Acta Psychologica 215 (2021) 103295

Contents lists available at ScienceDirect

Acta Psychologica

journal homepage: www.elsevier.com/locate/actpsy

# The role of executive functions in the effects of lying on memory

Fabiana Battista [a,b,*], Henry Otgaar [b,c], Ivan Mangiulli [b], Antonietta Curci [a]

[a] University of Bari "Aldo Moro", Bari, Italy
[b] Leuven Institute of Criminology, Catholic University of Leuven, Belgium
[c] Maastricht University, the Netherlands

ARTICLE INFO

*Keywords:*
Executive Functions
Fabrication
False denials
Memory outcomes

ABSTRACT

Recent studies have demonstrated that lying can affect memory and that such memory effects are based on the cognitive load required in performing the lie. The present study aimed to verify whether the impact of two deceptive strategies (i.e., false denials and fabrication) depends on individuals' cognitive resources in terms of Executive Functions (i.e., EF: Shifting, Inhibition, and Updating). A sample of 147 participants watched a video of a robbery and then were instructed to either fabricate (i.e., fabrication condition), deny (i.e. false denial condition), or tell the truth (i.e., truth-telling condition) to some questions about the crime. Two days later, all participants had to provide an honest account on a final memory test where they indicated their memory for having discussed details (i.e., fabricated, denied, or told the truth) and their memory for the video. Finally, their EF resources were also assessed. Our findings demonstrated that individual differences in EFs played a role in how the event was recalled and on the effects of lying on memory. That is, memory for the event after having lied depended especially on individuals' Shifting resources. We also found that the two deceptive strategies differentially affected individuals' memory for the interview and for the event: Denying affected memory for the interview while fabricating affected memory for the event. Our findings can inform legal professionals on the possibility to assess individuals' EF as an indicator of witnesses' credibility.

## 1. Introduction

One of the most important issues for legal professionals is recognizing when a suspect, eyewitness or victim reports a true or false statement. A plethora of studies have been conducted to gain knowledge about how to detect lies and which factors can interfere in lie detection (e.g., Duran et al., 2020; Verigin, Meijer, Bogaard, & Vrij, 2019; Verigin, Meijer, Vrij, & Zauzig, 2019; Vrij et al., 2010; Vrij et al., 2008). However, another relevant concern for understanding the statements' reliability (i.e., whether statements refer to truthful information) is the impact that lying may have on the deceiver's memory. Indeed, a series of studies have demonstrated that lying can affect the memory of the person who lied (e.g., Ackil & Zaragoza, 2011; Battista et al., 2020; Chrobak & Zaragoza, 2008; Gombos et al., 2012; Mangiulli et al., 2018; Otgaar et al., 2016; Paige et al., 2020; Pickel, 2004; Polage, 2018; Romeo et al., 2018; Vieira & Lane, 2013). That is, when in a first moment a person lies and in a subsequent moment decides to come forward with the truth, it could be the case that the person's memory is affected because of the exerted lie.

Research has shown that lying affects memory in various ways depending on how the person withholds the truth (see for a review Otgaar & Baker, 2018). Indeed, in many legal cases, different deceptive strategies can be used. People can simply choose to deny having experienced an event (i.e., false denial strategy) (Block et al., 2012; Goodman-Brown et al., 2003), or decide to simulate memory loss (i.e., feigned amnesia strategy) (Cima et al., 2002; Pyszora et al., 2003) or come up with a false account of the event (i.e., fabrication strategy) (Chrobak & Zaragoza, 2008; Pickel, 2004). Interestingly, each of these three deceptive strategies has an adverse and unique impact on memory. Specifically, studies on false denials have shown that this strategy might lead to forget having discussed (i.e., denied) event-related details and, in specific situations, to an impairment of the memory for the original event (e.g., Davis et al., 2018; Otgaar et al., 2016; Polage, 2018; Romeo et al., 2018; Romeo et al., 2019; Vieira & Lane, 2013). Concerning the memory effects of feigning amnesia, studies have similarly demonstrated an impairment on event recall (Bylin, 2002; Bylin & Christianson, 2002; Christianson & Bylin, 1999; Mangiulli et al., 2018; Sun et al., 2009; van Oorsouw & Merckelbach, 2004, 2006). Finally, studies on fabrication have shown that such a strategy consolidates memory for self-generated details, causing an individual's memory impairment for

* Corresponding author at: University of Bari "Aldo Moro", Bari, Italy.
*E-mail addresses:* fabiana.battista@kuleuven.be, fabiana.battista@uniba.it (F. Battista).

https://doi.org/10.1016/j.actpsy.2021.103295
Received 27 July 2020; Received in revised form 17 February 2021; Accepted 1 March 2021
Available online 19 March 2021

the actual event in terms of increased commission errors (Ackil & Zaragoza, 2011; Chrobak & Zaragoza, 2008; Nourkova et al., 2004; Van Oorsouw & Giesbrecht, 2008).

Based on the largely shared idea that the act of lying requires a higher cognitive load than telling the truth (e.g., Christ et al., 2009; Vrij & Ganis, 2014; Walczyk et al., 2014), Otgaar and Baker (2018), in their theoretical framework called the Memory and Deception (MAD) model, argued that the different effects of false denials, feigned amnesia and fabrication are related to the amount of cognitive resources entangled during the lie (Battista et al., 2021; Battista et al., *under review*). However, no studies have investigated whether the impact of lying on memory also depends on the individual's cognitive resources availability, like for instance executive functioning resources. Thus, the present experiment has been set up in order to examine that critical issue. Understanding the role of individual differences in determining recall accuracy following lying is crucial to help forensic professionals (e.g., policemen, judges, prosecutors, lawyers, legal psychologists) in their practice when witness' accounts are to be evaluated as to their reliability.

### 1.1. The effects of denial on memory

Research on the effects of (false) denials on memory have shown that such a strategy has a singular effect known as *denial-induced forgetting* (DIF; Otgaar et al., 2014). Denying an event or specific details of an event impairs memory for the discussion (i.e., denials) rather than it leads to an impairment for the original memory for the event (e.g., Otgaar et al., 2016; Otgaar et al., 2018; Vieira & Lane, 2013). The work on false denials has mainly examined this mnemonic effect by instructing participants to deny that an event really occurred (e.g., "*I did not steal anything*"). In one of the first studies on this topic, Vieira and Lane (2013) showed pictures (e.g., apple) to participants. Then, participants were randomly instructed to truthfully describe or falsely deny having seen the studied and unstudied pictures. After two days of delay, all participants completed a source monitoring task where their memory performance was measured for having studied a picture and for having talked (i.e., truthfully described or denied) about such specific pictures. Interestingly, participants had more difficulty in remembering whether they studied the pictures when they falsely denied them than when they truthfully discussed them.

Further evidence on the detrimental effect of false denials on memory was found by a recent line of studies (e.g., Otgaar et al., 2014; Otgaar et al., 2016; Otgaar et al., 2018; Romeo et al., 2018; Romeo et al., 2019). These studies have demonstrated that memory impairment is related to memory for having denied details of the event and not for the memory for the event. The typical procedure adopted by Otgaar and colleagues (e.g., Otgaar et al., 2014; Otgaar et al., 2016; Romeo et al., 2018) requires participants to view an event (e.g., video of a theft) and after that, to deny or tell the truth about all details of the event. Following a delay, both groups of participants are involved in a source monitoring task during which they honestly answer some questions on memory for the event and memory for having discussed (i.e., denied or honestly answered) specific details of the event in the first session. These studies have found what is called the *denial-induced forgetting* effect (Otgaar et al., 2014), meaning that deniers typically have more forgetting for memory for the interview than truth-tellers.

Although the DIF effect has been replicated in several studies by using different stimuli (e.g., pictures, virtual reality scenes), tasks (e.g., recall memory task), and populations (e.g., children), few studies have also demonstrated an undermining effect of denials on memory for the original event (e.g., Romeo et al., 2018). In particular, Romeo et al. (2018) showed that denials may affect memory for the event by adapting the classical procedure in a more ecological one (i.e., more realistic stimuli using virtual reality scenes of an airplane crash). Findings demonstrated that deniers reported a memory impairment for the original experience than participants that had never denied. The authors stated that forgetting for the initial event might be related to the emotional and the active involvement required by such a more realistic procedure (Romeo et al., 2018). Indeed, it could be the case that such an involvement required additional cognitive resources during the lie than usual, thus impacting the individual's memory for the event.

### 1.2. The effects of fabrication on memory

Studies on the impact of fabrication on memory have demonstrated that such a deceptive strategy affects memory for the event. This memory undermining effect has been typically investigated through the *forced confabulation paradigm* (e.g., Ackil & Zaragoza, 1998, 2011; Zaragoza et al., 2001). In this paradigm, participants watch a video and then answer some questions on it. During this phase, a group of participants is instructed to answer questions based on their actual memory and a second group is requested to fabricate both details presented and not presented in the video. After a delay of one week, a source monitoring task is administered to participants in order to test their memory for having discussed details in the first session and memory for having seen details in the video. By using this paradigm, many studies have demonstrated that fabrication makes people more likely to recognize their own fabrications as actual details of the event. Hence, fabricators are more prone to report commission errors (i.e., distortions or details never seen) when they decide to come forward with the truth (Chrobak & Zaragoza, 2008, 2012; Gombos et al., 2012; Van Oorsouw & Giesbrecht, 2008; Zaragoza et al., 2001). Moreover, other studies have shown that the memory impairment caused by fabrication occurs just for self-generated details and not for the entire memory for the event (e.g., Chrobak & Zaragoza, 2008; Pickel, 2004). That is, when asked to genuinely recall the event, fabricators report few correct details and more commissions for the details fabricated, while no mnemonic effects occur for not fabricated details.

Recently, research carried out by Polage (2004, 2012, 2018) has demonstrated that the act of fabrication has additional effects besides memory distortions. In particular, those studies shed light on the possible effects of fabrication on beliefs of having actually experienced the self-fabricated event. Polage asked participants to assess the occurrence that two events happened to them (i.e., one experimental and one control). Then, she invited participants who reported a low rate for the experimental event to write a false description of it. A week (or five weeks) later, participants completed a questionnaire where they again reported their beliefs concerning the possibility that the experimental event had really happened. Polage found two interesting findings: (i) 50% of fabricators decreased their beliefs while (ii) 10–16% of fabricators increased their beliefs for the occurrence of self-fabricated events. To clarify such a pattern of results, she carried out other studies (2012; 2018) demonstrating that fabricators increased their beliefs in their lies, a phenomenon called *fabrication inflation* (but see also Riesthuis et al., 2020).

