

Facilitating memory-based lie detection in immediate and delayed interviewing:**The role of mnemonics**

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Abstract

We experimentally investigated how different mnemonic techniques employed in an interview conducted immediately after an event affected truth tellers' and liars' responses when they were interviewed again after a two-week delay. We also compared how verbal accounts changed over time within truth tellers and liars, and how consistent both groups were. Participants ($n = 143$) were shown a mock intelligence operation video and instructed either to tell the truth or lie about its contents in two interviews, one of which was immediately after watching the video and the other after a two-weeks delay. In the immediate interview they were asked to provide a free recall and then asked to provide further information via one of three mnemonics: Context Reinstatement, Sketch, or Event-line. In the delayed interview they were asked to provide only a free recall. Truth tellers reported more visual, spatial, temporal and action details than liars both immediately and after a delay. Truth tellers experienced more of a decline in reporting details after a delay than liars, and this decline was affected by the mnemonic used. Truth-tellers thus showed, more than liars, patterns of reporting indicative of genuine memory decay. Liars produced patterns of a 'stability bias' instead. Truth tellers and liars were equally consistent between their immediate and delayed statements.

Keywords: Verbal lie detection, mnemonics, Reality Monitoring, richness of detail, consistency, repeated interviews, delay, memory.

Facilitating memory-based lie detection in immediate and delayed interviewing: The role of mnemonics

In deception research, truth tellers and liars are typically interviewed once, immediately after the event (Vrij, 2008, 2016), and truth tellers' statements typically include more detail than liars' statements (Amado, Arce, Fariña, & Vilarino, 2016; DePaulo et al., 2003; Vrij, 2008). However, in real life investigative situations, it is very common for interviewees to be interviewed several times about the same target event and after different delay periods (days, weeks, or months; Goldsmith, Koriat, & Pansky, 2005; Read & Conolly, 2007; Wysman, Scoboria, Gawrylowicz, & Memon, 2014). In the current experiment, truth tellers and liars were interviewed about a mock incident twice: Immediately after the incident and two weeks later.

Although the difference between truth tellers and liars in terms of the amount of reported details is evident when they are interviewed immediately after an event (Vrij, 2005, 2008, 2015), in those few studies where participants were interviewed at different points in time, this difference tended to decline when interviews were conducted after a delay, making the credibility cue '*richness of detail*' less diagnostic over time (Harvey, Vrij, Hope, Leal, & Mann, 2017; McDougall & Bull, 2014; Vrij et al., 2009). This effect reflects different response patterns amongst truth tellers and liars. Truth tellers show 'the forgetting curve' (Ebbinghaus, 1885/1913) of memory: People forget information over time when there is no active attempt to retain it (Evans & Fisher, 2011; Lawson & London, 2015; Turtle & Yuille, 1994). The passage of time weakens memory traces, thereby reducing access to the original information (Goldsmith et al., 2005; Penrod, Loftus, & Winkler, 1982; Schacter, 1999). In addition, studies examining witness' episodic memory showed a reduction in recall of details in repeated retrieval attempts over time (Turtle & Yuille, 1994; Tuckey & Brewer, 2004). Liars, however, show a 'stability bias' (Harvey et al., 2017). This bias refers to a

metacognitive error to correctly understand the nature of memory decline over time (Kornell & Bjork, 2009). According to this concept, liars overestimate memory and fail to accurately calibrate their verbal output to take into account genuine memory decay.

Deception researchers have started to address memory-related factors affecting the statements of both truth tellers and liars in repeated and delayed statements (McDougall & Bull, 2015; Vrij et al., 2009; Harvey et al., 2017). In interviewing contexts, memory-related issues are important for two reasons: First, complete and accurate statements provided by cooperative witnesses or suspects are one of the main goals of investigative interviews (Geiselman et al., 1984; Kebbel & Milne, 1998; Pansky & Nemets, 2012). Memory retrieval for original information becomes more difficult over time, which can result in less complete statements. A decrease in forensically relevant reported information may negatively affect a criminal investigation. Second, a vaguer content can raise doubts about someone's credibility. Previous studies with police officers have shown that the amount of information provided is an important cue for them to decide whether or not an interviewee is credible (Akehurst, Köhnken, Vrij, & Bull, 1996; Strömwall & Granhag, 2003).

One factor that could facilitate retrieval of information even after long retention intervals is the use of memory-enhancing techniques (or 'mnemonics') (Fisher & Geiselman, 1992). Using mnemonics is valuable in real life because truthful interviewees can provide a lot of details valuable for criminal investigations, including descriptions of people, times of the criminal activities, locations of various crime related objects, etc. It is also important to understand whether deceptive interviewees tend to respond differently to mnemonics after different retention intervals. We examined how different mnemonics affected immediate reports by truth tellers and liars and how these mnemonics affected their responses when they were interviewed again after a two-week delay.

Mnemonics and deception

Memory enhancing interview techniques take into account two basic principles of human memory: a) A memory trace has several features and the effectiveness of a retrieval cue is dependent on the amount of overlap between the retrieval cue and the encoded event (Flexser & Tulving, 1978); and b) several retrieval paths to the encoded event may be available, so that information not accessible with one retrieval cue may be accessible with another (Tulving, 1974). Regarding the latter, a person may not report specifically where s/he placed an item in the room when asked a direct question, but may recall a concrete location when requested to draw a layout of that room. Mnemonics are typically included in evidence-based investigative interviewing guidelines (Clarke & Milne, 2001; Clarke, Milne, & Bull, 2011; Fisher & Geiselman, 1992). Research has shown the advantage of using mnemonics over standard interviewing techniques in terms of eliciting more complete statements, without the cost of an inflated amount of inaccurate information (Davis, McMahon & Greenwood, 2005; Fisher, Geiselman, & Amador, 1989; Memon, Meissner & Fraser, 2010).

Different types of mnemonic techniques have been adapted for use in investigative interviewing, three of which are introduced in this paper. *Context reinstatement (CR)* requires witnesses to mentally place themselves back in the experienced event (Fisher & Geiselman, 1992). Studies have shown memory improvement in recalling details when using this mnemonic in both children and adults (Priestley, Roberts, & Pipe, 1999; Wong & Read, 2011). Another technique, making a *Sketch* of the crime scene, has also resulted in a more complete account of an event compared to standard questioning procedures (Dando, Wilcock, Behnkle, & Milne, 2011; Dando, Wilcock, & Milne, 2009). Finally, the *Event-line* mnemonic technique, is based on the Timeline interviewing format developed by Hope, Mullis, and Gabbert (2013), which is related to reproducing temporal context and sequence of actions in an event. The Timeline facilitated more correct information than a free recall both immediately after an event and after a two-week delay (Hope et al., 2013). In our study, we

positioned CR as a generic mnemonic which is known as an effective memory-enhancing technique (Dando et al., 2009; Emmett, Clifford, & Gwyer, 2003; Fisher & Geiselman, 1992). We also sought to examine the effects of more specialised mnemonics (sketch and event-line) that target specific types of information (spatial or temporal) and contrast them with performance on a generic CR.

Previous findings also suggest that the use of mnemonics can aid in discriminating between truthful and deceptive statements, because truth tellers benefit more from such memory enhancement techniques than liars. Liars may lack the imagination to report as many (plausible) details as truth tellers, or they may be unwilling to do so out of fear that these additional details give checkable leads to investigators (Vrij, Fisher, & Blank, 2017). In one study, truth tellers and liars were interviewed with the Cognitive Interview (CI), which contains various mnemonics, or with a standard interview protocol which did not contain mnemonics (Hernández & Alonso-Quequy, 1997). It was found that truth tellers reported more spatial, temporal, and sensory details than liars, and the difference was largest when the CI was used. In another study, it was found that the CI was more efficient than a standard interview in discriminating between truth tellers and liars when examining actions and objects details (Bembibre & Higuera, 2011). When the sketch mnemonic was introduced, it was found that a sketch resulted in more pronounced differences between truth tellers and liars than a verbal recall (Vrij et al., 2009; Vrij et al., 2010). Thus, previous findings suggest that mnemonics can aid in eliciting more information about the event in question, but also in better discrimination between truthful and deceptive accounts than standard questions.

Regarding real life interviewing settings, the application of mnemonics can be valuable because they do not require many resources (e.g., in contrast to polygraph machines), and are easy to implement and analyse (Vrij et al., 2010; Mac Giolla, Granhag, & Vernham, 2017). Thus, these techniques can be useful for practitioners to make inferences about the

credibility of interviewees. As yet it is unknown how different mnemonics affect not only immediate, but also delayed statements reported by truth tellers and liars.

