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Lie to me: investigating the strategic regulation of fine-grain details in truth-tellers and liars

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ABSTRACT

A metacognitive model of memory regulation was applied to information-gathering interviews with deceptive and truth-telling participants. Theoretically, differential strategies of the liars and truth-tellers would direct specific metacognitive processes and elicit veracity cues. 60 participants (40 female, 20 male) were interviewed and asked to lie or tell the truth about an event. Half the liars and half the truth-tellers were given 5 minutes preparation. It was found that, despite a majority of liars reported adopting an 'embedding' strategy (whereby lies are concealed within really experienced events), significantly more fine-grain precise details (e.g. 'he was 6' 3" tall', 'the chair was red') were reported by truth-tellers than liars. Additionally, truth-tellers reports contained significantly more reminiscence (recalling details in follow up questions not originally remembered) than liars. This provides the first evidence suggesting that embedding is not an effective counter-strategy to reminiscence based veracity tools. However, no evidence was found for increased verbal-decline for liars. Furthermore, no effect of preparation was found for fine-grain details, reminiscence, or verbal-decline. It is concluded that although the current results with respect to reminiscence are encouraging, the boundary conditions associated with fine-grain detail reporting should be established before such models are integrated into cognitive based lie-detectors.

KEY WORDS:	DECEPTION	COGNITIVE STRATEGIES	METACOGNITIVE REGULATION	GRAIN-SIZE	REMINISCENCE

‘Now I believe I can hear the philosophers protesting that it can only be misery to live in folly, illusion, deception and ignorance, but it isn't - it's human.’

- Desiderius Erasmus

Introduction

State of the ‘art’-

Decades of research on deception – defined as the ‘successful or unsuccessful deliberate attempt, without forewarning, to create in another a belief which the communicator considers to be untrue’ (Vrij, 2008, p. 15) – shows it is difficult to detect (Vrij, 2008; Granhag & Hartwig, 2008a). Meta-analysis of hundreds of studies shows the average accuracy rate to be only 54%, i.e. only marginally above the 50% level to be expected by chance (Bond & DePaulo, 2006). Further, despite the claim some people – so called ‘wizards’ – naturally use highly diagnostic cues (e.g. micro-expressions; Bond, 2012; Ekman, 1985/ 2001) and are thus highly accurate at detection deception, meta-analysis shows no such variety between people’s deception detection accuracy (Aamodt & Custer, 2006; Bond, 2008). One possible explanation for this uniformly poor performance is that that there are few valid cues to deception (Hartwig & Bond, 2011), and those few valid cues are typically subtle (Vrij, Granhag, & Porter, 2010; Vrij & Granhag, 2012a). Indeed, DePaulo et al.’s (2003) meta-analysis reported only 14 cues (out of 50) significantly related to deception. These 14 diagnostic cues to deception averaged an effect size of just d = .25 (i.e. slightly above the cut-off for a small effect; Cohen, 1988). A second possible explanation is that the arousal based assumptions (Fig 1 below) – that underpin most lie-detectors (Vrij, 2008) and the ‘wizard’ research (Vrij et al. 2012a) – are theoretically unreliable (Rational Research Council, 2003).[1]

[1] Curiously, some recommend *applying* such weak assumptions to training programs referred to as ‘state-of-the-art’ (Shaw, Porter, & ten Brinke, 2013). Researchers advocating arousal based lie detectors do so – to use the language of Signal Detection Theory (Green & Swets, 1966) – by arguing that correct classification of liars as lying (‘Hits’) is attainable because in high-stake contexts emotional based cues – voice stress, nervousness etc. – are diagnostic (e.g. Ekman & Frank, 1993; Frank et al., 2012; O'Sullivan et al. 2009). Alternatively, it is argued that incorrect classifications of liars as innocents (‘Misses’) are avoidable because emotion based cues (micro-expression, facial expressions etc.) are difficult to suppress (e.g. ten Brinke, Porter, & Baker, 2012; Ekman, 1985/ 2001; Ekman & O’Sullivan, 2006). Neither argument addresses why truth tellers will not also experience arousal (Rational Research Council, 2003; Vrij, 2008; Vrij and Granhag, 2012a) i.e. how false positives are avoided. This problem is more than purely academic with the American Transport Security Agency (TSA) estimated cost of Screening Passengers by Observational Techniques (SPOT) – an arousal based tool – is expected to reach $1.2 billion over the next 5 years (Holmes, 2011).