### 1.3. Theoretical explanations

The different effects of lying (e.g., false denials and fabrication) on memory have been explained through several theoretical perspectives. Studies on false denials have mainly associated the effect of *denial-induced forgetting* (Otgaar et al., 2016) with memory forgetting effects like, for example, the *directing forgetting* (Basden et al., 1993), *retrieval-induced forgetting* (Anderson et al., 1994), and forgetting caused by the *Think/No Think* paradigm (Anderson & Green, 2001). The common assumption of all these approaches is that forgetting for the original stimuli is due to inhibitory mechanisms. Specifically, because people suppress information when then they recall such information they have problems in such a recollection. Although some of these approaches (e.g., directed forgetting) refer to the suppression of information during the encoding of such information while liars suppress information immediately after they encoded it, scholars have speculated that these approaches can explain the inhibitory effect of denials. That is, liars that in a first moment deny the occurrence of event-related details are less likely to retrieve them after a delay because having denied such encoded details has a suppression effect on them (Battista et al., 2020; Otgaar et al., 2020).

By contrast, the *source monitoring framework* (SMF; Johnson et al., 1993) is a fruitful framework to elucidate the memory impairment for events (i.e., commissions) following fabrication. Source monitoring is a necessary process that allows individuals to distinguish between various memory sources (e.g., internal or external). That is, when people have to recognize a source for two memories (e.g., actually happened or just imagined), they make this decision by considering the characteristics of such memories. Hence, if one of these two memories (i.e., imagined event) has many characteristics in common with the other memory (i.e., actual event), people have more difficulties in recognizing the correct source (i.e., recognize the imagined memories as true or vice versa). This confusion is also experienced by fabricators. Indeed, when fabricators produce a new account of the event, they usually create the false version with features of experiences that actually happened in the past (e.g., Thomas et al., 2003). Therefore, when they come forward with the truth, the commonalities between the false (self-generated) event, and the actual event make it difficult to them differentiating between the two sources, causing source monitoring errors (e.g., Johnson et al., 1993; Johnson & Raye, 1981).

The recent MAD framework (Otgaar & Baker, 2018) involves a synthesis of the adverse memory outcomes related to each deceptive strategy (i.e., false denials, feigned amnesia, and fabrication). Specifically, Otgaar and Baker (2018) argued that a possible cause of the different effects on memory is the amount of cognitive resources implicated during the lie. Indeed, they conceptualized that the three strategies differ from each other with respect to the degree of resources required, where false denials need the lowest amount of resources and fabrication the highest. Based on this, the three strategies are part of a continuum that enables a prediction as to which memory outcomes the lie leads to. When a lie is less cognitively demanding (e.g., false denials and feigned amnesia) more omission errors thus occur, while when it is more demanding (e.g., fabrication) more commission errors are likely to occur.

However, the MAD model is silent on the possibility that the mnemonic effects of each deceptive strategy might depend not only on the cognitive resources required by denying, feigning amnesia, or fabricating but also on the role of the cognitive resources that individuals already possess. Indeed, lying entails that deceivers, irrespective of the strategy adopted, use more cognitive resources than truth tellers because they have to lie on the original event in a plausible and consistent way (Deeb et al., 2018; Verigin, Meijer, Bogaard, & Vrij, 2019; Verigin, Meijer, Vrij, & Zauzig, 2019). This makes it reasonable to believe that, besides the different cognitive efforts required by different kinds of lying, individual differences in cognitive resources are to be considered to predict the effects of lying on memory. That is, having a specific amount of cognitive resources (i.e., low vs high) might influence the typical effects of adopting different deceptive strategies on memories. It could be that people with a high amount of cognitive resources can easily encode the event-related details, and then have a lower impairment of their memory than people with a low amount of resources. Hence, our study aimed to examine this issue by testing a possible role of individuals' cognitive resources - in terms of the executive functions of Shifting, Inhibition and Updating (Miyake et al., 2000) - on the memory effects following false denials and fabrication.

### *1.4. Executive function resources and memory*

Recent studies have demonstrated that individuals' cognitive resources predict the formation of memory distortions when individuals try to genuinely recall an event (e.g., Battista et al., 2020; Gerrie & Garry, 2007; Leding, 2012; Marsh et al., 2005; Peters et al., 2007). Specifically, these studies have shown that people with a low availability of Executive Functions (EF) resources have a higher impairment (i.e., forgetting and memory errors) of the memory for the event than those who have a high availability of EF resources. For this reason, it might be plausible to assume that having a high availability of EF resources can also protect from the memory undermining effect (e.g., DIF, commissions) associated with each deceptive strategy (e.g., false denials and fabrication).

In general, EFs have been described as a set of cognitive functions responsible for modulating several cognitive subprocesses and the performance of complex executive tasks (Carpenter et al., 2000; Carretti et al., 2010; Miyake et al., 2000). A large number of processes (i.e., problem-solving, planning, selective attention, etc.) can be enumerated as EF abilities (e.g., Diamond, 2013). However, the most frequently theorized and the principal EFs involved in elaborate cognitive performances (e.g., memory recall) are *Shifting between tasks or mental sets*, *Inhibition of prepotent responses* and *Updating and monitoring of working memory representations* (e.g. Baddeley, 1996; Burgess & Simons, 2005; Diamond, 2013; Espy, 2004; Logan, 1985; Lyon et al., 1996; Miyake et al., 2000; Smith & Jonides, 1999).

In particular, *Updating* pertains to the individuals' ability to detect the relevant information to perform a task among different incoming information. Indeed, it enables changing the irrelevant information in working memory with a relevant one (Morris & Jones, 1990). The recognition of relevant information needs a "temporal tagging" (Miyake et al., 2000, p 57; Jonides & Smith, 1997). Beyond the passive maintenance of relevant information, this ability allows also the active manipulation of relevant information in working memory (Lehto, 1996; Morris & Jones, 1990).

The executive function *Shifting* refers to individual's capacity to move back and forth among different operations or tasks (Monsell, 1996). It is also called "attention switching" or "task switching". This operation requires that the irrelevant task set is disengaged in order to activate a new relevant task set. This process encompasses a temporal cost (e.g., Jersild, 1927; Rogers & Monsell, 1995) that becomes particularly demanding when the switching process is not driven by external prompts (Spector & Biederman, 1976). Furthermore, the Shifting ability entails the individual's ability to overtake proactive interference or negative priming (Allport & Wylie, 2000).

Finally, *Inhibition* concerns the ability to voluntarily suppress dominant, automatic and prepotent responses whether necessary (Miyake et al., 2000). However, this function can also refer to a process not necessarily intentional. In such a case, it is referred to "reactive inhibition" and pertains to the situations where in activation level occurs following a negative activation (Logan, 1994).

A study of Miyake et al. (2000) demonstrated the concurrently unitary and divergent identity of those three EFs. More specifically, despite the fact that every function is delegated to respond in specific situations, they seem to be strongly associated and depend on each other in the execution of complex tasks (e.g., Dempster & Corkill, 1999; Duncan et al., 1996, 1997; Engle & Kane, 2000; Miyake et al., 2000). Based on this, some scholars have collapsed multiple measures of EF into one unique score in their studies (Battista et al., 2020; Biederman et al., 2004; Giancola, 2004; Kersten et al., 2018; Salthouse et al., 2004; Thorell, 2007; Unsworth et al., 2009), an aggregate measure of EF. By contrast, other scholars have adopted a more specific measure of EF by considering a multifaceted and composed of distinct EF scores (e.g., Barkley, 1997; Fleming et al., 2016; Friedman et al., 2011; Langberg et al., 2013; Miller & Hinshaw, 2010). That is, these studies used the scores of Shifting, Inhibition, and Updating separately (i.e., one-facet EF measures) rather than collapse the three EF scores into one aggregate score. Due to the aim of our study, the use of one-facet EF measures seems to better explain how individual EFs resources can interfere with the effects of lying on memory. Indeed, by considering the separate EF scores, we might be able to understand whether a specific EF (i.e., Shifting, Inhibition, or Updating) is more responsible than others for such effects. Thus, in the current experiment, we followed a one-facet approach to assess individual Shifting, Inhibition, and Updating differences.

## 2. The present experiment

In the present experiment, participants watched a video (i.e., video of a robbery) and then their memory was tested. Then, participants answered some questions on the video according to their experimental condition: One group had to answer by fabricating completely false details (i.e., fabrication condition), a second group had to deny all questions (i.e., false denial condition), and a third group had to genuinely answer all questions (i.e., truth-telling condition). Two days later, participants' memory was tested through a final memory test. During this phase, participants genuinely answered all questions and indicated their memory (i) for the interview and (ii) for the video. Immediately after this final memory test, each participant completed three neuropsychological tasks assessing the individual abilities of executive functioning in terms of Shifting, Inhibition, and Updating.

Our expectation was that individuals' EF resources would predict the effects of lying on memory. More specifically, according to previous studies (e.g., Battista et al., 2020; Gerrie & Garry, 2007; Leding, 2012; Peters et al., 2007), we hypothesized that forgetting for the memory for the event would be higher with low EF resources than with high EF resources (Hypothesis 1). Moreover, in accordance with the Memory and Deception model (Otgaar & Baker, 2018) and evidence collected so far on the effects of false denials and fabrication on memory (e.g., Chrobak & Zaragoza, 2008, 2012; Otgaar et al., 2016; Otgaar et al., 2018; Vieira & Lane, 2013; Zaragoza et al., 2001), we expected that participants instructed to falsely deny would have more omission errors than participants in the truth-telling and fabrication condition, especially with low EF resources (Hypothesis 2). Furthermore, we expected that participants instructed to fabricate would produce more commission errors than participants in the truth-telling and false denials condition, especially with low EF resources (Hypothesis 3). In addition, with regards to memory for the interview, based on previous studies showing the occurrence of a *denial-induced forgetting* effect (e.g., Battista et al., 2020; Otgaar et al., 2014; Otgaar et al., 2016; Otgaar et al., 2018; Romeo et al., 2018; Romeo et al., 2019), we expected: (i) a higher impairment for participants in false denial condition than for participants in the truth-telling condition and fabrication condition (Hypothesis 4) and that (ii) and such an impairment would be higher for deniers with low EF resources than for deniers with high EF (Hypothesis 5).