Consistency as a cue to deceit

In real-life testimonies, consistency is regarded as an important cue for making credibility judgments (de Keijser, Malsch, Kranendonk, & de Gruijter, 2011; Granhag & Strömwall, 2001; Granhag, Mac Giolla, Sooniste, Strömwall, & Liu-Johnson, 2016). Both laypeople and legal professionals tend to believe that consistency is indicative of truth-telling, whereas inconsistency is a sign of lying (Bogaard, Meijer, Vrij, & Merckelbach, 2016; Granhag & Strömwall, 2000). Scientific evidence however has revealed an opposite pattern: Truth tellers can be equally or even less consistent in their statements than liars (Granhag & Strömwall, 2002; Strömwall & Granhag, 2005; Vredeveldt, van Koppen, & Granhag, 2014). This pattern can be explained by the nature of memory functioning in truth tellers and strategies commonly used by liars to mimic credibility. Specifically, Granhag and Strömwall (1999) introduced the '*repeat vs reconstruct hypothesis*' regarding the relationship between consistency and deception. This hypothesis is based on two premises: First, liars believe that being consistent is important in order to come across as being credible and they are therefore keen to repeat their original story when interviewed a second time. Second, truth tellers are less concerned with consistency than liars (Hartwig, Granhag, & Strömwall, 2007; Hartwig, Granhag, Strömwall, & Doering, 2010). When interviewed a second time, truth tellers go back to their memory of the event and, due to the malleable nature of human memory (Baddeley, 1990; Loftus, 1979), may subsequently add, omit or change details as a function of a repeated retrieval attempt (Hartwig et al., 2007; Hartwig et al., 2010). Therefore, when truth tellers rely on their memory of an event, their statements are likely to contain various types of inconsistencies (Vredeveldt et al., 2014). Consistency is related to repetition of the same details, whereas reminiscences (details reported in a subsequent account, but not mentioned

previously) and omissions (details reported previously but not in a subsequent account) are related to inconsistency (Vredevelt et al., 2014).

There are four different types of consistency typically analysed in deception studies: a) consistency between details within one statement, *within-statement consistency*; b) consistency between different statements made by one person, *between-statement consistency*; c) consistency between statements reported by different individuals about the same event, *within-group consistency*; and d) consistency between the statement and evidence, *statement-evidence consistency* (Vredevelt et al., 2014). Given our design and aims of the study, we will cover only the between-statement consistency. In this study, we examined the effects of three mnemonics on truth tellers' and liars' immediate statements and repeated statements after a two-week delay: CR mnemonic, spatial mnemonic (using sketch), and temporal mnemonic (using event-line). In the immediate interview, truth tellers and liars were first invited in a free recall to report everything they could remember about the event. After the free recall, a mnemonic was introduced and the interviewees were again invited to report all they could remember. Truth tellers and liars were then interviewed again after a two-week delay (free recall phase only).

Statement characteristics and hypotheses

The analysis of statements from truth tellers and liars was based on the Reality Monitoring approach (RM; Johnson & Raye, 1981). The main assumption of RM is that memories based on real experiences differ in quality from fictional 'recollections' (Masip, Sporer, Garrido, & Herrero, 2005; Vrij, 2015). Perceptual processes are involved in memories of real experiences (Johnson & Raye, 1981). Therefore, it is likely that they will contain, amongst other types of detail, sensory (smell, taste, touch, visual or audible details) and contextual (spatial and temporal details) information. In addition, real memories are usually clearer, sharper, and more vivid than imagined memories, which typically contain less detail

and are vaguer and less concrete (Vrij, 2015). The amount of different types of RM detail (visual, spatial, temporal, and action) between truthful and deceptive statements was compared. (In)consistency characteristics of truth tellers and liars (reminiscences, repetitions, and omissions; Granhag & Strömwall, 2002) typically identified in deception literature were also analysed.

In this study, we were interested in the differences between the report content of truth tellers and liars in immediate and delayed interviews. As a result of retrieval practice in the CR condition, we expected that neither truth tellers nor liars would show a memory decline in reporting detail after a delay, and that truth tellers would report even more visual, spatial, temporal, and action details than liars after a delay in the CR condition (Hypothesis 1). In the Sketch condition it was predicted that truth tellers would report more visual and spatial details than liars after a delay as a result of practising these details in the sketch. We also expected that truth tellers, but not liars, would show a memory decline in temporal and action details after a delay, as these details would be less practiced in the sketch (Hypothesis 2). In the Event-line condition, it was predicted that truth tellers would report more temporal and action details than liars after a delay as a result of practising these details in the event-line. Truth tellers, but not liars, would show a memory decline in visual and spatial details after a delay, as these details would be less practiced in the event-line (Hypothesis 3). Finally, we were also interested in how consistent truth tellers and liars would be in immediate and delayed interviews. In line with the above reasoning, we predicted that truth tellers would produce more reminiscences and omissions than liars between immediate and delay interviews (Hypothesis 4).

Our immediate interview included two parts, a free recall phase and a mnemonic phase, which we introduced due to its operational relevance. Specifically, in real life situations it is arguably more typical to start with a general open-ended request and then ask

for more specific information. Furthermore, the recent investigative interviewing guidelines suggest to use free recall first and follow with mnemonic techniques (Milne & Bull, 1999; Milne, Shaw, & Bull, 2007). In our analyses of the immediate and delayed reports, comparisons were made only between the free recall phases of the immediate and delayed interviews (the delayed interview only included a free recall phase). We did not take into account the information provided in the mnemonic phase of the immediate interview for two reasons: First, comparisons between immediate and delayed statements within conditions would be difficult in terms of the amount of details. In all experimental conditions, immediate statements would obviously be richer in detail because immediate interviews contain two phases whereas delayed statements only contain one. Second, different mnemonics could elicit different amounts of information due to their specifics. Therefore, it would also make comparisons of immediate and delayed reports complicated.

Although we did not specifically formulate hypotheses related to participants' performance during the mnemonic part of the immediate interview, we considered it important to report the outcomes of this phase of the interview, as it gives further insight into how truth tellers and liars respond to mnemonics.

Method

Participants

A total of 143 participants took part in the study. Their mean age was $M = 25.57$ ($SD = 12.55$) and 35.7% were male. In the sample, 80.4% were undergraduate and postgraduate students, and 18.6% were members of the general public. Participants were recruited via posters, flyers, online participant pool system, and online advertisements on the University's staff portals. As the experiment focused on the verbal content of the statements, native English speakers were prioritised to take part. The majority of participants (93.7%) were English native speakers; the remaining participants were fluent in English. Participants were

awarded two course credits or £10 for taking part in the study. In addition, all participants were entered into a draw to win a single prize worth £150 on completion of the experiment. The study was approved by the Science Faculty Ethics Committee of the University.

Design

A 2 (Veracity: Truthful vs deceptive) X 3 (Mnemonic type: CR vs sketch vs event-line) X 2 (Interview time: Immediate vs delayed) experimental design was used with Veracity and Mnemonic as between-subjects factors and Interview as within-subjects factor.

Participants were randomly assigned as truth tellers ($n = 70$) and liars ($n = 73$). Truth tellers were randomly allocated to the CR ($n = 24$), sketch ($n = 23$), or event-line conditions ($n = 23$). Similarly, liars were randomly assigned to one of the three mnemonic conditions (CR, $n = 23$; sketch, $n = 26$; and event-line, $n = 24$). All participants were interviewed on two occasions, immediately after the stimulus event and (approximately) two weeks later. Not all participants were available to be interviewed again after exactly 14 days and so the delay period for the second interview varied between 8 and 21 days ($M = 14.10$, $SD = 1.46$, $Mode = 14$ (61.5% of cases)).

Materials

Stimulus event. Participants were instructed to watch a video about a simulated break-in. They were instructed to imagine they were taking the role of an intelligence officer working undercover with another officer. They were told their task was to break into an apartment and secure some important intelligence information. This ‘special task’ was recorded from the perspective of the person (e.g. participant) who followed the other ‘officer’ throughout the break-in. Participants were explicitly instructed that they were ‘following their colleague’ during the break-in.