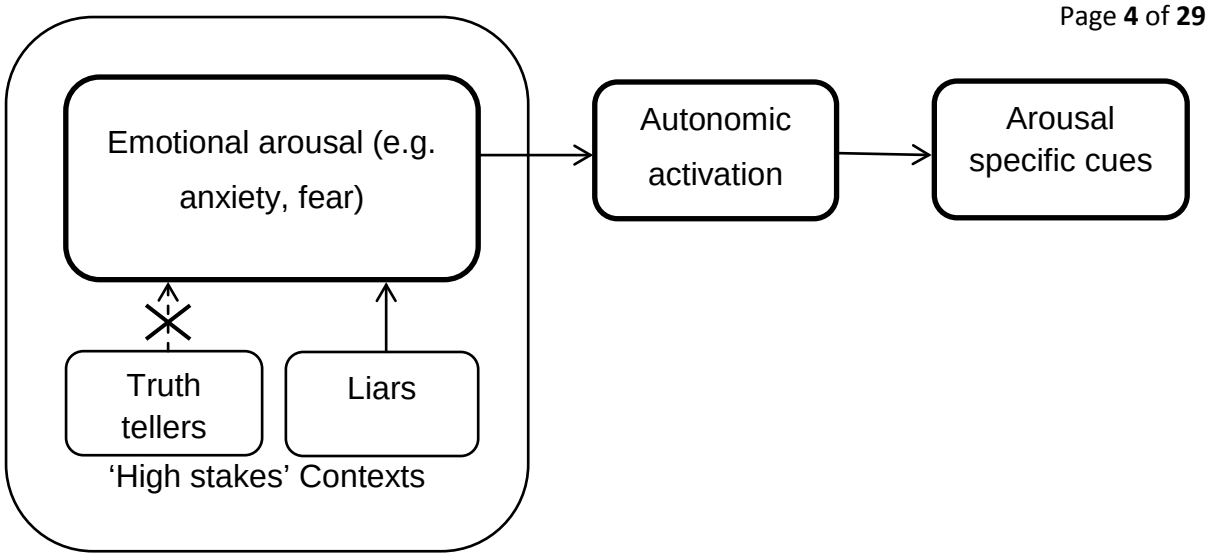

Figure 1. Theoretical assumptions underpinning arousal-based lie detectors

Indeed, recent research shows that emotional 'micro-expressions' (Ekman, 2001/1985; Ekman & Friesin, 1969) occur rarely, i.e. in only 14 out of 697 analysed facial expressions (ten Brinke, MacDonald, Porter, & O'Connor, 2012), seriously reducing its usefulness for detecting deception (Vrij et al. 2012a). Similarly, emotional facial expressions of liars in 'ultra-high stake' situations are only diagnostic of deception at rates around chance (ten Brinke, & Porter, 2012; ten Brinke, Porter, & Baker, 2012), and thus of limited applied use (Vrij et al. 2012a, Vrij & Granhag, 2012b). Another common arousal-based approach, the Behavior Analysis Interview (BAI; Inbau, Reid, Buckley, & Jayne et al. 2001) – an interview designed to detect deception – performs experimentally at accuracy below chance (Vrij, Mann & Fisher, 2006), and is totally atheoretical, i.e. reliant on (erroneous) 'common sense' (Massip, Barba, & Herrero, 2012; Massip & Herrero, 2013). Problematically, atheoretical and arousal based accusatory-style 'interrogations' that 'presume guilt' – i.e. the Reid Technique (Inbau et al., 2001, p. 364) – are more likely than theory based information-gathering interviews to result in false confessions[2] (Kassin et al. 2010; Gudjonsson et al. 2011) and produce false intelligence (Soufan, 2011). Hence, there is an urgent need for theoretically derived and empirically validated methods of deception detection. The current research attempts to build upon contempory cognitive approaches by using Ackerman and Goldsmith's (2008) metacognitive models of memory. Specifically, the strategic control of memory reports via the manipulation of grain-size (the precision at which an answer is provided; Koriat & Goldsmith, 1996) is explored with respect to liars and truth-tellers. Thus, this research explores the potential of supplementing cognitive based lie detection with metacognitive theory.

[2] As case studies (e.g. Leo, 2005) and post-convictional DNA-based exonerations (Kassin et al. 2010; Innocence Project, 2007) demonstrate, false confessions occur at frequencies greater than lay opinion suggests. Furthermore, such evidence – even if erroneously admitted and removed from court – appears highly influential with confessions constituting a potent weapon for criminal prosecution (e.g. Kassin et al. 2010, Gudjonsson et al. 2010).

Cognitive based approaches to lie detection-

Building on the insight that without theory-based, active interviewing there are few reliable cues to deception (Colwell et al. 2013; Vrij & Granhag, 2012a, b; Hartwig & Bond, 2011), three on-going research programmes – the Strategic Use of Evidence (SUE technique; Granhag & Hartwig 2008; Hartwig et al. 2007; Granhag, Strömwall, Willén, & Hartwig, 2012), Assessment Criteria Indicative of Deception (ACID; Collwell, Hiscock-Anisman, Memon, Taylor & Prewett, 2007; Suckle-Nelson, Colwell, Hiscock-Anisman, Florence, Youschak, & Duare, 2010; Ansarra, Colwell, Hisock-Anisman, Hines, Fleck, Cole, & Belarde, 2011), and enhanced Cognitive load (Vrij, Fisher, Mann, & Leal, 2006, 2008, 2011) – have examined the use of information-gathering interviews to detect deception while eliciting intelligence. All such methods are predicated on the reasonable assumption that liars and truth tellers use different cognitive processes[3] during interviews (Fig 2) (Leins et al. 2013; see Luke et al. 2013; Colwell et al. 2013; Vrij et al. 2012a).

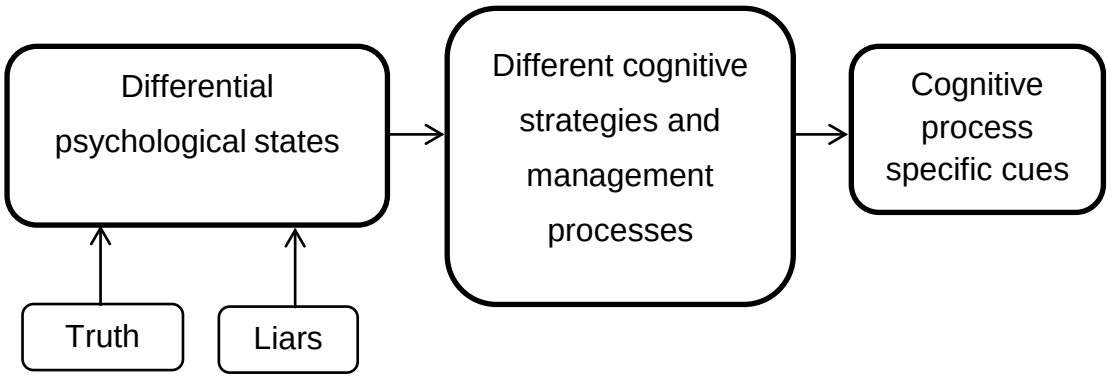

Figure 2. Theoretical assumptions underpinning cognitive-based lie detectors

There are good reasons to expect liars and truth-tellers to use different cognitive processes during interviews. Whereas truth tellers often do not adopt a strategy[4] (Vrij et al. 2010), offering the justification; 'I did not need a strategy because I was innocent' (Hartwig et al., 2007, p. 220), liars often prepare for an interview by constructing and rehearsing a false alibi/ lie script[5] (Colwell et al. 2006; 2013). By preparing details in advance of the interview questions, liars can repeat what they know will not be incriminating without exerting great mental effort. Because according to Zuckerman, DePaulo, and Rosenthal's (1981) Multi-Factor Model cues

[3] E.g. ten Brinke et al. (2012). Predictably, research on subjective strategies suggests liars are far from passive and actively deploy counter-measures to resist lie detectors (e.g. Leins et al. 2013).

[4] Theoretically, Belief in a just world (Lerner, 1980) and that innocence shines through (illusion of transparency; Gilovich et al. 1998) explains the propensity for this lack of preparation.

[5] Also referred to as 'superficial encoding' (Porter & Yuille, 1995)

to deception can be caused by the heightened cognitive load associated with lying, the reduction of cognitive load will reduce the available cues to deception (DePaulo et al. 2003; Vrij, et al. 2006, 2008, 2011; Vrij et al. 2009).

Contempory strategy research and counter-measures-

Leins et al. (2012) report that when given the freedom to lie however they wished, 67% of liars in their first experiment and 86% in the second, deceived using genuinely experienced events and details from real memory (thus 'embedded' their deception) rather than telling prepared outright fabrications. This strategy would violate the central theoretical assumption of two widely used tools to detect deception: Reality Monitoring (RM; Johnson, & Raye, 1981; see Masip, Sporer, Garrido, & Herrero, 2007; Memon, Fraser, Colwell, Odinot, Masteroberardo, 2010 for reviews) and Criteria Based Content Analysis (CBCA; Vrij, 2008; see Vrij 2005 for a review), i.e. that liars draw upon fabricated conceptual knowledge that differs in quality from real memory (Colwell et al. 2013; Vrij, 2008). Indeed, two previous studies have established that 'embedding' reduces the diagnostic accuracy of RM (Nahari et al. 2012; Gnisci, et al., 2010). Following Leins et al. (2012), it is expected that the majority of liars in the present study will spontaneously (i.e. voluntarily) use an embedding strategy (Hypothesis 1).