## 3. Method

### 3.1. Participants and design

Using G*Power (Faul et al., 2007), an a priori power analysis for a fixed ANOVA model with a power of 0.80 and a main effect size of 0.30 indicated that a sample of 138 participants was required. A total of 147 ($M_{age}$ = 23.53, $SD$ = 3.31, range 18–38, 118 women) students of the Department of Education, Psychology, and Communication of the University of Bari "Aldo Moro" participated in the study. The experiment used a 3 (Condition: Fabrication, False Denials, Truth-Telling) *between-subjects* design. The three measures (i.e., Shifting, Inhibition, and Updating) of individuals' EF resources were treated as covariates. The dependent variables were the two recognition scores (i.e., memory for having discussed items and memory for having seen items) and the three recall scores (i.e., correct details, omissions, and commissions) for the memory for the video. Participants were randomly assigned to one of the three different conditions (Fabrication: $n$ = 49, False Denials: $n$ = 49, Truth Telling: $n$ = 49). Each participant was tested individually in a lab session. Participants did not receive any compensation following the experiment as their participation was voluntary. The whole sample completed all sessions by following the instructions given. The ethical committee of the Department of Education, Psychology, Communication of the University of Bari "Aldo Moro" approved the study. The study was preregistered (https://osf.io/4b7ac) and all the data and materials are available on the Open Science Framework: https://osf.io/qg4rk/.

### 3.2. Materials

**Video.** Participants watched a video used in previous studies on false memories and lying (e.g., Otgaar et al., 2014, 2016; Takarangi et al., 2006). The video, known as "Eric the electrician", has a duration of 6.5 min. The video displays an electrician (i.e., Eric) while he does some jobs in a house and steals various objects, such as jewelry.

### 3.3. Individuals' EF assessment

**Updating: Verbal Fluency** (Novelli et al., 1986). In this task, the experimenter says a letter to the participant who is requested to provide as many words as possible beginning with such a letter in 60 s. The participant is requested to respond to three different letters (C, P, and S). All provided words are accepted except for first names of people and cities. The final score on this task is given by the average number of words provided for each letter. Hence, the final score does not consider repetitions (i.e., words repeated more times) and intrusions (i.e., words not conforming with the instructions) (Cronbach's α in the present study = 0.32).

**Shifting: Plus-Minus Task** (PMT; Jersild, 1927; Spector & Biederman, 1976). This task is composed of three trials of mathematical operations. In the first trial, the participant has to add three to a set of thirty numbers, while in the second trial has to subtract three from a different list of numbers. In the third and critical trial, the participant has to alternate between adding and subtracting three from numbers of the list. The participant starts adding three to the first number, goes on subtracting three to the second number and continues in this way for all the numbers of the list. The experimenter registers the time used by each participant to complete the calculations of every trial. The score is obtained by subtracting the average time of the first two trials from the time to complete the last trial (Cronbach's α in the present study = 0.28).

**Inhibition: Go-NoGo Task** (GNG; Bezdjian et al., 2009). The participant is seated in front of a computer screen in which a square is presented. This square is divided into four sub-squares where the letters P or R can appear in a random way. The participant, according to the block instructions, has to react to some stimuli (Go stimuli) and give no response for others (NoGo stimuli). In particular, in the first block the Go stimuli are given by the letter P. Hence, the participant has to press the mouse whether the P appears and does not press whether the letter R appears. By contrast, in the second block, the Go stimuli are the letter R. Thus, the participant has to press the mouse whether the letter R appears and does not do anything whether the letter P appears on the screen. Both the blocks consist of 160 stimuli and the letter remains on the screen for 500 milliseconds. The final score is obtained by averaging the commission errors reported at the first and second blocks (Cronbach's α in the present study = 0.21).

### 3.4. Procedure

The study was composed of two sessions. The first and the second sessions were carried out with a delay of 48 h from each other, and during both the sessions participants were tested individually. All participants took part at the second session after two days. The first session lasted thirty minutes, while the second one required twenty minutes, approximately.

### 3.5. Session 1

**Video Phase.** Before starting the study, participants signed an informed consent form. Immediately after, they watched the video "Eric the electrician". At the end of the video, all participants performed a filler task for 5 min (i.e., playing to the Solitaire game).

**Baseline Memory Test.** In order to ensure that all participants correctly encoded the event presented in the video, a baseline memory test was performed. Participants had to honestly answer 10 questions on items seen in the video (e.g., *"What vehicle did Eric arrive with?"*). The memory and belief ratings for each question were also assessed (e.g., *"Do you actually remember seeing what vehicle Eric arrived with?"*; 1 = no memory at all, 8 = clear and complete memory; *"How likely is that you saw what vehicle Eric arrived with?"*; 1 = definitely not likely, 8 = definitely likely; Scoboria et al., 2004). Then, participants were involved in a second 5-min filler task (i.e., playing to the game Solitaire).

**Interview Phase**. In this last phase, participants answered 12 questions - different from the questions in the baseline memory test – concerning the video. All participants had to imagine being an eyewitness of the crime and to be interviewed by a policeman in a police station. Participants answered questions according to the experimental condition they were assigned to. Hence, those in the truth-telling condition honestly answered each question (e.g., *"What vehicle did Eric arrive with?"*, correct answer: *Blue van*). Those in the fabrication condition had to answer each question by making up completely false details (e.g., *"What vehicle did Eric arrive with?"*, answer: *Eric arrived with a green car*). Finally, those in false denials condition had to deny each question (e.g., *"What vehicle did Eric arrive with?"*; answer: *Eric did not arrive with a vehicle*). Before starting the interview, the researcher provided each participant with an example of how to answer questions. This allowed us to ensure participants correctly accomplished the lying instructions (i.e., falsely denying or fabricating). The questionnaire was composed of 8 questions on details actually seen in the video (i.e., true items e.g. "*In which room did Eric open a window?*") and 4 questions on details never seen in the video (i.e., false items e.g., *"Which body part did Eric injure while he was in the house?"*).

### 3.6. Session 2

**Final Memory Test.** After two days, participants completed the final memory task composed of 16 questions. Note that, of the total number of questions, 8 were on details discussed (i.e., fabricated, denied or told the truth) during the interview phase and the remaining 8 questions on details never discussed. In addition, 10 questions were on true details and 6 questions pertained to false details (see Appendix A). All participants (i.e., fabrication, false denials, and truth-telling) were instructed to answer the questions truthfully. Hence, to assure that they followed the instructions, an example of questions was provided. For each question participants had to indicate: (i) memory for the interview and (ii) memory for the video. More specifically, both memory aspects were assessed by asking participants to recognize whether they remember having discussed specific details (e.g., *"When we spoke during the first session, did we discuss what vehicle Eric arrived with?"*, answer: *Yes/No*), and whether they remember having seen such details in the video (e.g., "*When watching the video, did you see what vehicle Eric arrived with?"*, answer: *Yes/No*). In addition, memory for the video was also tested though recall questions (e.g., *"When watching the video, did you see what vehicle Eric arrived with?"*, answer: *Detail remembered*). Moreover, participants indicated a memory rating (e.g., *"Do you actually remember saying/seeing what vehicle Eric arrived with?"*; 1 = *no memory of the event at all*; 8 = *clear memory of the event*) and a belief rating (e.g., *"How likely is that you said/saw what vehicle Eric arrived with?"*; 1 = *definitely not likely*, 8 = *definitely likely*) for memory for the video.

**Executive Functioning Assessment.** After having filled in the final memory test, to assess the individuals' executive functioning resources, participants performed the three neuropsychological tasks as follow: (1) Verbal Fluency (Novelli et al., 1986), (2) Plus-Minus Task (Jersild, 1927; Spector & Biederman, 1976), and (3) Go-NoGo Task (Bezdjian et al., 2009). Then, they were thanked and debriefed about the aim of the study.

### 3.7. Scoring

The final memory task was rated considering the recognition scores [i.e., a) items discussed during the interview; b) items seen in the video] and the recall scores for memory for the video [i.e., c) correct details, d) omissions, and e) commissions]. The memory scores were calculated based on a scoring system already used in previous research (Battista et al., 2020).

In particular, the recognition scores were computed attributing one point for each correct answer at the questions: (a) *"When watching the video, did you see what vehicle Eric arrived with?"* (correct answer: *yes*; score assigned: 1); (b) "*When we spoke during the first session, did we discuss what vehicle Eric arrived with?"* (correct answer: yes; score assigned: 1). With regards to the three recall scores (i.e., correct details, omissions, and commissions) for memory for the video: (c) For the correct details score, one point was assigned for each correct answer (e.g., "*When watching the video, did you see what vehicle Eric arrived with?"*; correct answer: *blue van*), a half-point was given to an answer partially distorted (e.g., *van*), while zero was given to a completely wrong answer (e.g., *green bus*) and when no answer was provided (e.g., *"I do not remember"*). (d) For omissions score, one point was assigned when participants gave no answer (e.g., *"I do not remember"*), while (e) for commissions score, one point was attributed for completely wrong answer (e.g., *green bus*) or a half-point for answer partially distorted (e.g., *white van*). Both the recognition and recall scores were summed considering all the 16 items of the final memory test (maximum score: 16) and just the items discussed during the interview (maximum score: 8). The final memory scores were given by calculating the proportions (score obtained divided by the maximum score).

The first author and a research assistant – blind to experimental conditions – scored the recall questions. The ICC average measures for the number of correct details scores for memory for the video was 0.90, $p < .001$. The ICC average measures for the omissions and commission scores for memory for the video were 0.89 and 0.73, $p_s < .001$, respectively.

## 4. Results

### 4.1. EF scores

Table 1 shows the descriptive information (i.e., mean, SD, minimum and maximum) reported by participants in the three EF tasks. Scores are divided into the three experimental conditions of fabrication, false denials, and truth-telling. The frequency distribution of each of the three tasks in the three condition groups has been also reported in Appendix B. Table 2 shows the indices of inter-relatedness of the EF scores.