The video event (lasting five minutes) shows a man entering a basement floor from the outside of the building. He then walks about ten metres through a corridor and tries to break

into one of the doors at the end of the corridor. After a couple of attempts to open the door with a key, he walks into the room. The man in the video searches the room (desks, shelves, cupboards, clothes, etc.). He takes two mobile phones from a desk, jewellery (necklace and two rings) from a cupboard, a laptop from a dining table, and a driving licence, debit card, 35 euros and 20 dollars in cash from a wallet in a jacket. He then leaves the room with these items. As the man walks back along the corridor on his way out, a neighbour opens a door, witnesses him leaving, and immediately closes the door. The man who broke in stops and briefly looks around by the building exit. Finally, he leaves.

Mnemonics. Three different memory-enhancing techniques used in this study are explained below.

CR. This mnemonic consisted of asking interviewees to mentally recreate the to-be-recalled event, as well as their physiological, cognitive and emotional states at the time of the event (Fisher & Geiselman, 1992). In our study we instructed participants to (mentally) go back to the very start of the break-in, take a few moments to picture in their mind where they were, who they were with and what they could see during the event including the descriptions of objects, locations, and the sequence of actions. Participants were asked to give themselves plenty of time to concentrate and visualise what happened during the break-in. Also, they were requested to shut their eyes while trying to remember the event.

Sketch. Interviewees were asked to sketch the event and then use that drawing to describe what they had experienced. Sketching the crime scene allows witnesses to initiate their own contextual retrieval cues (Paulo, Albuquerque, & Bull, 2013)¹. The participants made their drawing on an A3 sized blank sheet of paper. They were requested to use as much

¹ It is important to clarify the use of the term 'Sketch' in this paper. In the literature on the investigative interviewing this mnemonic is also known as 'Sketch Reinstatement of Context'. However, in some sources the term 'Sketch' can also be found, e.g., Hope et al., 2011; Rivard et al., 2014. In the deception literature, the term 'Sketch' (or 'Drawing') is more common (e.g., Hjelmsater et al., 2014; Mac Giolla et al., 2017; Vrij et al., 2010). Therefore, we decided to use the latter.

space as they needed to sketch the apartment as they remembered it. Participants were instructed to include as many details as possible about where different objects were in relation to other objects. They could also use labels and notes within their sketch to indicate the features of the scene or to indicate if they were not certain of something. After making the sketch, participants were asked to describe in as much detail as possible what they had witnessed during the break-in.

Event-line. In this study participants were instructed to write on an A3 sized sheet of paper with a graphical line (a grid divided into minutes) all actions from the event they could remember and to indicate on that line at what time these actions occurred. The grid was divided into six scale points (from 0 minutes to 5 minutes) because the actual break-in lasted 5 minutes and 15 seconds. The grid was located on the top of the page allowing enough space for participants to write underneath it. Participants were asked to write in the empty space and then put arrows on the event-line indicating the time of the specific activities. After completing the event-line, participants were instructed to describe the event-line in as much detail as possible.

Procedure

Pre-interview phase. After watching the break-in, each participant was instructed either to tell the truth or to lie during the interview. Truth tellers and liars were given almost identical instructions. To minimise the risk of liars telling an embedded lie (for example by describing the apartment they genuinely lived in), all interviewees were told that the apartment they broke in to was a staff room of a community centre. Truth tellers were told that the break-in was successful and that they would be interviewed by a fellow agent to continue the intelligence investigation. They were asked to report truthfully during the interview 1) the interior of the staff room in the video, and 2) what they took from there. Liars were also told that the break-in was successful. However, they were told that they would be

interviewed by an agent from a hostile organisation and that their task was, therefore, to mislead that agent. They were told that if the hostile agent came to know where exactly they broke in and exactly what was taken from the apartment, the entire investigation would be in jeopardy. They were instructed to tell the hostile agent a cover story that they broke into a different staff room in a different community centre. Therefore, liars were instructed to lie about 1) the interior of the apartment in the video, and 2) what they took from there. To motivate all participants to do well in the interviews they were told that they would receive two course credits or £10, and would only be entered in the draw to win £150 value prize if they were convincing during the interview. They were further told that if the interviewer thought that they did not report everything they remembered, they would only receive one course credit or £5, would be excluded from the draw, and would be asked to write down a full account of what happened in the video.

After the instructions to tell the truth or lie, participants were given unlimited time to prepare for the interview. They were given a blank sheet of paper and pen in case they needed to use whilst their preparation. However, they were not allowed to take any notes they made to the actual interview afterwards. When participants indicated that they had prepared themselves, they were given a pre-interview questionnaire in which both truth tellers and liars were requested to answer the questions truthfully. In the questionnaire participants were asked to rate on 7-point scales their preparation for the interview. They were asked to indicate how i) well they were prepared (1 = *very poor*, 7 = *very good*); and how ii) sufficient (1 = *insufficient*, 7 = *sufficient*); and iii) complete (1 = *incomplete*, 7 = *complete*) their preparation was. We clustered these three preparation items into one variable, Preparation quality, since Cronbach's alpha (.86) indicated high consistency. The pre-interview questionnaire also included questions on how iv) stressed (1 = *not at all*, 7 = *very stressed*); v) motivated (1 = *not at all*, 7 = *totally*), and vi) confident (1 = *not at all*, 7 = *totally*) the participants felt about

being convincing in the upcoming interview. This pre-interview questionnaire was administered twice, both before the immediate and delayed interviews. Cronbach's alpha for the preparation quality cluster was .86 for the delay interview.

Interviews. Participants were questioned by an interviewer who was blind to the aims of the study, stimulus material, and veracity conditions. At the beginning of the immediate interview, participants in all experimental conditions were given the same free recall (FR) instruction. They were asked to report everything they could remember from the break-in, including descriptions of objects and locations, the sequences of actions, and information about any people that were involved. After completion of this initial report, one of the three mnemonics (CR, sketch or event-line) was administered. Then participants were asked for a second report, i.e. to verbally reinstate the context, describe the sketch, or describe the event-line.

After the immediate interview all participants were told that they would have to come back again in two weeks' time. At the beginning of this delayed interview, the same procedure was used as in the immediate interview (instruction to tell the truth/lie, preparation, and pre-interview questionnaire). Participants were then asked to provide a free recall account about the break-in.

Our aim was that the same interviewer would conduct both interviews to avoid the risk of an interviewer influencing an interviewee's accounts. However, some participants were interviewed by different interviewers due to time management issues (e.g. availability of participants, research assistants or interviewers). The majority of participants (81.1%) were interviewed both times by the same interviewer and two interviewers conducted the majority of the interviews (72.0%). **To test possible random interviewer effects, we compared total details of the delayed accounts between participants who were questioned by the same interviewer during both interviews with participants who were questioned by the**

different interviewer during the delayed interview. The difference was not significant, $t(141) = 0.83, p = .408, d = .19$.

To achieve that interviewees followed identical instructions during pre-interview and interview phases, scripts were prepared that were required to use in every interview by the research assistants and interviewers.

Post-interview questionnaire. After the delayed interview, participants were asked to fill out a post-interview questionnaire. As with the pre-interview questionnaire, truth tellers and liars were requested to respond truthfully. The post-interview questionnaire included questions to assess (again, on 7-point Likert scales) what they thought the likelihood was of getting two credits or £10 and having to write a statement (1 = *not at all*, 7 = *very likely*). In addition, as previous research has shown that active repetition of learned information can buffer against memory decline, we asked participants in an open-ended question how many times they had tried to remember the break-in (truth tellers)/cover story (liars) in the time between the two interviews. Lastly, we asked participants to assess the extent to which they i) told the truth, and ii) lied during the interview. Answers were given on an 11-point Likert scale ranging from 0% (*not at all*) to 100% (*totally*). These two questions were asked twice to assess the truthfulness in both the immediate and delayed interviews.

After completing the questionnaire, participants were thanked and fully debriefed. All participants were paid £10 or given two credits for participation. After completing data collection, one participant was randomly selected as the £150 prize winner.