Assuming that liars embed deception within memories of actual events, and thus draw upon real memories, there exist good theoretical and empirical reasons to suggest they do so with different strategic goal priorities than truth tellers. Whereas truth tellers strategically 'try to be honest' (Clemens, Granhag, & Strömwall, 2012), 'forthcoming' (DePaulo et al. 2003) and 'tell the truth as it happened' (Hartwig et al. 2007, 2010; Strömwall et al. 2007; Vrij, Mann, Leal, & Granhag, 2010; Clemens, Granhag, & Strömwall, 2012; Granhag et al. 2012), liars – in contrast – engage in strategies such as 'keeping the story simple' (Vrij, Mann, Leal, & Granhag, 2010), 'remain consistent' (i.e. do not change the story) (Granhag, Giolla, Stromwall, & Rangmar, 2012), and 'be vague' (Vrij, Mann, Leal, & Granhag, 2010). Theoretically, both Grice's Theory of Communicative Implicature (1975), and its development – Information Manipulation Theory (IMT; McCornack, 1992) – together with developments of DePaulo et al.'s (2003; DePaulo, 1992) Self-Presentational perspective by Granhag and Hartwig (2008; Hartwig & Granhag, 2010) suggest that liars – but not truth-tellers – must engage in cognitive processes related to information management[6].

[6] In contrast, both liars and truth tellers want to be believed (Hartwig & Granhag, 2010) and thus face an identical objective during an interview: convince the interviewer of their innocence (Granhag & Hartwig 2008; Vrij, Mann, Leal, & Granhag, 2010). Critically, although liars do not take credibility for granted and try to project a convincing impression (DePaulo et al. 2003; Kassin, 2005), the self-presentational perspective (DePaulo et al. 2003) suggests both truth tellers and liars will engage in impression management by drawing upon shared beliefs regarding

Metacognitive models of memory regulation-

Considering the previous strategy research, it seems plausible liars and truth-tellers attempt to recall details during interviewing using different retrieval goals than truth-tellers. Critically, metacognitive models of memory regulation (Ackerman et al. 2008; Goldsmith, Koriat, & Pansky, 2005; Goldsmith, Koriat, & Weinberg-Eliezer, 2002; Koriat et al. 1996) stipulate specific processes by which strategic goals regulate memory reports.

According to Koriat and Goldsmiths (1996) metacognitive[7] model of memory regulation, report option (i.e. the ability to withhold reporting information due to uncertainty to improve potential accuracy) is governed by the placement of a confidence criterion, set by the rememberer, representing the lowest confidence at which information will be volunteered. This inevitably leads to a potential quantity-accuracy trade off (e.g. Koriat et al. 1996; Goldsmith et al., 2002) whereby the rememberer must decide what to prioritize: the amount (quantity; favouring a low confidence criterion placement) or quality (accuracy; favouring a high confidence criterion) of information. Similarly, precision (or grain-size) at which information is reported is also under strategic control (Yaniv & Foster, 1995). Fine-grain details are particular and specific details, such as time, (i.e. 5:23 p.m.), distance, (i.e. 340km), or height, (i.e. 6' 00") (Ackerman et al., 2008; Goldsmith et al., 2005; Koriat et al., 2002). Goldsmith et al. (2002) proposed that control of grain-size is guided by an accuracy-informativeness trade-off similar to the accuracy-quantity trade-off. Coarse grained answers, although more likely to be correct, are also less informative. Interestingly, rememberers appear sensitive to relative payoffs of any particular situation; for example, Fisher (1996), upon re-examining data, found that less precise information allowed participants to maintain high accuracy, at the expense of informativeness, whereas rememberers strategically provide more precise information when informativeness was required, at the expense of accuracy (Ackerman et al. 2008; Goldsmith et al. 2002; Yaniv & Foster 1997). More specifically, Goldsmith, Koriat, & Pansky (2005) successfully generalized Goldsmith et al.'s (2002) satisficing model of grain-size regulation from semantic memory to episodic memory (relevant for detecting deception). However in both models an asymmetry is introduced as it is assumed implicitly that adjusting response grain-size

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what behaviours appear credible/ deceitful and regulating their behaviour accordingly (Granhag et al. 2008; Hartwig et al. 2010). Indeed, research shows the non-verbal strategies of both liars and truth tellers to be similar (Hartwig, Granhag, Strömwall, & Doering, 2010; Strömwall, Hartwig & Granhag, 2006; Vrij, Mann, Leal, & Granhag, 2010). This that offers a plausible explanation for the low veracity rates achieved using non-verbal cues (Bond & DePaulo, 2006) and impression management measures (DePaulo et al. 2003; Vrij, 2008; Kassin, 2008) in detecting deception.

[7] Metacognition refers to thinking about one's own cognition (Flavel, 1979), and metacognitive models specify the processes by which a rememberer can mentally regulate their memory output (Ackerman et al. 2008; Koriat et al. 2008).

precision is similar to the explicitly theorized withholding response option (Ackerman & Goldsmith, 2008). In their dual-criterion model, Ackerman et al. (2008) explicitly proposes that reported information must pass both the confidence criterion (as per Koriat et al. 1996; Goldsmith et al. 2002, 2005) and a specific informativeness criterion (reflecting the minimum level of precision or coarseness constituting a reasonable response to the question). Empirically, Ackerman et al (2008, experiments 1A and 2) found that when both criterions conflicted, i.e. when both informativenss and correctness could not be satisfied, participants scarified correctness (i.e. provided answers that could wrong) to protect informativeness (e.g. Goldsmith et al. 2002; Yaniv & Foster 1997) presumably because beyond a minimum informative level, the answer violates social communicative norms (Grice, 1975) and is perceived as being deliberately unhelpful (Sperber & Wilson, 1995). Assuming that truth-tellers can be modelled as honest rememberers, it can be hypothesised they too will prioritize informativeness over accuracy in interviews.