**Table 1**
Table shows the descriptive information reported by the three groups (i.e., fabrication, false denials, and truth-telling) at the three EF (i.e., shifting, inhibition, and updating) tasks.

| | Fabrication | False denials | Truth-telling |
|---|---|---|---|
| Shifting | | | |
| Mean (SD) | 100.02 (77.33) | 85.59 (72.00) | 83.15 (85.66) |
| Min–max | −2.50–337.93 | −22.21–267.22 | −47.88–309.76 |
| Inhibition | | | |
| Mean (SD) | 303.27 (20.07) | 290.00 (42.25) | 293.78 (43.25) |
| Min–max | 188.00–320.00 | 160.00–320.00 | 160.00–320.00 |
| Updating | | | |
| Mean (SD) | 16.37 (4.68) | 15.64 (4.09) | 14.85 (4.45) |
| Min–max | 8.70–28.40 | 8.00–27.00 | 6.70–30.40 |

**Table 2**
Table shows Spearman's r between the three EF (i.e., updating, shifting, inhibition) scores. *$p < .05$.

| | Updating | Shifting |
|---|---|---|
| Shifting | −0.04 | |
| Inhibition | −0.03 | −0.21* |

### 4.2. Baseline memory test

In order to verify whether the video-related details were correctly encoded by all participants, a 3 (Condition: Fabrication, False Denials, Truth-Telling) *between-subjects* ANOVA was conducted on the baseline memory scores. The average proportion for the first memory test ($M = 0.77$, $SD = 0.16$) suggests that the crime video was correctly encoded by all participants (fabrication: $M = 0.79$, $SD = 0.20$; false denial: $M = 0.77$, $SD = 0.15$; truth telling: $M = 0.75$, $SD = 0.13$), with no statistically significant main effect of the factor condition, $F(2, 143) = 0.63$, $p = .53$, $\omega^2 = 0.000$.

### 4.3. Final memory test

#### 4.3.1. Recognition scores

A set of 3 (Condition: Fabrication, False Denials, Truth-Telling) *between-subjects* ANCOVAs with the three scores (treated as continuous variables) of each EF (i.e., Shifting, Inhibition, and Updating) as covariates was conducted on the recognition scores of the a) memory performance for the interview and b) memory performance for items seen in the video both for the overall score for the final memory test and for the score for items discussed during the interview (see Scoring section).

**Memory for the Interview.** Concerning the overall memory performance for what was discussed during the interview, the main effect of condition was statistically significant, $F(2, 135) = 6.91$, $p = .001$, $\omega^2 = 0.07$. However, the main effects of the covariates Shifting, Inhibition, and Updating were not statistically significant, $F(1, 135) = 0.63$, $p = .43$, $\omega^2 = 0.000$, $F(1, 135) = 0.06$, $p = .81$, $\omega^2 = 0.000$, and $F(1, 135) = 3.83$, $p = .05$, $\omega^2 = 0.02$, respectively. Also the interaction effects of condition by Shifting, Inhibition, and Updating were not statistically significant, $F(2, 135) = 2.05$, $p = .13$, $\omega^2 = 0.01$, $F(2, 135) = 0.68$, $p = .51$, $\omega^2 = 0.004$, and $F(2, 135) = 1.52$, $p = .22$, $\omega^2 = 0.007$, respectively. Post hoc corrected Bonferroni comparisons demonstrated that participants in the truth-telling group reported a statistically significant higher score than participants in both the false denial ($p = .003$, 95% CI [0.02, 0.10], $d = 0.76$) and in the fabrication group ($p = .01$, 95% CI [0.01, 0.09], $d = 0.58$). No other differences reached statistical significance (all $p_s > .05$). A Bayesian analysis was also conducted, supporting strong evidence for the null hypothesis concerning the effects of the Shifting, Inhibition, and Updating scores, $BF_{10} = 0.02$, error % = 0.012, $BF_{10} = 0.02$, error % = 0.012, $BF_{10} = 0.05$, error % = 0.012, respectively, and the interaction effects of condition by Shifting, Inhibition, and Updating, $BF_{10} = 0.51$, error % = 3.09, $BF_{10} = 0.26$, error % = 2.20, $BF_{10} = 0.33$, error % = 1.70, respectively.

Similarly, with regards to memory performance for only the items discussed during the interview, the main effect of condition reached statistical significance, $F(2, 135) = 7.75$, $p < .001$, $\omega^2 = 0.08$. The main effects of the covariates Shifting, Inhibition, and Updating were not statistically significant, $F(1, 135) = 0.33$, $p = .57$, $\omega^2 = 0.000$, $F(1, 135) = 0.30$, $p = .59$, $\omega^2 = 0.000$, and $F(1, 135) = 1.66$, $p = .20$, $\omega^2 = 0.004$, respectively. In addition, the three interactions effect of condition by Shifting, Inhibition, and Updating did not reach statistical significance, $F(2, 135) = 1.54$, $p = .22$, $\omega^2 = 0.007$, $F(2, 135) = 1.06$, $p = .35$, $\omega^2 = 0.001$, and $F(2, 135) = 0.63$, $p = .53$, $\omega^2 = 0.005$, respectively. Post hoc corrected Bonferroni comparisons showed that participants in the truth-telling group reported a statistically significant higher score than both the false denial ($p < .001$, 95% CI [0.04, 0.17], $d = 0.85$) and the fabrication group ($p = .03$, 95% CI [0.01, 0.14], $d = 0.54$). Other differences did not reach the statistical significance (all $p_s > .05$). The Bayesian analysis showed evidence for the null hypothesis concerning the effects of the Shifting, Inhibition, and Updating scores, $BF_{10} = 0.006$, error % = 0.006, $BF_{10} = 0.006$, error % = 0.006, $BF_{10} = 0.008$, error % = 0.006, respectively, as well as for the interaction effects of condition by Shifting, Inhibition, and Updating, $BF_{10} = 0.50$, error % = 3.42, $BF_{10} = 0.37$, error % = 2.11, $BF_{10} = 0.22$, error % = 2.73, respectively.

**Memory for the Video.** Regarding the overall memory performance for what was seen in the video, the main effect of condition was not statistically significant, $F(2, 135) = 0.52$, $p = .60$, $\omega^2 = -0.007$ as well as the effects of the covariates Shifting, Inhibition, and Updating, $F(1, 135) = 1.13$, $p = .29$, $\omega^2 = 0.001$, $F(1, 135) = 3.23$, $p = .07$, $\omega^2 = 0.02$, and $F(1, 135) = 2.19$, $p = .14$, $\omega^2 = 0.08$, respectively. The interaction effects of condition by Shifting, Inhibition, and Updating were also not statistically significant, $F(2, 135) = 0.48$, $p = .62$, $\omega^2 = -0.007$, $F(2, 135) = 0.66$, $p = .52$, $\omega^2 = -0.05$, and $F(2, 135) = 0.17$, $p = .84$, $\omega^2 = -0.011$, respectively. A Bayesian analysis was also conducted, demonstrating strong evidence for the null hypothesis concerning the effects of condition, $BF_{10} = 0.004$, error % = 0.008 and the Shifting, Inhibition, and Updating scores, $BF_{10} = 0.04$, error % = 0.003, $BF_{10} = 0.96$, error % = 0.008, $BF_{10} = 0.05$, error % = 0.003, respectively. Also evidence for the null hypothesis regarding the condition by Shifting, Inhibition, and Updating effects were found, $BF_{10} = 0.18$, error % = 2.36, $BF_{10} = 0.22$, error % = 2.50, $BF_{10} = 0.12$, error % = 2.32, respectively.

Also the analysis on the memory score just for items discussed during the interview did not show a statistically significant main effect of condition, $F(2, 135) = 0.001$, $p = .99$, $\omega^2 = -0.014$ and of the effects of the covariates Shifting, Inhibition, and Updating, $F(1, 135) = 0.52$, $p = .47$, $\omega^2 = -0.003$, $F(1, 135) = 2.92$, $p = .09$, $\omega^2 = 0.01$, and $F(1, 135) = 0.52$, $p = .47$, $\omega^2 = 0.01$, respectively. In addition, the interaction effects of condition by Shifting, Inhibition, and Updating did not reach the statistical significance, $F(2, 135) = 1.14$, $p = .32$, $\omega^2 = 0.002$, $F(2, 135) = 0.04$, $p = .96$, $\omega^2 = -0.01$, and $F(2, 135) = 0.65$, $p = .52$, $\omega^2 = -0.005$, respectively. Also the Bayesian analysis showed evidence for the null hypothesis regarding the effects of condition, $BF_{10} = 0.04$, error % = 0.009 and the Shifting, Inhibition, and Updating scores, $BF_{10} = 0.09$, error % = 0.004, $BF_{10} = 0.73$, error % = 0.004, $BF_{10} = 0.52$, error % = 0.004, respectively, as well as for the interaction effects of condition by Shifting, Inhibition, and Updating, $BF_{10} = 0.38$, error % = 2.29, $BF_{10} = 0.13$, error % = 1.94, $BF_{10} = 0.28$, error % = 2.72, respectively.

#### 4.3.2. Recall scores

A set of 3 (Condition: Fabrication, False Denials, Truth-Telling) *between-subjects* ANCOVAs with the three scores (treated as continuous variables) of each EF (i.e., Shifting, Inhibition, and Updating) as covariates was run on the recall scores of memory for the video in terms of c) correct details, d) omissions, and e) commissions for the overall score for the final memory test and for the score for items discussed during the interview (see Scoring).

**Correct Details.** Concerning the overall score of correct details, the main effect of condition was statistically significant, $F(2, 135) = 16.83$, $p < .001$, $\omega^2 = 0.16$. In addition, the effects of the covariates Shifting and Inhibition were statistically significant, $F(1, 135) = 4.38$, $p = .04$, $\omega^2 = 0.02$, and $F(1, 135) = 9.54$, $p = .002$, $\omega^2 = 0.06$, respectively. That is, the higher Shifting score, the higher the proportion of correct details ($\beta = 0.16$, $t = 2.09$, $p = .04$) as well as the higher the Inhibition score, the higher the proportion of reported correct details provided ($\beta = 0.30$, $t = 3.09$, $p = .002$). By contrast, the effects of the covariate Updating was not statistically significant, $F(1, 135) = 2.50$, $p = .12$ $\omega^2 = 0.01$. Neither the interaction effects of condition by Shifting, $F(2, 135) = 0.94$, $p = .39$, $\omega^2 = -0.001$, nor Inhibition, $F(2, 135) = 0.05$, $p = .95$, $\omega^2 = -0.001$, or Updating, $F(2, 135) = 0.66$, $p = .52$, $\omega^2 = -0.004$ were statistically significant. Post hoc corrected Bonferroni comparisons showed that participants in the fabrication group reported statistically significant lower correct details than individuals in both the truth-telling ($p < .001$, 95% CI [0.06, 0.19], $d = 0.89$) and in the false denial group ($p < .001$, 95% CI [0.09, 0.23], $d = 1.11$). No other differences reached statistical significance (all $p_s > .05$). A Bayesian analysis was also conducted, demonstrating moderate evidence for the null hypothesis concerning the effects of Updating score, $BF_{10} = 0.20$, error % = 0.003, and the interaction effects of condition by Shifting, Inhibition, and Updating, $BF_{10} = 0.24$, error % = 1.28, $BF_{10} = 0.11$, error % = 1.31, $BF_{10} = 0.19$, error % = 1.29, respectively.