Coding

RM details. Interviews were transcribed verbatim. All statements were coded for the details provided by interviewees. Details were counted separately for responses to: 1) free recall (FR); 2) one of three mnemonics in the immediate interviews; and 3) FR in the delayed interviews. Each detail was counted once per question response. For example, if the word

'*table*' was mentioned twice during the FR in the immediate interview (and had the meaning of the same '*table*'), it was counted only once. However, if the same detail was mentioned in the different parts of the interview or different interviews, it was counted separately. Four types of detail were coded: i) visual details: specific items/description of items seen by the interviewee. For example, '*He*¹ walked through a *double*² *brown*³ *door*⁴' contains four visual details; ii) spatial details: information about locations or spatial arrangements of people or objects. For example, 'There were two doors on *either side*¹ of the corridor and one door *in front*², and I was walking *behind* my colleague³' contains three spatial details; iii) temporal details: reference to the sequence of activities, their duration, or information when something happened: '*When*¹ we got there, it took us *about a minute*² to open the door, *then*³ we *quickly*⁴ searched the room' contains four temporal details; and iv) action details: information about the actions carried out by people in the event: 'He *picked up*¹ a laptop, we then *walked over*² to the entrance door and *left*³ through that door' contains three action details. This coding system is based on the Reality Monitoring approach (Johnson & Raye, 1981) and has been used frequently in previous deception research (Vrij, 2008).

Two coders carried out the coding. Both coders were trained by a senior member in the research lab. They received definitions and examples of the to-be-coded variables and were asked to code some practice statements. The trainer gave feedback on the coding and gave the coders a few more practice statements. The coders were given permission to start coding the interviews when the trainer was satisfied with their coding of the practice statements.

The first coder, the first author of this study, marked all transcripts. The second coder, blind to the hypotheses, stimulus event, and veracity of the statements, marked a random sample of 29 interview scripts (20.28%) to measure reliability. Inter-rater reliabilities between the two coders for the frequency of detail in both (immediate and delayed) statements were

measured via interclass correlation coefficients (ICC). The ICC revealed excellent inter-rater values: .99, CI [.98,.99] for visual details; .98, CI [.88,.99] for spatial details; .92, CI [.82,.96] for temporal details; and .97, CI [.84,.98] for action details.

Between-statement consistency. We measured consistency in the responses between the immediate FR and delayed FR. The RM details coded previously were used for consistency analysis. This time we did not split details into visual, spatial, temporal, and action details, but only examined the total amount of RM details. We made a distinction between repetitions (details reported in both immediate and delayed FR), reminiscences (details reported in the delayed FR but not in the immediate FR), and omissions (details reported in the immediate FR but not in the delayed FR). These measures are typically used in deception studies analysing consistencies, as contradictions (the fourth aspect of consistency) do not occur often enough in most experimental deception research to be used in the statistical analyses (e.g. Granhag & Strömwall, 2002; Granhag et al., 2016; Deeb et al., 2017).

The coders only marked reminiscences. Repetitions and omissions were obtained by using arithmetic calculations. We coded details as reminiscent in the delayed interview if they were not present in the FR of the immediate interview. Repetitions were computed by deducting reminiscences from the total amount of details in the delayed interview and omissions were calculated by deducting repetitions from the total amount of details in the immediate FR.

The same two coders who marked the RM details were used for the consistency coding. The consistency training they received followed a similar format as the training they received for the RM details. Again, the first coder marked all transcripts and the second coder marked 20.28% of the interviews. We examined inter-rater reliability for reminiscences only because that was the only measure coded manually. The analysis revealed moderate ICC of .71, CI [.36,.86] reminiscences in the delayed vs. immediate FRs.

Results

Manipulation checks

Insert Table 1 about here

Mixed ANOVAs with Interview as the within-subject factor and Veracity as the between-subjects factor were used for all the manipulation checks. Table 1 shows mean scores, standard deviations and confidence intervals for truth tellers and liars to the pre- and post- questionnaires.

The Veracity main effect was significant for Stress (liars felt more stressed than truth tellers, $F(1, 138) = 6.47, p = .012, d = 0.43$), Confidence to convince the interviewer (truth tellers felt more confident than liars in their ability to convince the interviewer that they were telling the truth, $F(1, 136) = 28.13, p < .001, d = 0.90$), and How many times they thought about the event/story before the second interview (liars thought more often about the event than truth tellers, $F(1, 140) = 3.92, p = .02, d = 0.40$)¹. These results reflected the theoretical assumption of deception that lying is more mentally taxing task than truth telling (Vrij, 2015). The Veracity main effect was also significant for Extent of truthfulness (truth tellers were more truthful than liars during both the immediate, $F(1, 139) = 89.05, p = .01, d = 6.29$ and delayed interviews, $F(1, 139) = 65.54, p = .01, d = 5.98$), indicating that participants followed the instructions. All other Veracity main effects were not significant, all F 's < 9.14 , all p 's $> .165$, see Table 1.

Main effects for Interview emerged for Motivation, $F(1, 137) = 4.39, p = .038, d = 0.16$. Participants were slightly more motivated before the immediate interview ($M = 6.15, SD = 0.81, 95\% CI [5.96, 6.35]$) than before the delayed interview ($M = 6.01, SD = 0.93, 95\% CI [5.82, 6.19]$). However, the means showed that participants were highly motivated before both interviews as their scores were at the upper end of the motivation scale. The Interview main effect was significant for: Preparation quality, $F(1, 126) = 13.12, p < .001, d = 0.32$;

Participants rated their preparation level higher before the immediate interview ($M = 5.27$, $SD = 0.98$, 95% CI [5.10,5.44]) than before the delayed interview ($M = 4.96$, $SD = 0.93$, 95% CI [4.77,5.15]); Preparation time, $F(1, 132) = 21.59$, $p < .001$, $d = 0.40$. Participants used more preparation time before the immediate interview ($M = 258.34$, $SD = 157.85$, 95% CI [231.28,285.39]) than before the delayed interview ($M = 196.81$, $SD = 148.50$, 95% CI [171.56,222.06]); and Stress, $F(1, 138) = 6.48$, $p = .012$, $d = 0.19$. Participants felt more stressed before the immediate interview ($M = 3.74$, $SD = 1.59$, 95% CI [3.48,4.00]) than before the delayed interview ($M = 3.44$, $SD = 1.56$, 95% CI [3.18, 3.70]). The Interview main effect for Confidence was not significant, $F(1, 136) = 0.03$, $p = .869$, $d = 0.02$. Interview effects on quality of preparation, time for preparation, and stress level were probably found because participants were less familiar with the settings before the immediate interview than before the delayed interview.

Significant Veracity x Interview interaction effects emerged for Preparation time, $F(1, 132) = 4.33$, $p = .039$, $\eta_p^2 = .03$. However, simple effect ANOVAs revealed no differences between truth tellers and liars in the immediate, $F(1, 132) = 0.34$, $p = .576$, $d = 0.10$, and delayed interviews, $F(1, 132) = 2.43$, $p = .122$, $d = 0.27$. All other Veracity x Interview interaction effects were not significant, all F 's < 3.93 , $p > .050$.

A oneway ANOVA with Incentive as dependent variable revealed a significant main effect for Veracity. Truth-tellers were more convinced than liars that they would receive the full incentive of £10/2 credits, $F(1, 140) = 17.49$, $p < .001$, $d = 0.70$, see Table 1. A oneway ANOVA with Likelihood to write a statement as dependent variable revealed no significant main effect for Veracity, $F(1, 140) = 1.92$, $p = .17$, $d = 0.23$, see Table 1. (In the two latter analyses Interview was not included as a factor as the question referred to the two interviews combined.)

In summary, the results showed that the manipulations in this study were successful.

Effects of Veracity, Mnemonic type and Interview time on the RM details

To examine whether the amount of information changed between the immediate and delayed interviews, a mixed ANOVA was carried out with Veracity (Truth tellers vs. Liars) and Mnemonic (FR in the CR vs. Sketch vs. Event-line) as the between-subjects factors and Interview (Immediate vs. Delayed) as the within-subject factor. With visual details as dependent variable a significant main effect emerged of Veracity, $F(1, 137) = 22.54, p < .001, d = 0.79$. Truth tellers ($M = 103.09, SD = 35.04, 95\% \text{ CI } [95.38, 110.74]$) reported more visual details than liars ($M = 74.40, SD = 37.34, 95\% \text{ CI } [66.73, 83.98]$). The main effect of Interview was also significant, $F(1, 137) = 14.12, p < .001, d = 0.18$. Interviewees reported more visual details immediately after watching the video ($M = 60.74, SD = 26.90, 95\% \text{ CI } [56.55, 64.93]$) than after a two-week delay ($M = 55.98, SD = 27.17, 95\% \text{ CI } [51.73, 60.22]$). The Mnemonic main effect was not significant, $F(2, 137) = 0.46, p = .633, \eta_p^2 = .01$, neither were the Veracity x Interview, $F(1, 137) = 0.06, p = .633, \eta_p^2 = .01$, Mnemonic x Interview, $F(2, 137) = 0.30, p = .744, \eta_p^2 = .004$, and Veracity x Mnemonic x Interview, $F(2, 137) = 0.71, p = .495, \eta_p^2 = .01$, interaction effects.