Although numerous metaphors have been used in memory research – form Plato's wax tablet to the hologram (Draaisma, 1995) – of particular relevance here are the storehouse and correspondence metaphors (Koriat et al. 1996). The storehouse metaphor entails an understanding of memory as something that merely retains a quantity of previously encountered items (e.g. Ebbinghaus, 1885). In contrast, the correspondence metaphor understands memory as something that can retain accuracy, i.e. precise faithfulness to the past. The empirical finding that truth-tellers produce longer statements (Nahari et al. 2012; see Vrij et al. 2008; Colwell et al. 2013) can be interpreted via the storehouse model as suggestive of the fact being informative is prioritized by the truth-tellers (thus, more details are reported). However, the correspondence metaphor suggests a second hypothesis regarding truth-tellers attempted 'informativeness'. Additionally to providing many details, the details provided may themselves be reported at very precise levels (Ackerman et al., 2008; Koriat et al. 1996, 2008). Thus, truth-tellers are expected to report more fine-grained details than liars (Hypothesis 2).

To further validate grain-size as a theoretically derived index of deception, two additional hypotheses can be formulated. First, Colwell et al. (2013) reports that the net addition of new details across an interview (i.e. Reminiscence; Payne, 1987) is 'the most powerful predictor of honest responding' found thus far in the ACID literature. Theoretically, genuine memory is characterized by its reconstructive nature (Bartlett, 1932; Loftus, 1979; Tulving, 2002; see Granhag, Strömwall, & Jonsson, 2003) and recalled details serve as additional retrieval cues that gradually reinstate the original encoding (Fisher, & Geiselman, 1992) context and facilities additional recall (as per encoding specificity principle; e.g. Tulving, 1974; Tulving & Thomson, 1973). However, if liars embed deception within really memory (Hypothesis 1) reminiscence may be expected for both liars and truth-tellers. Yet, if truth-teller's and liar's reports differ in terms of fine-grained details due to strategically guided retrieval implicated by metacognitive models, it can be

hypothesised that truth teller's reports will display significantly more reminiscence than the liars (Hypothesis 3).

Second, Lancaster et al. (2013) reports that truth tellers display less verbal decline (the within-subjects measure of the difference in detail provided to an expected question relative to an unexpected question) than liars. It is normally assumed that unexpected questions counter liar's preparation by forcing them to answer questions they did not anticipate spontaneously, and thus impose cognitive load upon liars resulting in more cues to detection (Vrij et al., 2009, 2011). If verbal decline exists when liars have embedded a lie in actual memory (Hypothesis 1), it must be due, in part, to the strategic objectives guiding recall. Thus, verbal decline between prepared truth tellers and liars may manifest in the difference between fine-grain details reported for the expected question (e.g. a free-recall question) relative to an unexpected question. Specifically, truth tellers are hypothesised to display significantly less verbal decline (as assessed using the frequency of fine-grain details) than liars (Hypothesis 4).

In sum, these theoretically derived predictions were experimentally tested using an interview based study. If the theory described above is correct, liars and truth-tellers are predicted to display different verbal cues to deception. Specifically, it was hypothesised that i), that the majority of liars will report using real memories to base their lie (embedding; Hypothesis 1), ii) truth-tellers will report significantly more fine-grain details than liars (Hypothesis 2), iii) truth-tellers will produce reports displaying significantly more reminiscence (versus liars; Hypothesis 3), and iv), truth-tellers will exhibit significantly less verbal decline than liars (Hypothesis 4).

Method

Participants-

60 participants (N= 20 male, N= 40 female) were recruited from the University of Portsmouth in exchange for Psychology undergraduate course-credit. Their mean age was 20.9 years (SD = 2.78) and their age ranged between 18 and 36 years. Participants were randomly allocated to one of four experimental conditions (truth without preparation, truth with preparation, lie without preparation, or lie with preparation) by the first experimenter, with an equal number of participants per cell.

Design-

The experiment used a 2 (Veracity; Truth/Lie) x2 (Preparation; No Delay/ Delay) between-subjects design. Dependent measures where the number of unique fine-grain details (precise details that were not recorded on their second or subsequent repetition in each transcript), verbal decline (the differences in details reported for the first time in each question between the unexpected question and the expected free-recall question) and reminiscence (the number of new and unrepeated details, not originally reported in the free-recall question, subsequently added to the report in one of the three follow up questions (probes)).

Materials-

After gaining informed consent and randomly allocating participants into experimental conditions, basic demographics were collected. The interview's question protocol was adapted from previous research (Beniniman, 2012) and comprised of four questions; a free-recall question ('Please tell me all you can remember about meeting someone for the first time), 2-open ended information-gathering questions ('tell me about this persons appearance' and 'tell me about your thoughts and feelings when you meet this person'), and finally an unexpected question ('tell me about your physical surrounds'). The sequence of the questions was not varied. Post-interview questionnaires were designed specifically for this study to allow assessments of the strategies used by liars to appear convincing.

Procedure-

Two experimenters were used throughout the experiment to ensure the conducting of interviews, transcribing of the interviews, and coding of transcripts were all completed by a researcher blind to the experimental condition of each participant. Additionally, standardized instructions where used throughout to ensure reliability. Interviews were administered individually and were dived into a pre-interview stage, the interview itself, and a post-interview questionnaire stage. In the pre-interview stage, the participants were briefed by the first experimenter to either lie or tell the truth in forthcoming interview. Each participant was read his/her instructions by the first experimenter who provided any clarifications needed. Half of the participants were then given 5 minutes to prepare themselves before the interview. The

remaining participants were not given preparation time and were interviewed immediately. The interview itself was conducted by a second experimenter (blind to the experimental condition) and all interviews were audio recorded to permit later transcription. The instructions and questions were read from a standardised script. Each participant was given unlimited time to answer each of the four information-gathering questions. Once completed, the first experimenter gave each participant a personal post-interview questionnaire to complete, and again provided assistance if required. The pre-interview instructions, interview questions, and post-interview stages took no longer than 15 minutes on total for each participant to complete. Once completed, participants were debriefed, thanked for their time, and awarded course-credit. Recorded interviews were then digitally stored in a password protected file in a secure department office prior to transcription.

Coding-

Interviews were transcribed verbatim and coded twice, by a coder blind to the veracity of the transcript. First, the transcripts were coded for the number of unrepeated (i.e. unique) fine-grained details reported across the entire transcript. Second, transcripts were coded for the number of fine-grained details reported for the first time in each the free-recall and unexpected questions. Thus, a detail in the second coding could be counted twice (on its first appearance in each question, as per Lancaster et al. (2013)) whereas any detail in the first coding could only count once (on its first appearance in the transcript) as all repeated details were ignored. This coding protocol was adopted due to interest in both the addition of new details across interviewing (i.e. reminiscence) – as per ACID research, (e.g. Collwell et al. 2013) and the total amount of details provided in the expected question relative to the unexpected question – verbal decline – (Lancaster et al., 2013). Unlike previous research (e.g. Lancaster et al. 2013; Colwell et al. 2013), coding was not derived from Reality Monitoring and/or Criteria Based Content Analysis but upon research pertaining to the metacognitive regulation of grain-size. Items were coded as fine-grain details (Koriat & Goldsmith, 1996; Koriat, Goldsmith, & Halamish, 2008) if and only if they reported a particular, such as time, (i.e. 5:23 p.m.), distance, (i.e. 340km), or height, (i.e. 6’ 00”) (Koriat, Goldsmith, & Weinberg-Eliezer, 2002; Goldsmith, Koriat, & Pansky, 2005; Ackerman & Goldsmith, 2008) and if they could not have reasonably been reported at a more precise level. For example, ‘I met my fiancé[1] at Portsmouth University[2] when she[3] was 18[4]’ would contain 4 fine-grain details, whereas ‘I think he[1] was tall and his hair was dark’ contains 1 fine-grained detail (both ‘tall’ and ‘dark’ could clearly have been reported more precisely). Proper nouns were recorded as fine-grain details. Because both affective details (I felt ‘x’) and cognitive details (I thought ‘y’) lack a clear coarse/ fine-grain hierarchy, they were excluded from coding.