Regarding the correct details score just for the items discussed during the interview, we found a statistically significant main effect of factor condition, $F(2, 135) = 31.94$, $p < .001$, $\omega^2 = 0.27$ and statistically significant effects of the covariates Shifting and Inhibition, $F(1, 135) = 19.72$, $p < .001$, $\omega^2 = 0.10$ and $F(1, 135) = 6.94$, $p = .01$, $\omega^2 = 0.03$, respectively. The higher the Shifting and Inhibition scores, the higher the proportion of reported correct details ($\beta = 0.31$, $t = 4.44$, $p < .001$ and $\beta = 0.23$, $t = 2.63$, $p = .009$, respectively). Also the interaction effect of condition by Shifting was statistically significant, $F(2, 135) = 5.42$, $p = .005$, $\omega^2 = 0.05$. Specifically, the individual's Shifting resources maximized the difference between the fabrication group and the false denials group, in that a higher proportion of correct details was reported by individuals in the false denials group than in the fabrication group ($\beta = 0.58$, $t = 3.28$, $p = .001$). Similarly, the individual's Shifting resources maximized the difference between the false denials group and the truth-telling group, in that a higher proportion of correct details was reported by individuals in the false denials than fabrication group ($\beta = 0.35$, $t = 2.04$, $p = .04$). No other effects were statistically significant (all $p_s > .05$). By contrast, the main effect of the covariate Updating was not statistically significant, $F(1, 135) = 3.47$, $p = .06$, $\omega^2 = 0.01$. Neither the interaction effect of condition by Inhibition, $F(2, 135) = 0.53$, $p = .59$, $\omega^2 = -0.005$ nor of condition by Updating, $F(2, 135) = 0.96$, $p = .39$, $\omega^2 = 0.000$ reached statistical significance. Post hoc corrected Bonferroni comparisons showed that participants in the fabrication group reported statistically significant lower correct details than those in both the truth-telling ($p < .001$, 95% CI [0.17, 0.34], $d = 1.33$) and in the false denial group ($p < .001$, 95% CI [0.20, 0.38], $d = 1.48$). Other differences did not reach statistical significance (all $p_s > .05$). The Bayesian analysis demonstrated evidence for the null hypothesis concerning the effect of the Updating score, $BF_{10} = 0.18$, error % = 0.003 and the interaction effects of condition by Inhibition and Updating, $BF_{10} = 0.15$, error % = 6.43 and $BF_{10} = 0.36$, error % = 6.34, respectively.

**Omissions.** Regarding the overall score of omissions, the main effect of condition reached statistical significance, $F(2, 135) = 6.63$, $p = .002$, $\omega^2 = 0.07$. Also the effects of the covariates Shifting and Inhibition were statistically significant, $F(1, 135) = 4.96$, $p = .03$, $\omega^2 = 0.02$ and $F(1, 135) = 5.29$, $p = .02$, $\omega^2 = 0.03$, respectively. That is, the higher the Shifting and Inhibition scores, the lower the proportion of omissions ($\beta = -0.18$, $t = -2.23$, $p = .03$ and $\beta = -0.24$, $t = -2.30$, $p = .02$, respectively). No statistically significance was found for the effect of the covariate Updating, $F(1, 135) = 2.94$, $p = .09$, $\omega^2 = 0.003$. Also the interaction effects of condition by Shifting, Inhibition, and Updating were not statistically significant, $F(2, 135) = 2.34$, $p = .10$, $\omega^2 = 0.02$, $F(2, 135) = 0.20$, $p = .82$, $\omega^2 = -0.01$, and $F(2, 135) = 0.59$, $p = .55$, $\omega^2 = -0.005$, respectively. Post hoc corrected Bonferroni comparisons demonstrated that participants in the fabrication group reported statistically significant higher omissions than participants in the false denial group ($p = .001$, 95% CI [−0.19, −0.04], $d = 0.72$). No other differences reached statistical significance (all $p_s > .05$). A Bayesian analysis was carried out showing evidence for the null hypothesis of the Updating score, $BF_{10} = 0.24$, error % = 0.003 and for the interaction effects of condition by Shifting, Inhibition, and Updating, $BF_{10} = 0.96$, error % = 0.99, $BF_{10} = 0.16$, error % = 1.12, and $BF_{10} = 0.19$, error % = 2.94, respectively.

Similarly, the analysis on the omissions score just for the items discussed during the interview demonstrated a statistically significant main effect of condition, $F(2, 135) = 2.77$, $p = .07$, $\omega^2 = 0.02$. Moreover, the effects of the covariates Shifting and Inhibition were statistically significant, $F(1, 135) = 12.75$, $p < .001$, $\omega^2 = 0.07$ and $F(1, 135) = 5.14$, $p = .03$, $\omega^2 = 0.03$, respectively. The higher the Shifting and Inhibition resources, the lower the proportion of omissions ($\beta = -0.29$, $t = -3.57$, $p < .001$ and $\beta = -0.23$, $t = -2.27$, $p = .02$, respectively). Also the interaction effect of condition by Shifting was statistically significant, $F(2, 135) = 5.65$, $p = .004$, $\omega^2 = 0.06$. That is, the individual's Shifting resources maximized the difference between the fabrication group and the false denials group in that a higher proportion of omissions was reported by individuals in the fabrication than false denials group ($\beta = 0.69$, $t = 3.36$, $p = .001$). No statistically significant effect was found for the effect of the covariate Updating, $F(1, 135) = 2.07$, $p = .15$, $\omega^2 = 0.006$. Also the interaction effects of condition by Inhibition and Updating were not statistically significant, $F(2, 135) = 0.37$, $p = .69$, $\omega^2 = -0.007$ and $F(2, 135) = 0.006$, $p = .99$, $\omega^2 = -0.01$, respectively. Post hoc corrected Bonferroni comparisons did not demonstrate statistically significant differences between groups (all $p_s > .05$). The Bayesian analysis showed evidence for the null hypothesis concerning the effect of the Updating score, $BF_{10} = 0.19$, error % = 0.003 and for the interaction effects of condition by Inhibition and Updating, $BF_{10} = 0.16$, error % = 1.37 and $BF_{10} = 0.12$, error % = 1.44, respectively.

**Commissions.** The main effect of condition was statistically significant on the overall score of commissions, $F(2, 135) = 3.35$, $p = .04$, $\omega^2 = 0.03$. Furthermore, neither the main effects of the covariates nor the interaction effects reached statistical significance. In particular, the main effects of the covariates Shifting, Inhibition, and Updating were, $F(1, 135) = 0.02$, $p = .88$, $\omega^2 = -0.007$, $F(1, 135) = 0.09$, $p = .77$, $\omega^2 = -0.006$, and $F(1, 135) = 0.80$, $p = .37$, $\omega^2 = -0.001$, respectively. Post hoc corrected Bonferroni comparisons showed that participants in the fabrication group reported statistically significant higher commissions than those in the false denial group ($p = .04$, 95% CI [−0.14, −0.004], $d = 0.62$). Other differences did not reach statistical significance (all $p_s > .05$). A Bayesian analysis was also carried out, demonstrating strong evidence for the null hypothesis concerning the effects of the Shifting, Inhibition and Updating scores, $BF_{10} = 0.18$, error % = 0.003, $BF_{10} = 0.20$, error % = 0.003, $BF_{10} = 0.23$, error % = 0.008, respectively. Moreover, support for the null hypothesis regarding the interaction effects of condition by Shifting, Inhibition, and Updating were also found, $BF_{10} = 0.71$ error % = 4.57, $BF_{10} = 0.17$, error % = 3.00, $BF_{10} = 0.15$, error % = 2.87, respectively.

Concerning the commissions score just for the items discussed during the interview, the main effects of condition and the covariates Shifting, Inhibition, and Updating were not statistically significant, $F(2, 135) = 0.77$, $p = .47$, $\omega^2 = 0.000$, $F(1, 135) = 0.66$, $p = .42$, $\omega^2 = 0.01$ $F(1, 135) = 0.95$, $p = .33$, $\omega^2 = 0.58$ and $F(1, 135) = 0.31$, $p = .58$, $\omega^2 = 0.33$, respectively. In addition, the interaction effects of condition by Inhibition and Updating did not reach the statistical significance, $F(2, 135) = 0.38$, $p = .68$, $\omega^2 = -0.008$ and $F(2, 135) = 0.11$, $p = .90$, $\omega^2 = -0.01$, while the interaction effect of condition by Shifting was statistical significant, $F(2, 135) = 4.01$, $p = .02$, $\omega^2 = 0.04$. Specifically, the individual's Shifting resources maximized the difference between the fabrication group and the false denials group in that a higher proportion of commissions was reported by individuals in the fabrication than false denials group ($\beta = 0.47$, $t = 2.17$, $p = .03$). Moreover, the individual's Shifting resources maximized also the difference between the fabrication group and the truth-telling group, in that a higher proportion of commissions was reported by individuals in the truth-telling than fabrication group ($\beta = -0.54$, $t = 2.65$, $p = .009$). Bayesian analysis demonstrated strong evidence for the null hypothesis concerning the effects of condition, $BF_{10} = 0.13$, error % = 0.007, as well as for the effects of the Shifting. Inhibition, and Updating scores, $BF_{10} = 0.21$, error % = 0.003, $BF_{10} = 0.28$, error % = 0.003, $BF_{10} = 0.22$, error % = 0.003, respectively. In addition, the analysis showed evidence for the null hypothesis of the interaction effects of condition by Inhibition and Updating, $BF_{10} = 0.18$, error % = 1.93, $BF_{10} = 0.16$, error % = 1.98 respectively (Table 3).