A mixed ANOVA with Veracity and Mnemonic as between-subjects factors and Interview as within-subject factor and spatial detail as the dependent variable revealed a significant main effect for Veracity, $F(1, 137) = 49.07, p < .001, d = 1.17$. Truth tellers ($M = 56.42, SD = 23.71, 95\% \text{ CI } [51.23, 62.14]$) reported more spatial details than liars ($M = 32.16, SD = 17.45, 95\% \text{ CI } [28.43, 36.27]$). The main effects for Mnemonic, $F(2, 137) = 1.34, p = .265, \eta_p^2 = .02$, Interview, $F(1, 137) = 0.23, p = .636, d = 0.02$, and the Veracity x Interview, $F(1, 137) = 0.03, p = .858, \eta_p^2 = .00$, Mnemonic x Interview, $F(2, 137) = 0.70, p = .500, \eta_p^2 = .004$, and Veracity x Mnemonic x Interview, $F(2, 137) = 1.12, p = .329, \eta_p^2 = .02$, interaction effects were all not significant.

The same mixed ANOVA with temporal details as dependent variable revealed a significant main effect for Veracity, $F(1, 137) = 82.78, p < .001, d = 1.56$. Truth tellers reported more temporal details ($M = 26.59, SD = 12.09, 95\% \text{ CI } [23.69, 29.58]$) than liars ($M = 10.99, SD = 7.42, 95\% \text{ CI } [9.33, 12.63]$). The Mnemonic main effect was not significant, $F(2, 137) = 0.33, p = .721, \eta_p^2 = .01$. The Veracity x Interview interaction effect was significant, $F(1, 137) = 7.76, p = .006, \eta_p^2 = .05$. Truth tellers reported more temporal details in the immediate interview ($M = 18.32, SD = 8.61, 95\% \text{ CI } [16.71, 19.94]$) than in the delayed interview ($M = 16.58, SD = 8.10, 95\% \text{ CI } [14.89, 18.27]$), $F(1, 141) = 8.83, p = .003, d = 0.21$, whereas for liars the amount of temporal information reported did not differ between the immediate ($M = 7.19, SD = 4.86, 95\% \text{ CI } [5.61, 8.78]$) and delayed interviews ($M = 7.73, SD = 6.32, 95\% \text{ CI } [6.07, 9.39]$), $F(1, 141) = 0.85, p = .358, d = 0.10$. There was also a significant Mnemonic x Interview interaction effect, $F(2, 137) = 3.79, p = .025, \eta_p^2 = .05$. Interviewees reported more temporal details in the immediate ($M = 12.77, SD = 8.22, 95\% \text{ CI } [10.68, 14.63]$) than in the delayed interview ($M = 11.07, SD = 7.25, 95\% \text{ CI } [9.01, 13.13]$) in the CR condition, $F(1, 140) = 4.98, p = .027, d = 0.22$, whereas the difference in the sketch condition between the immediate ($M = 13.53, SD = 10.54, 95\% \text{ CI } [11.59, 15.47]$) and delayed interview ($M = 12.33, SD = 9.66, 95\% \text{ CI } [10.31, 14.36]$), $F(1, 140) = 2.50, p = .116, d = 0.12$, and in the event-line condition between the immediate ($M = 12.08, SD = 7.80, 95\% \text{ CI } [10.11, 14.06]$) and delayed interview ($M = 13.07, SD = 8.39, 95\% \text{ CI } [11.00, 15.13]$), $F(1, 140) = 1.90, p = .170, d = 0.12$, were not significant. The Veracity x Mnemonic x Interview interaction effect was not significant, $F(2, 137) = 0.09, p = .914, \eta_p^2 = .001$.

A mixed ANOVA with Veracity and Mnemonic as between-subjects factors and Interview as within-subject factor and action details as dependent variable revealed a significant main effect for Veracity, $F(1, 137) = 79.09, p < .001, d = 1.48$. Truth tellers reported more action information ($M = 37.30, SD = 14.59, 95\% \text{ CI } [34.33, 40.26]$) than liars

($M = 18.63$, $SD = 10.16$, 95% CI [15.73, 21.54]). Interview main effect was also significant, $F(1, 137) = 10.78$, $p = .001$, $d = 0.15$. Participants reported more action details in the immediate ($M = 28.93$, $SD = 16.16$, 95% CI [26.29, 31.56]) than in the delayed interview ($M = 26.55$, $SD = 16.23$, 95% CI [23.89, 29.24]). The Mnemonic x Interview interaction effect was also significant, $F(2, 137) = 3.21$, $p = .043$, $\eta_p^2 = .05$. In the sketch condition, interviewees reported more action details in the immediate interview ($M = 31.06$, $SD = 18.88$, 95% CI [28.18, 35.41]) than in the delayed interview ($M = 26.41$, $SD = 18.95$, 95% CI [23.21, 30.98]), ($F(1, 140) = 14.33$, $p < .001$, $d = 0.25$, whereas no differences emerged between the interviews in the CR, $F(1, 140) = 2.93$, $p = .089$, $d = 0.15$, and event-line, $F(1, 140) = 0.04$, $p = .852$, $d = 0.02$, conditions. The Veracity x Interview, $F(2, 137) = 2.69$, $p = .103$, $\eta_p^2 = .02$ and Veracity x Mnemonic x Interview interaction effects, $F(2, 137) = 0.12$, $p = .885$, $\eta_p^2 = .002$, were not significant.

Hypotheses testing

Amount of details in the CR mnemonic

In Hypotheses 1 to 3 we predicted that in the delayed interview specific differences between truth tellers and liars would emerge as a function of mnemonic. Table 2 shows the results. As predicted in Hypothesis 1, truth tellers reported more visual, spatial, temporal, and action details than liars in the CR condition after a delay. All effect sizes were substantial (from 0.58 to 1.19).

Insert Table 2 about here

Insert Table 3 about here

In the CR condition, truth tellers reported significantly fewer temporal details in the delayed than in the immediate FR, $F(1, 137) = 8.32$, $p = .005$, $d = 0.38$ (for means, standard deviations and confidence intervals, see Tables 2 and 3). For truth tellers, no significant

differences emerged between the immediate and delayed interview for visual, $F(1, 137) = 2.49, p = .117, d = 0.19$, spatial, $F(1, 137) = 0.43, p = .515, d = 0.09$, and action details, $F(1, 137) = 3.42, p = .066, d = 0.26$. Liars in the CR condition did not show a significant difference in reporting visual, $F(1, 137) = 1.90, p = .171, d = 0.13$, spatial, $F(1, 137) = 0.09, p = .228, d = 0.04$, temporal, $F(1, 137) = 0.09, p = .765, d = 0.06$, or action details, $F(1, 137) = 3.42, p = .066, d = 0.09$ between the immediate and delayed interviews. These results partially support Hypothesis 1, in which it was predicted that in the CR condition neither truth tellers nor liars would produce a memory decline in reporting detail after a delay.

Amount of details in the sketch mnemonic

Truth tellers reported significantly more visual, spatial, temporal, and action details in the sketch condition, which was not predicted in Hypothesis 2. All effect sizes were substantial (from 0.73 to 1.76), see Table 2.

In the sketch condition, truth tellers reported the same amount of visual, $F(1, 137) = 0.17, p = .680, d = 0.04$, and spatial details, $F(1, 137) = 0.01, p = .909, d = 0.01$ in the immediate and delayed interviews. However, truth tellers reported less temporal, $F(1, 137) = 5.72, p = .018, d = 0.27$, and action details, $F(1, 137) = 9.32, p = .003, d = 0.70$ in the delayed interview than in the immediate interview. Liars in the sketch condition reported less visual, $F(1, 137) = 4.08, p = .045, d = 0.23$ and action details, $F(1, 137) = 5.41, p = .022, d = 0.36$ in the delayed interview than in the immediate interview. Liars showed no difference in reporting spatial, $F(1, 137) = 1.47, p = .228, d = 0.19$, and temporal details, $F(1, 137) = 0.002, p = .968, d = 0.01$, between the immediate and delayed interviews. This provides support for Hypothesis 2 in which it was predicted that in the sketch condition truth tellers, but not liars, would show memory decline in temporal and action details after a delay.