Results

In the post-interview questionnaire, the majority of both Unprepared Liars (80%) and Prepared Liars (53%) reported using real memories and/or real experiences to generate their deception. In total, 'embedding' was reported by 66% of all liars, thus Hypothesis 1 (*the majority of liars will report using an embedding strategy*) was supported. Descriptive statistics for fine-grain detail, reminiscence, and verbal-decline are shown in Table 1.

Table 1

Means and standard deviations for fine-grained details, reminiscence and verbal decline by veracity, preparation and overall totals

	Fine-Grain Details		**Reminiscence**		**Verbal Decline**	
	M	*SD*	*M*	*SD*	*M*	*SD*
Truth						
Prepared	15.20	6.01	9.20	4.65	-.33	1.99
Unprepared	16.00	4.80	10.73	4.35	.73	2.71
Liar						
Prepared	9.60	3.22	6.67	3.18	-.73	2.76
Unprepared	9.87	4.47	6.53	3.54	-.93	2.37
Overall Veracity						
All Truth	15.60	5.36	9.97	4.49	.20	2.40
All Liar	9.73	3.83	6.60	3.31	-.83	2.53
Overall Preparation						
All Prepared	12.40	5.53	7.93	4.12	-.53	2.37
All Unprepared	12.93	5.52	8.63	4.44	-.10	2.64

First, a 2 (Veracity: truth/liar) x 2 (Preparation: yes/no) independent-groups ANOVA was conducted to examine reported fine-grain detail at different levels of preparation, depending on veracity. A significant main effect of Veracity was found, $F(1, 59) = 23.06$, $p < .001$, $\eta^2_p = .29$, whereby truth-tellers (M =15.6, SD = 5.36) reported more fine-grain details than liars (M = 9.73, SD = 3.83). Generally, a η^2 of about .01 corresponds to a small effect size, about .06 to a medium effect, and about .14 to a large effect (Cohen, 1988).

No significant main effect was found for Preparation, $F(1, 59) = .19$, $p = .664$, $\eta^2_p = .003$, *n.s.,* whereby the fine-grain detail reported in the Prepared conditions (M = 12.40, SD = 5.53) was not significantly different from the fine-grain details reported in the Unprepared conditions (M = 12.93, SD = 5.52).

No significant interaction was found between level of Preparation and Veracity, $F(1, 59) = .048$, $p = .828$, $\eta^2_p = .001$, *n.s.* (See Figure 1 below). Thus, Hypothesis 2 (*truth tellers will report significantly more fine grained details in their reports than liars*) was supported.

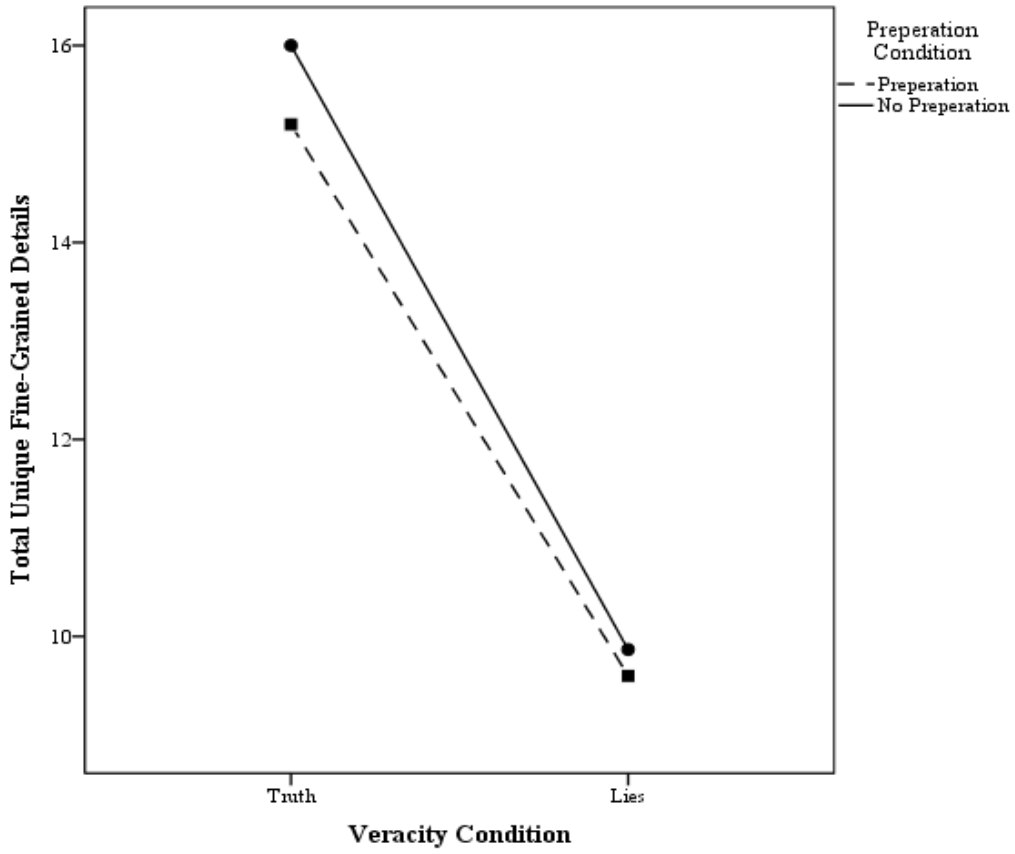

Figure 1: Participant Fine-Grain Scores with respect to Preparation and Veracity

Second, a 2 (Veracity: truth/liar) x 2 (Preparation: yes/no) independent-groups ANOVA was conducted to examine reported Reminiscence at different levels of Preparation, depending upon Veracity. A significant main effect for Veracity was found, $F(1, 59) = 10.77$, $p = 0.02$, $\eta^2_p = .16$, whereby truth-teller's ($M = 9.97$, $SD = 4.49$) reports contained more Reminiscence than liar's reports ($M = 6.60$, $SD = 3.31$).