**Table 3**
Descriptive statistics (mean proportions, standard deviations, and 95% CI) of the overall scores of memory (i) for the interview and (ii) for the video considering the three groups (i.e., fabrication, distortion, and truth-telling).

| Measures | Truth-telling | | False denials | | Fabrication | |
|---|---|---|---|---|---|---|
| | Overall score | Discussed items score | Overall score | Discussed items score | Overall score | Discussed items score |
| *Recognition scores* | | | | | | |
| Memory for the video | 0.76 (0.11) | 0.77 (0.17) | 0.76 (0.14) | 0.78 (0.17) | 0.74 (0.10) | 0.78 (0.17) |
| | 95% CI[0.73, 0.78] | 95% CI[0.73, 0.81] | 95% CI[0.76, 0.82] | 95% CI[0.77, 0.84] | 95% CI[0.70, 0.77] | 95% CI[0.70, 0.79] |
| Memory for the interview | 0.79 (0.08) | 0.86 (0.12) | 0.73 (0.07) | 0.75 (0.13) | 0.76 (0.10) | 0.79 (0.16) |
| | 95% CI[0.77, 0.82] | 95% CI[0.81, 0.90] | 95% CI[0.69, 0.73] | 95% CI[0.69, 0.76] | 95% CI[0.76, 0.80] | 95% CI[0.70, 0.81] |
| *Recall scores* | | | | | | |
| Memory for the video | | | | | | |
| *Correct details* | 0.38 (0.16) | 0.46 (0.21) | 0.38 (0.16) | 0.49 (0.22) | 0.24 (0.13) | 0.24 (0.16) |
| | 95% CI[0.25, 0.33] | 95% CI[0.29, 0.40] | 95% CI[0.28, 0.35] | 95% CI[0.32, 0.42] | 95% CI[0.23, 0.29] | 95% CI[0.25, 0.33] |
| *Omission errors* | 0.53 (0.15) | 0.42 (0.18) | 0.48 (0.19) | 0.43 (0.25) | 0.18 (0.17) | 0.49 (0.21) |
| | 95% CI[0.54, 0.63] | 95% CI[0.47, 0.58] | 95% CI[0.54, 0.63] | 95% CI[0.47, 0.58] | 95% CI[0.57, 0.64] | 95% CI[0.50, 0.59] |
| *Commission errors* | 0.18 (0.17) | 0.20 (0.20) | 0.14 (0.12) | 0.16 (0.13) | 0.23 (0.11) | 0.18 (0.16) |
| | 95% CI[0.11, 0.17] | 95% CI[0.10, 0.16] | 95% CI[0.10, 0.17] | 95% CI[0.09, 0.14] | 95% CI[0.13, 0.19] | 95% CI[0.13, 0.23] |

0.05.

## 5. Discussion

Previous studies have demonstrated that memory accuracy for an event is affected by the individuals' EF resources availability (Battista et al., 2020; Gerrie & Garry, 2007; Jaschinski & Wentura, 2002; Mirandola et al., 2015; Peters et al., 2007; Watson et al., 2005). The current study was carried out with the aim to verify whether individuals' EF resources can also be involved in the mnemonic effects following the act of lying (i.e., false denying and fabricating). We found the following results. In line with our expectations (Hypothesis 1), we observed that the recall of an event depended on individuals' EF resources. Specifically, having a higher amount of Shifting and Inhibition resources made people more prone to report correct details and fewer omissions. Moreover, individual's Shifting resources affected the effects of lying on memory for the event – with regards to both correct details and memory distortions (i.e., omissions and commission) reported by liars. Also, and in line with previous research (e.g., Battista et al., 2020; Otgaar et al., 2016; 2018), we found memory undermining effects for having discussed specific event-related information in both the groups of deception (i.e., false denials and fabrication). Finally, in line with previous studies showing that the impact of lying depends on the type of deceptive strategy implemented (e.g., Ackil & Zaragoza, 2011; Gombos et al., 2012; Mangiulli et al., 2018; Otgaar et al., 2016; Romeo et al., 2019; Vieira & Lane, 2013), we found that individuals who deceived by using the fabrication strategy reported a higher memory impairment (i.e., memory errors) for the event than those who falsely denied and told the truth.

However, in contrast with our expectation (Hypothesis 5), our findings on the recognition of details discussed during the interview (i.e., lied or told the truth) demonstrated that EF resources did not influence participants' memory performance for the interview. Based on the definition of EFs (i.e., abilities to switch among different items, inhibit irrelevant information, and code relevant one; see Miyake et al., 2000), we expected an exacerbation of the undermining effect on participants' memory for the interview with regards to EF resources. Yet, our pattern of results suggests that individual's availability of EF resources does not play a role on the typical effects of lying on memory. Indeed, we found only statistical differences in terms of instructions between both groups of deceivers (i.e., deniers and fabricators) and truth-tellers, but no statistical difference between deceptive strategies used. Specifically, truth-tellers were more able to recognize items discussed during the interview than both deniers and fabricators. These findings are partially in line with studies showing that the act of denying impairs memory for the interview rather than memory for the event (i.e., DIF; Otgaar et al., 2016). The explanation for such an effect is typically that those who deceive by denying an event do not rehearse the related information. This lack of rehearsal, hence, leads to an impaired memory for the interview (e.g., Otgaar et al., 2014; Vieira & Lane, 2013). Although the impairment of memory for the interview has been mainly displayed following the act of false denials (e.g., Otgaar et al., 2016; Vieira & Lane, 2013), more recent studies have demonstrated that also other deceptive strategies (e.g., feigned amnesia) can affect recollection of an interview (e.g., Romeo et al., 2018). Our findings on fabricators' recollection for the interview seem also to support the idea that an undermining-memory effect for the interview can also occur when other types of lies are executed. However, lack of rehearsal does not justify such effect in the case of the fabrication strategy. Indeed, the implementation of this strategy requires that the liar suppresses the truth in order to make up false details for the event (e.g., Chrobak & Zaragoza, 2008; Otgaar & Baker, 2018). It is indeed plausible that the DIF effect in fabricators is related to an attentional deployment (i.e., strategy requiring an attentional focus towards specific aspects of the stimulus) towards the creation of false details rather than for the interview. It could be the case that – because of the high effort for coming up with false information – people have engaged and shifted all their resources in the elaboration of the lie and did not pay attention to which details they were discussing. Hence, during the recognition of the details discussed or not, they had a low memory performance.

Our data on the ability to recognize details seen in the video did not show any statistically significant effects. Indeed, we did not find statistical effects of the three EF scores and the type of deceptive strategy adopted or an interaction between the EFs resources and deception. These findings are unexpected and are not in line with those reported by previous studies showing that EF resources influence how people recall an event (e.g., Battista et al., 2020; Gerrie & Garry, 2005; Peters et al., 2007; Watson et al., 2005). In particular, these studies have shown that having higher abilities in cognition lead to better encoding of event-related details resulting in a good retrieval of the event. A possible explanation for having failed to replicate previous findings could be related to the type of EFs score used in this experiment. That is, contrary to the above mentioned studies using an aggregate measure of EF or a measure of WM abilities, we have also examined the three EF scores of Shifting, Inhibition, and Updating separately. We chose this one-facet approach in order to examine which specific EF was more responsible for the mnemonic consequences of lying. However, because the three EFs are strictly related to each other during the execution of a complex task (e.g., recalling an experience; Dempster & Corkill, 1999; Duncan et al., 1996, 1997; Engle & Kane, 2000; Miyake et al., 2000), it could be that this approach has limited the possibility to find an effect of EF on memory. Also, the lack of difference in the recollection of items seen in the video among truth-tellers, false deniers, and fabricators is not in line with prior studies on lying and memory (e.g., Battista et al., 2020).

However, our data on the recall scores (i.e., correct details, omissions, and commissions) for the memory for the video demonstrated a different pattern of results. We showed that EF resources affected the recall of the video. Indeed, we found that the higher Inhibition and Shifting resources, the higher amount of correct details and the lower amount of omissions were reported. Moreover, we also found that the interaction between Shifting resources and the type of deceptive strategy adopted had a statistically significant effect on the correct details and both memory distortions (i.e., omissions and commissions) scores. In particular, our results demonstrated that Shifting resources maximized the difference between fabricators and false deniers as well as between false deniers and truth-tellers with regards to the amount of correct details reported. Moreover, with respect to memory distortions (i.e., omissions and commissions), Shifting resources gained the difference between fabricators and false deniers for omissions, and between fabricators and both false deniers and truth-tellers for commissions. Collectively, this pattern of results suggests that the individual availability of resources to suppress irrelevant information (i.e., Inhibition) and to switch among different tasks or stimuli (i.e., Shifting) is perhaps the most important EFs to correctly recall an event. Thus, in line with previous studies (e.g., Battista et al., 2020; Leding, 2012; Mirandola et al., 2015), we replicated prior results on EFs and memory accuracy showing that a higher amount of EF resources leads to a better memory by isolating the role played by the Inhibition and Shifting resources. Second and in line with our expectations, we also found that the individuals' availability of EF resources, specifically of Shifting resources, influenced the mnemonic consequences of lying on memory. These results are especially relevant because they elucidate which deceptive strategy is more related to individual differences in terms of executive resources. The memory undermining effect due to fabrication has been mainly explained in light of the Source Monitoring Framework (SMF; Johnson et al., 1993). Based on this framework, fabricators report few correct details and thus, in turn, a higher number of commission errors because of a difficulty in recognizing different sources. As such, it is not surprising that fabricators reported fewer correct details and more commissions than false deniers because of Shifting resources. This evidence was also in line with other work showing that the likelihood to report more correct details goes hand in hand with the likelihood to report fewer commissions (e.g., Battista et al., 2020; Battista et al., *under review*).

However, the finding that false deniers reported more omissions than fabricators due to Shifting resources is unexpected. As a matter of fact, the typical argument for this type of memory distortions has been related to an inhibitory mechanism (e.g., Otgaar et al., 2020). That is, because denying an event consists in the inhibition of the memory traces for the original event, when people then recall the actual event, they are less able to retrieve such inhibited traces. Based on this, it was expected that the omissions associated with false denials were more related to a higher individuals' availability of Inhibition resources instead of Shifting resources. Yet, our findings seem to suggest that inhibition processes are implicated during the act of false denials rather than being a protective factor from the consequences of false denials on memory. In other words, it seems that inhibition intervene after the encoding of the information instead of making people more or less susceptible to the effects of false denials on memory. Of course, this was a very first attempt to verify whether individuals' availability of each EF can contribute to the consequences of lying on memory. Therefore, future studies on this issue are needed.