Amount of details in the event-line mnemonic

Truth tellers reported significantly more visual, spatial, temporal, and action details in the event-line condition, which was not predicted in Hypothesis 3. All effect sizes were substantial (from 0.78 to 1.40), see Table 2.

In the event-line condition, truth tellers reported significantly less visual details, $F(1, 137) = 5.22, p = .024, d = 0.34$, in the delayed interview than in the immediate interview. Truth tellers showed no difference in reporting spatial, $F(1, 137) = 1.72, p = .024, d = 0.16$, temporal, $F(1, 137) = 0.01, p = .932, d = 0.01$, or action details, $F(1, 137) = 1.14, p = .288, d = 0.13$ between the immediate and delayed interviews. Liars showed no difference in reporting visual, $F(1, 137) = 2.45, p = .120, d = 0.26$, spatial, $F(1, 137) = 0.25, p = .621, d = 0.08$, temporal, $F(1, 137) = 3.54, p = .062, d = 0.28$, or action details, $F(1, 137) = 0.61, p = .435, d = 0.17$ between the immediate and delayed interview. These results partially support Hypothesis 3, in which it was predicted that in the event-line condition, truth tellers, but not liars, would show a memory decline in visual and spatial details after a delay.

We made a closer observation of the patterns of total details reported by truth tellers and liars across conditions in the immediate and delayed FR phases. Our results revealed that liars showed flat tendency to report details irrespective of condition and time of the interview. However, there was more variability across truth tellers, see Figure 1.

Insert Figure 1 about here

Consistency between the immediate and delayed interviews

A 2 (Veracity) x 3 (Mnemonic) analysis of covariance was conducted with reminiscences as the dependent variable and Total detail at immediate FR as a covariate. The reason for including this covariate was that the number of reminiscences in the delayed interview depends on the amount of detail provided in the FR part of the immediate interview. That is, the more detail provided in the immediate FR, the less opportunity to add new detail in the delayed interview. Veracity, $F(1, 131) = 0.61, p = .437, d = .14$, and Mnemonic, $F(2,$

131) = 1.50, $p = .228$, $\eta_p^2 = .02$ main effects, or Veracity x Mnemonic interaction effect, $F(2, 131) = 0.95$, $p = .388$, $\eta_p^2 = .01$ were not significant. This showed no support for Hypothesis 4.

A 2 (Veracity) x 3 (Mnemonic) analysis of covariance with repetitions in the delayed interview as dependent variable and Total detail in the immediate FR as covariate did not result in significant main effects for Veracity, $F(1, 131) = 0.71$, $p = .680$, $d = .07$, and or Mnemonic, $F(2, 131) = 0.19$, $p = .831$, $\eta_p^2 = .003$. Although the Veracity x Mnemonic interaction effect was significant, $F(2, 131) = 4.28$, $p = .016$, $\eta_p^2 = .06$, simple effect analyses showed no significant differences. That is, in the CR condition, truth tellers provided a similar amount of repetitions ($M = 100.21$, $SD = 43.24$, 95% CI [85.60,117.29]) to liars ($M = 105.84$, $SD = 52.87$, 95% CI [87.73,122.38]), $F(1, 43) = 0.68$, $p = .415$, $d = 0.12$; in the sketch condition, truth tellers provided a similar amount of repetitions ($M = 106.27$, $SD = 62.36$, 95% CI [87.57,128.42]) to liars ($M = 91.64$, $SD = 32.27$, 95% CI [76.52,120.50]), $F(1, 45) = 4.05$, $p = .05$, $d = 0.29$; and in the event-line condition, truth tellers reported a similar amount of repetitions ($M = 111.26$, $SD = 43.74$, 95% CI [96.61,125.14]) to liars ($M = 117.29$, $SD = 41.20$, 95% CI [86.71,119.29]), $F(1, 43) = 1.11$, $p = .297$, $d = 0.14$.

As the number of omissions was derived from the number of total details minus number of repetitions, a 2 (Veracity) x 3 (Mnemonic) analysis of covariance with omissions as the dependent variable and Total detail at immediate FR as covariate resulted in identical effect sizes (not significant) as in the analysis of repetitions. Thus, Hypothesis 4 was not supported.

RM details in mnemonics

A 2 (Veracity) X 3 (Mnemonic) ANOVA with the number of visual details in the mnemonic part of the immediate interview as dependent variable revealed a significant main

effect for Mnemonic, $F(2, 137) = 6.88, p = .001, \eta_p^2 = .09$. Tukey post-hoc tests showed that interviewees reported significantly more visual details in the sketch condition ($M = 52.63, SD = 28.46, 95\% \text{ CI } [45.86, 60.41]$) than in the CR condition ($M = 32.68, SD = 27.45, 95\% \text{ CI } [25.43, 41.90]$). Participants in the event-line condition ($M = 46.43, SD = 26.03, 95\% \text{ CI } [39.90, 53.79]$) also reported significantly more visual details than participants in the CR condition. There was no significant main effect for Veracity, $F(1, 137) = 2.25, p = .136, d = 0.22$, or a significant Veracity x Mnemonic interaction, $F(2, 137) = 1.96, p = .145, \eta_p^2 = .03$.

A 2 (Veracity) X 3 (Mnemonic) ANOVA with the number of spatial details in the mnemonic part of the immediate interview as dependent variable revealed a main effect for Veracity, $F(1, 137) = 9.59, p = .002, d = 0.45$. Truth tellers gave more spatial information ($M = 26.87, SD = 20.33, 95\% \text{ CI } [22.25, 31.80]$) than liars ($M = 19.00, SD = 14.04, 95\% \text{ CI } [15.97, 22.11]$). The Mnemonic main effect was also significant $F(2, 137) = 12.10, p < .001, \eta_p^2 = .15$. Post-hoc tests revealed that interviewees provided more spatial details in the sketch ($M = 28.67, SD = 16.07, 95\% \text{ CI } [24.39, 32.94]$) and event-line conditions ($M = 25.87, SD = 19.51, 95\% \text{ CI } [20.58, 31.91]$) than in the CR condition ($M = 13.77, SD = 14.02, 95\% \text{ CI } [10.38, 17.50]$). The Veracity x Mnemonic interaction effect was not significant, $F(2, 137) = 3.04, p = .051, \eta_p^2 = .04$.

A 2 (Veracity) X 3 (Mnemonic) ANOVA with the number of temporal details in the mnemonic part of the immediate interview as dependent variable revealed a significant main effect for Veracity, $F(1, 137) = 10.35, p = .002, d = 0.45$. Truth tellers reported more temporal details ($M = 10.96, SD = 11.07, 95\% \text{ CI } [8.16, 13.84]$) than liars ($M = 6.75, SD = 7.43, 95\% \text{ CI } [6.01, 8.84]$). In addition, the Mnemonic main effect was significant $F(2, 137) = 31.85, p < .001, \eta_p^2 = .32$. Post-hoc tests showed that more temporal details were reported in the event-line condition ($M = 16.21, SD = 9.80, 95\% \text{ CI } [13.29, 19.22]$) than in the CR ($M = 5.53, SD = 6.81, 95\% \text{ CI } [3.87, 7.38]$) and sketch conditions ($M = 4.86, SD = 7.44, 95\% \text{ CI } [3.87, 7.38]$).

[2.98,6.89]). The Veracity x Mnemonic interaction effect was not significant, $F(2, 137) = 2.76, p = .067, \eta_p^2 = .04$.

A 2 (Veracity) X 3 (Mnemonic) ANOVA with the number of action details as dependent variable revealed a significant main effect for Veracity, $F(1, 137) = 9.66, p = .002, d = 0.46$. Truth tellers mentioned more action details ($M = 21.63, SD = 21.45, 95\% CI [17.21,26.59]$) than liars ($M = 13.40, SD = 13.60, 95\% CI [10.33,16.77]$). The Mnemonic main effect was also significant, $F(2, 137) = 20.12, p < .001, \eta_p^2 = .23$. Post-hoc tests revealed that in the event-line ($M = 29.28, SD = 17.97, 95\% CI [24.31,34.50]$) condition, interviewees reported more information about actions than in the CR ($M = 12.77, SD = 17.01, 95\% CI [8.46,17.68]$) and sketch conditions ($M = 10.53, SD = 13.98, 95\% CI [7.04,14.55]$). The Veracity x Mnemonic interaction effect was not significant, $F(2, 137) = 2.21, p = .113, \eta_p^2 = .03$.

