General questions score (= standard approach)

versus spatial, temporal and drawing scores combined (= cognitive lie detection approach). (25) Vrij,

Leal, Mann, & Granhag (2011). Students in Exp. 2 read transcribed statements (1 truthful, 1

deceptive) from military/police officers in Exp. 1. Past activities (Condition 1 in Exp. 2 = standard

approach) versus intentions (Condition 2 = cognitive lie detection approach) comparison. Condition 3

(past activities and intentions) was excluded. (26) Warmelink, Vrij, Mann, Jundi, & Granhag (2012).