In addition, we found interesting differences between deceivers (i.e., deniers and fabricators) and truth-tellers in their memory performance which conform with our hypotheses (Hypotheses 2 and 3). More specifically, fabricators recalled fewer correct details than both deniers and truth-tellers. Moreover, our data on omission and commission errors also showed that fabricators reported higher omissions and commissions than deniers, whereas no statistically significant differences were found between fabricators and truth-tellers. These findings are consistent with the MAD model (Otgaar & Baker, 2018) and previous studies showing that each deceptive strategy differently affects individuals' memory (e.g., Ackil & Zaragoza, 2011; Gombos et al., 2012; Mangiulli et al., 2018; Otgaar et al., 2016; Romeo et al., 2019; Vieira & Lane, 2013) as well as with studies conducted so far that have shown that fabrication typically leads to a forgetting of the event especially in terms of commission errors (e.g., Chrobak & Zaragoza, 2008, 2012). As mentioned above, fabricators' memory impairments have been explained by considering source monitoring errors (e.g., Chrobak & Zaragoza, 2008; Zaragoza et al., 2001). That is, fabricators reported more memory errors due to an inability to recognize the sources (i.e. false self-generated or true experienced) of information during retrieval of the original event (e.g., Johnson et al., 1981, 1993). Overall, our results suggest that the impairment of memory for the original stimuli in fabricators is simultaneously related to fewer correct details and more memory distortions (i.e., omissions and commissions). What is particularly interesting is the fact that our findings demonstrated that fabricators reported more memory errors (i.e., omissions and commissions) than deniers. Previous studies have mainly demonstrated that fabrication leads to a higher impairment for the event than telling the truth (e.g., Chrobak & Zaragoza, 2008, 2012). Although our findings seem to contradict that, they are in line with the idea of the MAD framework (Otgaar & Baker, 2018). Specifically, when the deceptive strategy requires a high involvement of cognitive resources (i.e., fabrication), people are more prone to experience difficulty in recalling the event – by reporting more memory distortions – than when the strategy requires a low involvement of cognitive resources (i.e., false denials). Those data support the idea that cognitive resources involved during the act of lying are related to the effects of deception on memory.

### *5.1. Conclusion and practical implications*

In the present experiment, we have investigated whether individual differences – in terms of EF resources – interact with the effects of lying on memory (i.e., false denials and fabrication). We found partial support to the idea that individual differences concerning executive functions made individuals more or less susceptible to the adverse consequences of lying on memory. In particular, we found that the effects of lying on memory were mainly related to the individuals' Shifting resources. Moreover, in line with previous studies (e.g., Chrobak & Zaragoza, 2008; Otgaar et al., 2016; Romeo et al., 2018), we found further evidence on the divergent impact of false denials and fabrication on memory. The results of our study provide thus additional information on the factors influencing the reliability of witnesses, suspects, and victims' statements and offer important information for legal professionals (e.g., judges, interviewers). Legal professionals need to take into account multiple factors when making a decision on statements' reliability. Previous studies on individual differences in cognition (e.g., Executive Functions, Working Memory) and memory accuracy (e.g., Battista et al., 2020; Leding, 2012; Watson et al., 2005) may have encouraged legal professionals (i.e., judges, interviewers) to adopt the assessment of individuals' cognitive resources as evidence to support their decision. The findings of the current study give support to this suggestion, simultaneously warning law enforcement about the possible errors that they could fall into when other aspects are not considered (e.g., type of assessment, or which memories witnesses, suspects, or victims are recalling).

Supplementary data to this article can be found online at https://doi.org/10.1016/j.actpsy.2021.103295.

*Acknowledgements*

We would like to thank Federica Cuccia for her help in collecting data.

*Disclosure statement*

No potential conflict of interest was reported by the authors.

## References


Ackil, J. K., & Zaragoza, M. S. (1998). Memorial consequences of forced confabulation: Age differences in susceptibility to false memories. *Developmental Psychology, 34*, 1358–1372. https://doi.org/10.1037/0012-1649.34.6.1358

Ackil, J. K., & Zaragoza, M. S. (2011). Forced fabrication versus interviewer suggestions: Differences in false memory depend on how memory is assessed. *Applied Cognitive Psychology, 25*, 933–942. https://doi.org/10.1002/acp.1785

Allport, A., & Wylie, G. (2000). Task switching, stimulus-response bindings, and negative priming. In *, XVIII. Control of cognitive processes: Attention and performance* (pp. 35–70).

Anderson, M. C., Bjork, R. A., & Bjork, E. L. (1994). Remembering can cause forgetting: Retrieval dynamics in long-term memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20*, 1063–1087. https://doi.org/10.1037/0278-7393.20.5.1063

Anderson, M. C., & Green, C. (2001). Suppressing unwanted memories by executive control. *Nature, 410*, 366–369. http://doi:10.1038/35066572.

Baddeley, A. D. (1996). Exploring the central executive. *Quarterly Journal of Experimental Psychology, 49A*, 5–28. https://doi.org/10.1080/027249896392784

Barkley, R. A. (1997). Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying therapy of ADHD. *Psychological Bulletin, 121*, 65–94. https://doi.org/10.1037/0033-2909.121.1.65

Basden, B. H., Basden, D. R., & Gargano, G. J. (1993). Directed forgetting in implicit and explicitmemory tests: A comparison of methods. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19*, 603–616. https://doi.org/10.1037/0278-7393.19.3.603

Battista, F., Otgaar, H., Lanciano, T., & Curci, A. (2020). Individual differences impact memory for a crime: A study on executive functions resources. *Consciousness and Cognition, 84*, 103000. https://doi.org/10.1016/j.concog.2020.103000

Battista, F., Curci, A., Mangiulli, I., & Otgaar, H. (2021). What can we remember after complex denials? The impact of different false denials on memory. *Psychology, Crime & Law*, 1–18. https://doi.org/10.1080/1068316X.2020.1865956

Battista, F., Curci, A., Mangiulli, I., Riesthuis, P., & Otgaar, H. Do liars really remember what they said? Howfabrication can shape memory. Under review.

Bezdjian, S., Baker, L. A., Lozano, D. I., & Raine, A. (2009). Assessing inattention and impulsivity in children during the Go/NoGo task. *British Journal of Developmental Psychology, 27*, 365–383. https://doi.org/10.1348/026151008x314919

Biederman, J., Monuteaux, M. C., Doyle, A. E., Seidman, L. J., Wilens, T. E., Ferrero, F., … Faraone, S. V. (2004). Impact of executive function deficits and attention-deficit/hyperactivity disorder (ADHD) on academic outcomes in children. *Journal of Consulting and Clinical Psychology, 72*, 757–766. https://doi.org/10.1037/0022-006x.72.5.757

Block, S. D., Shestowsky, D., Segovia, D. A., Goodman, G. S., Schaaf, J. M., & Alexander, K. W. (2012). "That never happened": Adults' discernment of children's true and false memory reports. *Law and Human Behavior, 36*, 365–374. https://doi.org/10.1037/h0093920

Burgess, P. W., & Simons, J. S. (2005). Theories of frontal lobe executive function: Clinical applications. In P. W. Halligan, & D. T. Wade (Eds.), *Effectiveness of rehabilitation for cognitive deficits* (pp. 211–231). New York: Oxford Univ. Press.

Bylin, S. (2002). How does repeated simulation of memory impairment affect genuine memory performance? *Psychology, Crime & Law, 8*(3), 265–288. https://doi.org/10.1080/10683160208401819

Bylin, S., & Christianson, S.-Å. (2002). Characteristics of malingered amnesia: Consequences of withholding vs. distorting information on later memory of a crime event. *Legal and Criminological Psychology, 7*, 45–61. https://doi.org/10.1348/135532502168379

Carpenter, P. A., Just, M. A., & Reichle, E. D. (2000). Working memory and executive function: Evidence from neuroimaging. *Current Opinion in Neurobiology, 10*, 195–199. https://doi.org/10.1016/s0959-4388(00)00074-x

Carretti, B., Belacchi, C., & Cornoldi, C. (2010). Difficulties in working memory updating in individuals with intellectual disability. *Journal of Intellectual Disability Research, 54*, 337–345. https://doi.org/10.1111/j.1365-2788.2010.01267.x

Christ, S. E., Van Essen, D. C., Watson, J. M., Brubaker, L. E., & McDermott, K. B. (2009). Thecontributions of prefrontal cortex and executive control to deception: Evidence from activation likelihood estimate meta-analyses. *Cerebral Cortex, 19*, 1557–1566. https://doi.org/10.1093/cercor/bhn189

Christianson, S. A., & Bylin, S. (1999). Does simulating amnesia mediate genuine forgetting for a crime event? *Applied Cognitive Psychology, 13*, 495–511. https://doi.org/10.1002/(sici)1099-0720(199912)13:6<495::aid-acp615>3.0.co;2-0

Chrobak, Q. M., & Zaragoza, M. S. (2008). Inventing stories: Forcing witnesses to fabricate entire fictitious events leads to freely reported false memories. *Psychonomic Bulletin & Review, 15*, 1190–1195. https://doi.org/10.3758/PBR.15.6.1190

Chrobak, Q. M., & Zaragoza, M. S. (2012). The misinformation effect. In A. M. Ridley, F. Gabbert, & D. J. La Rooy (Eds.), *Suggestibility in legal contexts: Psychological research and forensic implications (pp. 21–44)*. Wiley Blackwell. https://doi.org/10.1002/9781118432907.ch2.

Cima, M., Merckelbach, H., Nijman, H., Knauer, E., & Hollnack, S. (2002). I can't remember yourhonor: Offenders who claim amnesia. *German Journal of Psychiatry, 5*, 24–34.