None of the interaction effects were significant. However, these interaction effects do not necessarily reflect the specific type of interaction we were interested in: Comparing the details between truth tellers and liars for the three mnemonic parts of the interview separately. In alignment with Nahari and Ben-Shakhar (2011) and previous deception literature (e.g. Deeb et al., 2017; Shaw et al., 2015) we believe that this justifies further examination of the data, specifically, examining the simple Veracity effects for the three mnemonic parts of the interview separately. The results are provided in Table 4.

Insert Table 4 about here

We found no significant differences between truth tellers and liars in reporting visual, spatial, temporal, and action details in the CR condition. In the Sketch condition, truth tellers reported more spatial and temporal details than liars. Other mean differences were not significant in this mnemonic group. In the event-line condition, truth tellers provided more visual, spatial, temporal, and action details than liars.

Discussion

This study examined how different mnemonic techniques employed in an immediate interview affected delayed statements. In the CR condition, truth tellers provided more visual, spatial, temporal and action details than liars after a delay. This finding was in line with Hypothesis 1. In addition, as predicted, liars did not show a decline in reporting details over time. Truth tellers, however, showed a decline in reporting temporal details over time, which was not expected, as it was thought that the CR mnemonic would ‘buffer’ the truth tellers against forgetting.

In line with Hypothesis 2, in the sketch condition truth tellers reported more visual and spatial details than liars in the delayed accounts. In addition, truth tellers, but not liars, showed a decline in reporting temporal and action details over time. There were two findings we did not predict. First, truth tellers also reported more temporal and action details than liars after a delay, suggesting that when the sketch technique was used, truth tellers provided richer reports in terms of all types of detail. Second, liars also showed a decline in reporting visual and action details. According to the ‘*repeat vs reconstruct hypothesis*’ (Granhag & Strömwall, 1999), liars show a tendency to repeat their stories when interviewed repeatedly. The findings suggest that liars experienced difficulties in mimicking natural memory retrieval that should be produced by truth tellers. A sketch facilitates retrieval of visual and spatial details. Liars did not consider that if the sketch facilitates retrieval of such details, their memories for these details should be less affected than for action and temporal details after a delay (the pattern shown by truth tellers in this study).

In the event-line condition, truth tellers again reported more visual, spatial, temporal, and action details than liars after a delay. As predicted in Hypothesis 3, truth tellers showed a decline in providing visual details, but the predicted decline in reporting spatial details did not occur. In support of Hypothesis 3, liars reported a similar amount of visual, spatial, temporal

and action details both immediately and after a delay. Again, truth tellers showed to some extent a natural decline of the details that were less prominent with the event-line technique (visual details), but liars did not consider that after a delay some details should be better remembered than others.

When considering the reporting patterns of truth tellers and liars across conditions, our study showed as a general tendency that truth tellers showed more of a decline in the amount of details reported compared to liars. The truth tellers' findings are in line with memory theory that highlights a reduction in recall of information over time because of weakened memory traces (Goldsmith et al., 2005; Penrod et al., 1982; Schacter, 1999). The liars' results provide evidence for a stability bias: Liars' failure to calibrate accurately their verbal output to take into account genuine decline in memory (Harvey et al., 2017).

With regard to consistency between the immediate and delayed statements, we found no differences in consistency between truth tellers and liars, and Hypothesis 4 was therefore rejected. In alignment with previous research (Granhag & Strömwall, 2002; Vredeveldt et al., 2016) but in contrast to the widely held stereotypical view (Bogaard et al., 2016), our study showed that truth tellers and liars can be equally consistent in their statements.

Although our study concentrated on comparisons between immediate and delayed accounts, we also reported comparisons between the initial and mnemonic parts of the immediate interview. In brief, we found that participants in the CR mnemonic performed the worst in eliciting additional detail, and the event-line mnemonic the best. Also in terms of the ability to discriminate between truth tellers and liars, the CR mnemonic was the least, and the event-line was the most effective mnemonic. Perhaps the event-line mnemonic was the most effective in eliciting information and in distinguishing between truth tellers and liars because the stimulus event (break-in) was dynamic. The entire 5 minute video was full of different

activities, and in such a situation the event-line technique might be very helpful for truth tellers in facilitating recall of actions and events, and their temporal order. Liars typically experience an information management dilemma (Granhag & Hartwig, 2008). They are typically motivated to report some information, but not too much. This dilemma might exist even when mnemonics are used in interviews.

The differences between truth tellers and liars were substantial (i.e. effect sizes were high) across all conditions. Our findings thus revealed that the ‘richness of detail’ verbal cue remains a diagnostic cue to deceit, even after longer delay periods. This is a novel finding compared with previous studies that showed that truth tellers’ and liars’ accounts became similar over time (Harvey et al., 2017; Vrij et al., 2009). The important difference between those studies and the current study is that in those studies participants were interviewed only once, either immediately or after the delay, whereas in the current study they were interviewed twice. Perhaps the immediate interview in truth tellers served as a buffer for forgetting in the delayed interview. The use of mnemonics in the immediate interview may have further strengthened this buffer effect.

The findings have important practical implications. First of all, they suggest that using mnemonic techniques during the first interview is helpful in terms of information gathering during subsequent interviews with the interviewee. Furthermore, using mnemonic techniques during the first interview can aid discriminating between truth tellers and liars in subsequent interviews.

Methodological considerations and future research

The main methodological consideration in our study might be that it did not contain a ‘no mnemonics’ control group, which makes it impossible to determine whether the mere presence of a mnemonic has influenced the delayed reports of truth tellers and liars. However, our main concern was to examine how different mnemonics would affect the reports of truth

tellers and liars over time. Further deception studies might profit from examining separate mnemonics (e.g. event-line) and compare them to the performance of a no mnemonics control group.

Research has shown that an immediate retrieval act tend to strengthen episodic memory and facilitate later retrieval (Bjork, 1988; Shaw, Bjork, & Handal, 1995; Roediger & Karpicke, 2006). Therefore, truth tellers in our study could maintain rich accounts after a delay due to immediate retrieval practice, but not as a result of specific mnemonic techniques per se. In further studies it would be valuable to examine truth tellers' and liars' performances when a first statement is not given immediately, but after some delay, and how mnemonic techniques then affect first and subsequent statements. In real-life cases this situation occurs frequently. Further studies could use scenarios with active involvement of participants, rather than passively watching a video as we did in this study. Using a video has a benefit of exerting complete experimental control with all participants witnessing exactly the same event. However, this benefit comes at the expense of ecological validity.

Conclusion

This study showed that when mnemonics were used during the immediate interview, the verbal cue 'richness of detail' remained a diagnostic cue to deceit even after a delay. In addition, truth tellers more often than liars showed a decline in reporting details after a delay. Truth tellers showed patterns of reporting indicative of genuine memory decay, whereas liars showed patterns of 'stability bias', a failure to accurately estimate memory decay (Harvey et al., 2017). Overall, the findings indicate that using mnemonic techniques such as the CR, using a sketch, or event-line in a first interview are promising tools to deception detection in subsequent interviews.