No significant main effect was found for Preparation, $F(1, 59) = .465$, $p = .489$, $\eta^2_p = .008$, *n.s.*, whereby the Reminiscence reported in the Prepared conditions ($M = 7.93$, $SD = 4.12$) was not significantly different from the Reminiscence reported in the Unprepared conditions ($M = 8.63$, $SD = 4.44$).

No significant interaction was found between levels of Preparation and Veracity, $F(1, 59) = .660$, $p = .42$, $\eta^2_p = .012$, *n.s.* (see Figure 2 below). Thus, Hypothesis 3 (*truth tellers will exhibit more reminiscence than both liars*) was supported.

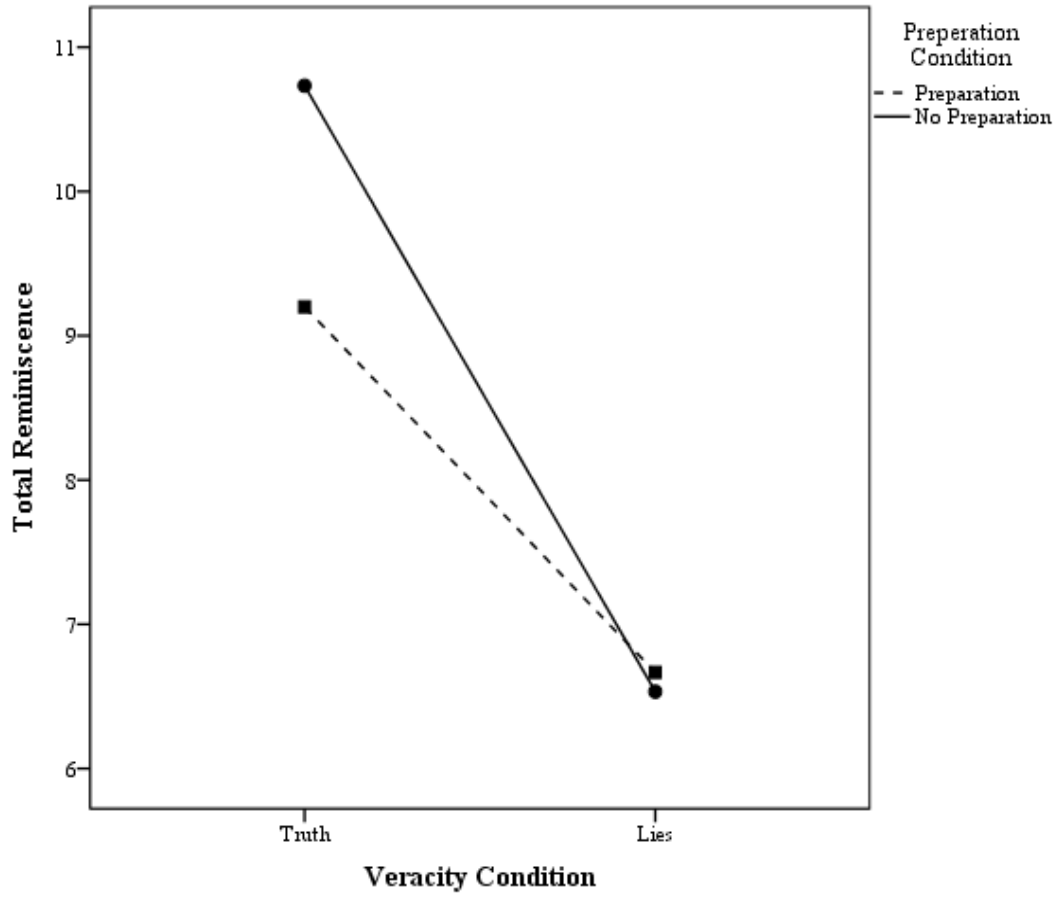

Figure 2: Participant Reminiscence Scores with respect to Preparation and Veracity

Third, a 2 (Veracity: Truth/Liar) x 2 (Preparation: yes/no) independent-groups ANOVA was conducted to examine verbal decline at different levels of Preparation, depending upon Veracity. No significant main effect was found for Veracity, $F(1, 59) = 2.606$, $p = .112$, $\eta^2_p = .044$, *n.s.,* whereby verbal decline reported in the truthful conditions ($M = .20$, $SD = 2.40$) was not significantly different from the verbal decline reported in the liar conditions ($M = -.83$, $SD = 2.53$).

No significant main effect was found for Preparation, $F(1, 59) = .458$, $p = .501$, $\eta^2_p = .008$, *n.s.,* whereby the verbal decline in the Prepared conditions ($M = -.53$, $SD = 2.37$) was not significantly different from the verbal decline in the Unprepared conditions ($M = -.10$, $SD = 2.64$).

No significant interaction was found between levels of Preparation and Veracity, $F(1, 59) = .979$, $p = .327$, $\eta^2_p = .017$, *n.s.* (see Figure 3 below). Thus, Hypothesis 4 (*prepared truth tellers will display less verbal decline than both prepared and unprepared liars*) was not supported.