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Table 1

Means, standard deviations and confidence intervals for the answers to pre-interview and post-interview questionnaires

Measure	Truth			Lie		
	<i>M</i>	<i>SD</i>	<i>95% CI</i>	<i>M</i>	<i>SD</i>	<i>95% CI</i>
Motivation to convince the interviewer	6.15	0.81	5.94,6.35	6.00	0.78	5.82,6.20
Preparation quality	5.19	1.00	4.94,5.43	5.05	0.79	4.86,5.25
Preparation time (sec.)	233.68	129.20	203.34,265.37	221.49	135.59	190.26,254.52
Stress before the interview	3.29	1.47	2.94,3.69	3.89	1.30	3.58,4.19
Confidence to convince the interviewer	5.42	1.02	5.17,5.67	4.48	1.06	4.22,4.74
Likelihood to receive £10/2 credits	5.21	1.23	4.92,5.50	4.32	1.32	4.01,4.60
Likelihood to write a statement	3.51	1.69	3.12,3.90	3.86	1.24	3.55,4.15
Times thought about the event/story	2.23	1.27	1.96,2.51	2.85	1.75	2.44,3.27
Extent of truthfulness in the immediate interview	99.41	2.37	98.78,100.00	20.82	17.14	16.96,25.46
Extent of truthfulness in the delayed interview	98.53	4.32	97.41,99.55	20.82	17.93	16.53,25.37

Table 2

RM details in delayed FR as a function of veracity and mnemonic condition

Detail	Truth			Lie			<i>F</i>	<i>p</i>	<i>d</i>
	<i>M</i>	<i>SD</i>	95% CI	<i>M</i>	<i>SD</i>	95% CI			
CR									
Visual	62.58	25.21	52.23,72.94	47.09	28.26	36.51,57.66	4.29	.040	0.58
Spatial	31.83	13.82	25.73,37.93	21.22	14.89	14.99,27.45	5.80	.017	0.74
Temporal	14.83	7.19	11.95,17.72	7.30	5.06	4.36,10.25	13.03	<.001	1.21
Action	32.83	12.93	27.29,38.38	17.70	12.41	12.03,23.36	14.27	<.001	1.19
Sketch									
Visual	70.26	35.05	59.69,80.36	48.27	24.53	38.32,58.22	8.97	.003	0.73
Spatial	41.35	21.63	35.12,47.58	22.50	10.43	16.64,28.36	18.99	<.001	1.11
Temporal	18.78	8.87	15.84,21.73	5.89	5.36	3.11,8.66	39.72	<.001	1.76
Action	38.30	19.35	32.64,43.97	15.89	10.72	10.56,21.21	32.53	<.001	1.43
Event-line									
Visual	64.52	20.28	53.95,75.10	43.13	17.20	32.77,53.48	8.18	.005	1.14
Spatial	40.87	15.92	34.64,47.10	21.08	12.20	14.98,27.18	20.14	<.001	1.40
Temporal	16.13	8.04	13.18,19.08	10.00	7.73	7.11,12.89	8.64	.004	0.78
Action	35.44	14.08	23.77,41.10	20.54	11.67	15.00,26.09	13.81	<.001	1.15

Table 3

RM details in the immediate FR as a function of veracity and mnemonic condition

Detail	Truth			Lie			<i>F</i>	<i>p</i>	<i>d</i>
	<i>M</i>	<i>SD</i>	95% CI	<i>M</i>	<i>SD</i>	95% CI			
CR									
Visual	67.46	28.84	57.25,77.67	51.44	32.81	41.00,61.86	4.71	.032	0.52
Spatial	33.04	14.04	27.36,38.73	21.78	13.07	15.98,27.59	7.51	.007	0.83
Temporal	17.71	7.81	14.95,20.47	7.61	4.80	4.79,10.43	25.56	<.001	1.56
Action	36.08	12.21	30.93,41.23	18.70	9.38	13.43,23.96	21.81	<.001	1.60
Sketch									
Visual	71.57	23.57	61.14,82.00	54.27	27.46	44.46,64.08	5.71	.018	0.68
Spatial	41.13	18.49	35.36,46.94	20.35	11.75	14.89,25.81	26.59	<.001	1.34
Temporal	21.22	9.29	18.40,24.04	5.85	4.68	3.19,8.50	61.52	<.001	2.09
Action	43.78	17.93	38.52,49.04	19.81	10.98	14.86,24.76	43.08	<.001	1.61
Event-line									
Visual	71.74	22.00	61.31,82.17	47.96	19.96	37.75,58.17	10.38	.002	1.13
Spatial	38.39	14.54	32.59,44.20	22.00	11.87	16.32,27.68	15.92	<.001	1.23
Temporal	16.04	8.87	13.22,18.87	8.13	5.36	5.36,10.89	15.71	<.001	1.08
Action	37.35	14.75	32.09,42.61	19.17	9.48	14.02,24.32	23.84	<.001	1.47

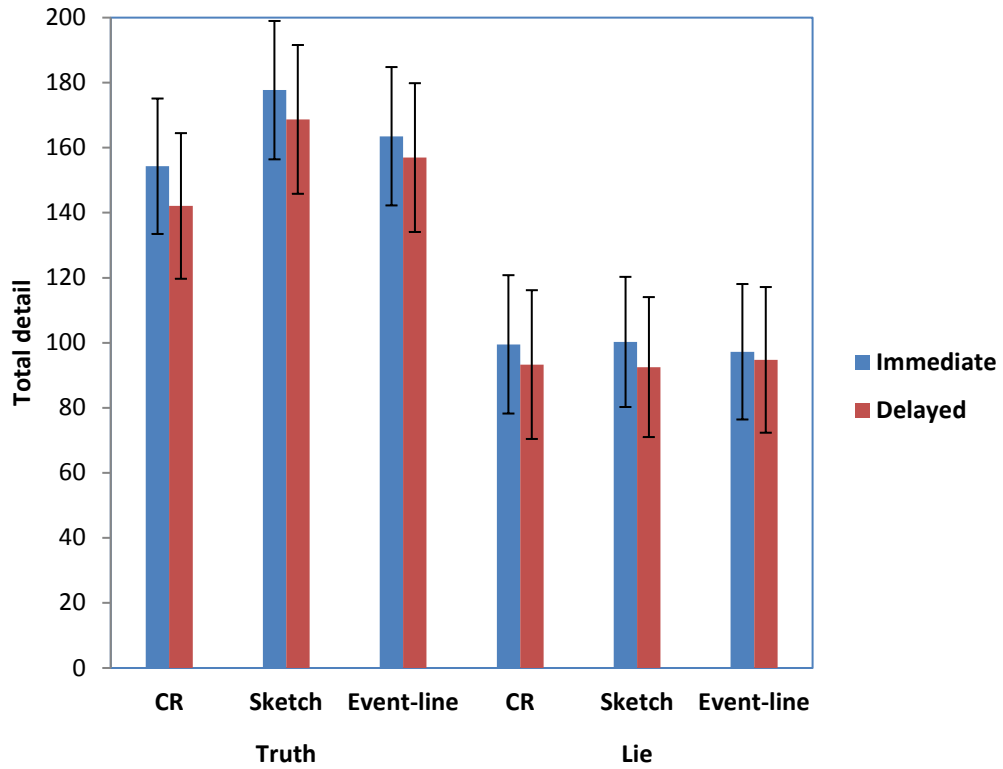


Figure 1. Total amount of details with confidence intervals in the immediate and delayed FRs across conditions.

Table 4

RM details in the different mnemonic conditions in the immediate interview

Detail	Truth			Lie			<i>F</i>	<i>p</i>	<i>d</i>
	<i>M</i>	<i>SD</i>	95% CI	<i>M</i>	<i>SD</i>	95% CI			
CR									
Visual	31.29	28.43	22.13,41.86	34.13	26.94	24.88,46.23	0.13	.720	0.10
Spatial	13.58	15.68	8.55,20.19	13.96	12.40	9.46,18.90	0.01	.936	0.03
Temporal	5.54	7.62	3.59,10.39	5.52	6.02	3.41,8.20	0.00	.993	0.002
Action	13.92	20.41	6.72,22.47	11.57	12.90	7.23,17.61	0.26	.610	0.14
Sketch									
Visual	54.96	24.46	44.90,65.87	50.58	31.93	40.66,62.55	0.32	.573	0.15
Spatial	30.70	15.47	27.35,40.33	24.27	15.54	19.99,29.62	4.29	.04	0.61
Temporal	7.61	8.88	4.05,11.31	2.42	4.88	1.04,4.13	5.45	.021	0.72
Action	14.00	14.26	8.35,19.82	7.46	13.24	3.48,12.82	2.10	.15	0.48
Event-line									
Visual	56.24	28.25	46.63,67.20	37.21	20.27	30.11,45.89	5.40	.018	0.77
Spatial	33.91	22.51	26.00,42.87	18.17	12.25	13.77,23.46	11.42	.001	0.87
Temporal	19.96	12.62	9.83,15.88	12.63	7.31	9.83,15.88	5.45	.021	0.68
Action	37.30	20.53	29.43,45.64	21.58	10.78	17.78,25.76	11.68	.001	0.96

¹ When this variable was introduced as a covariate in the analyses, there was no significant effect in the delayed statement on Total detail, $F(1, 138) = 1.09, p = .298, \eta_p^2 = .01$, Reminiscences, $F(1, 138) = 0.17, p = .684, \eta_p^2 = .001$, Repetitions, $F(1, 140) = 2.90, p = .091, \eta_p^2 = .02$, or Omissions, $F(1, 138) = 0.40, p = .526, \eta_p^2 = .003$.