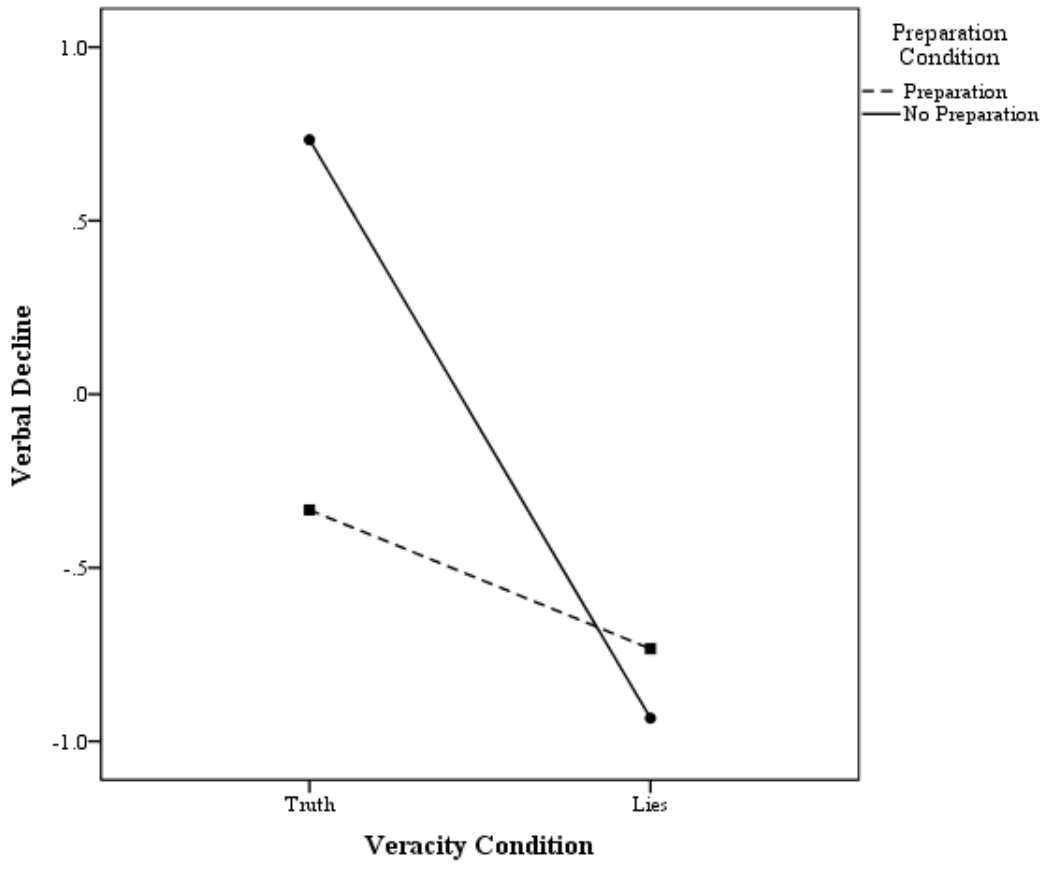

Figure 3: Participant Verbal Decline with respect to preparation and veracity

Discussion

The purpose of this study was to theoretically introduce, and empirically test, the application of metacognitive models of strategic memory regulation to cognitive based deception detection. With respect to strategies, it was predicted (Hypothesis 1) and found that the majority of liars (66%) reported freely choosing to 'embed' their lie (i.e. strategically using 'actual experiences' and 'discrete event details retrieved from autobiographical memory' to base their lie upon; Leins et al. 2013, p. 148). This supports previous research by Gnisci et al. (2010) that reported half of the liars (80/158) indicated using real memory of events to lie, and by Leins et al. (2013) who found that 67% of liars in their first experiment, and 86% in the second, reported using genuine details from memory to lie. Thus, a small but consistent literature indicates that 'when given the freedom to choose the contents of their reports, liars chose to report from actual experiences more often than choosing to fabricate their reports based upon imagined events that were never experienced' (Leins et al. 2013, p. 148). As noted elsewhere (Leins et al. 2013; Nahari et al. 2012) these findings render problematic the usage of RM and CBCA based approaches to detect deception because the assumption that liars use imagined memory (Vrij, 2008; Memon et al. 2010; Massip et al. 2007) is violated. However, the limits of the current study in this regard must be clearly understood. This current research neither used RM coding, nor the RM procedure of obtaining written statements from the participants (Vrij, 2008; Nahari et al. 2012; Masip et al., 2007; Memon et al., 2010). Thus, the question of if the embedding strategy would have reduced the utility of RM is beyond the scope of the current research.

At a very general level, the finding that truth-tellers reported significantly more fine-grained detail (details that were highly specific, such as reporting a height as '5' 6"' rather than coarse details such as 'quite tall') than liars (Hypothesis 2) can be interpreted as evidence liars and truth tellers differ with respect to mental strategies they employ during an interview (e.g. Jordan & Hartwig, 2012; Strömwall & Willén, 2011; Vrij et al. 2010; Hines et al. 2010; Granhag & Hartwig, 2008; Hartwig & Granhag, 2010; Colwell et al. 2013). This supports the most basic assumption of cognitive based lie detectors (Leins et al. 2013). More specifically, it appears truth-tellers strategically regulate their reports grain-size to include overall more fine-grain responses. The prioritizing and reporting of fine-grained details has been observed experimentally when incentives are provided for being informative rather than accurate (Koriat, Goldsmith, & Halamish, 2008; Ackerman & Goldsmith, 2008; Evans & Fisher, 2011). This finding is remarkable when considered together with the finding 66% of liars embedded their lie in genuine memory details. As stated above, this suggests liars did not use fabricated conceptual knowledge (hence violating the RM assumption) but rather used real memory analogously to truth-tellers. Thus, the significant grain-size differences between liars and truth-tellers appear resistant to embedding as a strategy. Given the importance of developing lie-detectors resistant to counter-measures, this finding requires replication.

Further, because fine-grain details are specific items (e.g. ‘he was 6’ 2” tall’), but subject-matter general (a specific item can be colour, height, distance, name, etc.), the finding truth-tellers provide more of such detail than liars supports Colwell et al.’s (2013) hypothesis that the utility of RM to detect deception is due to honest respondents providing more general detail than liars, rather than because of RM’s specifically valid assessment criteria. If this is indeed the case, fine-grain details may serve as the foundation of a theoretically derived content analysis. For example, in this study only fine-grain details were coded, but theoretically, hierarchies of grain size (from ‘coarse’ to ‘fine’) are often distinguished in the cognitive literature (Koriat et al. 1996, 2002, 2005, 2008). Any such future research could address the fining that no effect of preparation was found for reported fine-grain details (or indeed any other measure in the current research). At an elementary level, two explanations are possible. First, regulation of grain-size may be unaffected by preparation. Given the literature on metacognitive grain-size regulation across time (see Koriat et al., 2008), this possibility seems implausible for all but the most trivially short preparation times. More likely is the second option: the preparation manipulation used in this study may not have been powerful enough to produce preparation effects. Given a longer preparation condition for liars analytically increases the experienced delay for truth-tellers. This weakening of the memory representation is likely to have several consequences. Given only a modest delay (i.e. a week between an event taking place and the forensic interview) truth-tellers may have forgotten a large amount of information. Research shows when this occurs rememberers often compensate with reporting more coarsely grained-detail to maintain accuracy. Yet this would also reduce the difference (and hence diagnosticity) between the fine-grain detail reported by liars and truth-tellers. A further extension of the current research could also explore the effects of incidental versus intentional encoding on fine-grain details. Encoding can be divided into attempts to intentionally encode information (where the participant is aware of the need to memorize the information for a later test), and incidental encoding (where the participant is unaware of the need to remember the details) (Postman, Adams, & Phillips, 1955; Williams 2010). Problematically, in applied contexts where any lie-detector must be validated, incidental encoding is likely to predominate for truth-tellers. This is simply because truth-tellers who are questioned will often have had no reason to direct their attention to encode details. Thus runs contra the basic assumptions of both RM and SCAN (Vrij, 2008) that honest accounts should be more detailed. Rather, given the importance of attention in directing deep memory encoding (Craik, Govoni, Naveh-Benjamin, & Anderson, 1996; Naveh-Benjamin, Gavrileseu, & Anderson, 2000), such incidental encoding (expected of truth-tellers) should result in weaker memories. Given that fine-grain details presuppose a strong memory of an event this is a serious concern for the utility of grain-size as a deception detection tool. Liars in contrast, who prepare an alibi in advance (Vrij et al., 2006, 2008, 2011) and thus reducing the cognitive load based cues to deception (DePaulo et al., 2003; Zuckerman et al., 1981) should have an intentionally encoded memory. Thus, given a suitable opportunity and time to prepare for liars on one hand, and given the likelihood of a delay in interviewing and

dominance of incidental encoding for truth-tellers on the other, clearly an effect of preparation is theoretically expected. However, this study asked participants to remember or lie about any memory of a general event. Thus, truth tellers had the freedom to report any strong or salient memory without the restriction. As argued above, theoretical considerations clearly suggest boundary-conditions imposed by encoding type (incidental versus intentional) and additional research is required.

Reminiscence , i.e. 'when material not recalled on one test may be successfully recalled on a subsequent test' (Smith & Vela, 1991, p. 168) – as assessed via the addition of new fine-grain details in follow up questions not reported in the free-recall – was exhibited in truth-teller reports significantly more than liars, as hypothesised (Hypothesis 3).Given reminiscence was observed despite the liars strategies of embedding, the current results suggest reminiscence is related to retrieval processes rather than the underlying memory per se. It is coherent with the current results to suggest that the underlying metacognitive processes that result in truth-tellers reporting more fine-grain details also drives the increased reminiscence. If truth-tellers reduce the familiarity criterion level that perspective details must pass to be reported (e.g. Koriat et al. 1996) and thus prioritize providing a greater volume of details (informativeness) at the expense of accuracy (Ackerman et al. 2008), then the truth-tellers motivation to continue searching their memory (Barnes, Nelson, Dunlosky, Mazzoni, & Narens, 1999) longer than liars should result in the increased reminiscence. If this explanation is correct, it implies memory search termination (to the author's best knowledge currently unexamined in the published detection literature) may be a useful cue to deception.

With respect to memory search termination as a metacognitive cue to deception, the recently developed measure of 'Exit Latency' (Dougherty et al., 2007) may have utility. Exit latency is a 'means of measuring when during retrieval participants decided to terminate the search' (Unsworth, Brewer, and Spillers, 2011, p. 19). Specifically, defined as the time invested in retrieval attempts – after the last detail is recalled – and before the decision to terminate the memory search (Davelaar et al., 2013; Dougherty et al. 2007; Harbison et al. 2009; and Unsworth et al. 2011), liars would be expected terminate their memory search quicker than truth-tellers. Conjecturally, a possible theoretical foundation would be that the 'avoid and escape' strategy of liars (Hartwig, et al. 2007; Strömwall et al. 2006) coupled with truth-tellers desire to be informative (Ackerman et al. 2008) may results in detectable differences in memory retrieval effort. Additionally, and coherent with the advantages with respect to deception detection provided by information-gathering interviews (Vrij, Mann, & Fisher, 2006) – and unlike response latency typically assessed using yes/no responses (see Gregg, 2007; Walczyk, Igou, Dixon, & Tcholakian, 2013; Walczyk, Roper, Seemann, & Humphrey, 2003; Walczyk, Schwartz, Clifton, Adams, Wei, & Zha, 2005) – exit latency is designed for open-ended free-recall tasks (Harbison et al. 2009).

No evidence of Verbal Decline was found. However, the methodological differences between Lancaster et al.'s (2013) study and current research are plausibly the cause. Specifically, Lancaster et al. (2013) i) actively imposed addition cognitive load on the participants via a secondary task, ii) used a highly cognitively demanding unexpected question involving perspective shifts, and iii) used multiple thematically related pairs of questions to elicit differences coded using a scheme inspired by RM. In contrast, the objective of the current study was to examine difference in grain-size reporting between liars and truth tellers, i.e. a specific cognitive process, as called for by Bond (2012), rather than the use of cognitive load as a means to detect deception (e.g. e.g. Vrij et al. 2006, 2008, 2011; Lancaster et al. 2013). The current study used an unexpected question concerning spatial detail (that liars do not prepare for (Vrij et al. 2009, 2011; Lancaster et al., 2013). However, by comparasion to the questions used by Lancaster et al. (2013), it was a simple question and lacked either a concurrent secondary task (to increase cognitive load) or a perspective shift (further increasing cognitive load). Thus, the null finding for verbal decline in the present study underscores the need for actively imposed manipulations to elicit cues to deception that are otherwise absent (Vrij et al. 2012a). This is an important insight for any attempts to replicate or extend the current research.

In conclusion, the current research found that, as hypothesised, when given the freedom to report liars freely (i.e. without instruction) the majority (66%) used real memories to embed deception. This finding is consistent with previous research (Gnisci et al. 2010; Leins et al. 2013). Additionally, truth-tellers were found to report significantly more fine-grained details that liars. No effect of preparation was found. Furthermore, truth-tellers reports were found to contain significantly more reminiscence than the liar's reports. Interpreting reminiscence as an ACID variable (Colwell et al., 2013), these results provide – to the authors best knowledge – the first experimental evidence that 'embedding' is not an effective counter-measure against at least one of the ACID interviewing system's dependent measures. Again, no effect of preparation was found with respect reminiscence. No evidence of verbal decline – as assessed using fine-grain details – was found in this study. Given this is one of few studies to investigate the application of metacognitive theory to deception detection the present results should be treated provisionally as a 'proof of concept'. Meta-cognitive approaches to deception detection involve using theoretically derived and empirically tested models of human memory. Meta-cognitive research attempts to specify the underlying mechanisms of strategic regulation under remember control (Ackerman et al. 2008), processes historically regarded as nuisance variables by mainstream cognitive research and eliminated in the name of experimental purity (Lories, Dardenne, & Yzerbyt, 1998; Dunlosky & Metcalfe, 2009; Nelson & Narens, 1994). Similarly, deception detection has only relatively recently researched the subjective strategies used by liars and truth-tellers in interviews. Thus, at a more conceptual level, a focus on metacognition makes explicit the contempory understanding of deception detection as the actively exploiting of strategic control processes (implicit within SUE, ACID, and enhance Cognitive Load research). This

opposes the historical conceptualization, underscoring decades of research showing deception detection is highly inaccurate (DePaulo et al. 2003), that deceit is detected by the passive observation of a highly reactive emotional state (i.e. the leakage model of deception detection; Ekman et al. 1969). In closing, it is suggested meta-cognitive models of memory regulation and control provide a theoretical counterpoint to such a passive understanding of how to detect deception, while providing a wealth of theory based, empirically tested models of relevance to deception detection in interview contexts.

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