Davis, J., Bayantemur, S., Seecharan, S., Unger, L., Hellgren, J., & Stone, C. (2018). Fluctuating confidence: The dynamic consequences of true/false affirmatives and denials on how a listener appraises their personal past. *Memory, 26*, 882–893. https://doi.org/10.1080/09658211.2018.1468468

Deeb, H., Granhag, P. A., Vrij, A., Strömwall, L. A., Hope, L., & Mann, S. (2018). Visuospatial counter-interrogation strategies by liars familiar with the alibi setting. *Applied Cognitive Psychology, 32*, 105–116. https://doi.org/10.1002/acp.3383

Dempster, F. N., & Corkill, A. J. (1999). Individual differences in ssceptibility to interference and general cognitive ability. *Acta Psychologica, 101*, 395–416. https://doi.org/10.1016/s0001-6918(99)00013-x

Diamond, A. (2013). Executive functions. *Annual Review of Psychology, 64*, 135–168. https://doi.org/10.1146/annurev-psych-113011-143750

Duncan, J., Emslie, H., Williams, P., Johnson, R., & Freer, C. (1996). Intelligence and the frontal lobe: The organization of goal-directed behavior. *Cognitive Psychology, 30*, 257–303. https://doi.org/10.1006/cogp.1996.0008

Duncan, Johnson, R., Swale, M., & J.. (1997). Frontal lobe deficits after head injury: Unity and diversity of function. *Cognitive Neuropsychology, 14*, 713–741. https://doi.org/10.1080/0264329973814

Duran, G., Dochez, S., Tapiero, I., & Michael, G. A. (2020). *Opinions, actions and emotions: Does the content of lies affect their detectability?* (pp. 1–23) Crime & Law: Psychology. https://doi.org/10.1080/1068316x.2020.1742341

Engle, R. W., & Kane, M. J. (2000). *Working memory, controlled attention and task switching.* https://doi.org/10.21236/ada375952

Espy, K. A. (2004). Using developmental, cognitive, and neuroscience approaches to understand executive control in young children. *Developmental Neuropsychology, 26*, 379–384.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*, 175–191. https://doi.org/10.3758/BF03193146

Fleming, K. A., Heintzelman, S. J., & Bartholow, B. D. (2016). Specifying associations between conscientiousness and executive functioning: Mental set shifting, not prepotent response inhibition or working memory updating. *Journal of Personality, 84*, 348–360. https://doi.org/10.1111/jopy.12163

Friedman, N. P., Miyake, A., Robinson, J. L., & Hewitt, J. K. (2011). Developmental trajectories in toddlers' self-restraint predict individual differences in executive functions 14 years later: A behavioral genetic analysis. *Developmental Psychology, 47*, 1410. https://doi.org/10.1037/a0023750

Gerrie, M. P., & Garry, M. (2007). Individual differences in working memory capacity affect false memories for missing aspects of events. *Memory, 15*, 561–571. https://doi.org/10.1080/09658210701391634

Giancola, P. R. (2004). Executive functioning and alcohol-related aggression. *Journal of Abnormal Psychology, 113*(4), 541–555. https://doi.org/10.1037/0021-843x.113.4.541

Gombos, V., Pezdek, K., & Haymond, K. (2012). Forced confabulation affects memory sensitivity as well as response bias. *Memory and Cognition, 40*, 127–134. https://doi.org/10.3758/s13421-011-0129-5

Goodman-Brown, T. B., Edelstein, R. S., Goodman, G. S., Jones, D. P. H., & Gordon, D. S. (2003). Why children tell: A model of children's disclosure of sexual abuse. *Child Abuse & Neglect, 27*, 525–540. https://doi.org/10.1016/S0145-2134(03)00037-1

Jaschinski, U., & Wentura, D. (2002). Misleading postevent information and working memory capacity: An individual differences approach to eyewitness memory. *Applied Cognitive Psychology, 16*, 223–231. https://doi.org/10.1002/acp.783

Jersild, A. T. (1927). Mental set and shift. Archives of Psychology, Whole No. 89. *Journal of Experimental Psychology, 49*, 29–50.

Johnson, M. K., Raye, C. L., Foley, H. J., & Foley, M. A. (1981). Cognitive operations and decision bias in reality monitoring. *American Journal of Psychology, 94*, 37–64. https://doi.org/10.2307/1422342

Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin, 114*, 3–28. https://doi.org/10.1037/0033-2909.114.1.3

Johnson, M. K., & Raye, C. L. (1981). Reality monitoring. *Psychological Review, 88*, 67–85. https://doi.org/10.1037/0033-295X.88.1.67

Jonides, J., & Smith, E. E. (1997). The architecture of working memory. In M. D. Rugg (Ed.), *Cognitive neuroscience* (pp. 243–276). Cambridge, MA: MIT Press.

Kersten, A. W., Earles, J. L., Aucello, K., Tautiva, E., McRostie, N., Brydon, C., & Adaryukov, J. (2018). Influences of executive and memory functioning on memory for the sources of actions. *Psychology and Aging, 33*, 1115–1133. https://doi.org/10.1037/pag0000312

Langberg, J. M., Dvorsky, M. R., & Evans, S. W. (2013). What specific facets of executive function are associated with academic functioning in youth with attention-deficit/hyperactivity disorder? *Journal of Abnormal Child Psychology, 41*, 1145–1159. https://doi.org/10.1007/s10802-013-9750-z

Leding, J. K. (2012). Working memory predicts the rejection of false memories. *Memory, 20*, 217–223. https://doi.org/10.1080/09658211.2011.653373

Lehto, J. (1996). Are executive function tests dependent on working memory capacity? *The Quarterly Journal of Experimental Psychology A, 49*, 29–50. https://doi.org/10.1080/027249896392793

Logan, G. D. (1985). Executive control of thought and action. *Acta Psychologica, 60*, 193–210. https://doi.org/10.1016/0001-6918(85)90055-1

Logan, G. D. (1994). On the ability to inhibit thought and action: A user's guide to the stop signal paradigm. In D. Dagenbach, & T. H. Carr (Eds.), *Inhibitory processes in attention, memory, and language (pp. 189–239)*. Academic Press.

Lyon, G. R., Krasnegor, N. A., & McMenamin, S. (1996). Attention, memory, and executive function. *Journal of Developmental & Behavioral Pediatrics, 17*, 278. https://doi.org/10.1097/00004703-199608000-00014

Mangiulli, I., van Oorsouw, K., Curci, A., Merckelbach, H., & Jelicic, M. (2018). Feigning amnesia moderately impairs memory for a mock crime video. *Frontiers in Psychology, 9*, 625. https://doi.org/10.3389/fpsyg.2018.00625

Marsh, E. J., Balota, D. A., & Roediger, H. L. (2005). Learning facts from fiction: Effects of healthy aging and early-stage dementia of the Alzheimer type. *Neuropsychology, 19*, 115–129. https://doi.org/10.1037/0894-4105.19.1.115

Miller, M., & Hinshaw, S. P. (2010). Does childhood executive function predict adolescent functional outcomes in girls with ADHD? *Journal of Abnormal Child Psychology, 38*, 315–326. https://doi.org/10.1007/s10802-009-9369-2

Mirandola, C., Toffalini, E., Ciriello, A., & Cornoldi, C. (2015). Working memory affects false memory production for emotional events. *Cognition and Emotion, 31*, 33–46. https://doi.org/10.1080/02699931.2015.1075379

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 41*, 49–100. https://doi.org/10.1006/cogp.1999.0734

Monsell, S. (1996). Control of mental processes. In V. Bruce (Ed.), *Unsolved mysteries of the mind: Tutorial essays in cognition (pp. 93–148)*. Erlbaum.

Morris, N., & Jones, D. M. (1990). Memory updating in working memory: The role of the central executive. *British Journal of Psychology, 81*, 111–121. https://doi.org/10.1111/j.2044-8295.1990.tb02349.x

Nourkova, V., Bernstein, D., & Loftus, E. (2004). Altering traumatic memory. *Cognition and Emotion, 18*, 575–585. https://doi.org/10.1080/02699930341000455

Novelli, G., Papagno, C., Capitani, E., & Laiacona, M. (1986). *Tre test clinici di ricerca e produzione lessicale. Taratura su soggetti normali. Archivio di psicologia, neurologia e psichiatria*.

Otgaar, H., & Baker, A. (2018). When lying changes memory for the truth. *Memory, 26*, 2–14. https://doi.org/10.1080/09658211.2017.1340286

Otgaar, H., Howe, M. L., Mangiulli, I., & Bücken, C. (2020). The impact of false denials on forgetting and false memory. *Cognition, 202*, 104322. https://doi.org/10.1016/j.cognition.2020.104322

Otgaar, H., Howe, M. L., Memon, A., & Wang, J. (2014). The development of differential mnemonic effects of false denials and forced confabulations. *Behavioral Sciences & the Law, 32*, 718–731. https://doi.org/10.1002/bsl.2148

Otgaar, H., Howe, M. L., Smeets, T., & Wang, J. (2016). Denial-induced forgetting: False denials undermine memory but external denials undermine belief. *Journal of Applied Research in Memory and Cognition, 5*, 168–175. https://doi.org/10.1016/j.jarmac.2016.04.002

Paige, L. E., Wolf, J. M., & Gutchess, A. (2020). Evaluating heart rate variability as a predictor of the influence of lying on memory. *Memory*, 1–11. https://doi.org/10.1080/09658211.2020.1849307

Peters, M. J. V., Jelicic, M., Verbeek, H., & Merckelbach, H. (2007). Poor working memory predicts false memories. *European Journal of Cognitive Psychology, 19*, 213–232. https://doi.org/10.1080/09541440600760396

Pickel, K. (2004). When a lie becomes the truth: The effects of self-generated misinformation on eyewitness memory. *Memory, 12*, 14–26. https://doi.org/10.1080/09658210244000072

Polage, D. C. (2004). Fabrication deflation? The mixed effects of lying on memory. *Applied Cognitive Psychology, 18*, 455–465. https://doi.org/10.1002/acp.995

Polage, D. C. (2012). Fabrication inflation increases as source monitoring ability decreases. *Acta Psychologica, 139*, 335–342. https://doi.org/10.1016/j.actpsy.2011.12.007

Polage, D. C. (2018). Liar, liar: Consistent lying decreases belief in the truth. *Applied Cognitive Psychology*. https://doi.org/10.1002/acp.3489

Pyszora, N. M., Barker, A. F., & Kopelman, M. D. (2003). Amnesia for criminal offences: A study of life sentence prisoners. *The Journal of Forensic Psychiatry, 14*, 475–490. https://doi.org/10.1080/14789940310001599785

Riesthuis, P., Otgaar, H., Mangiulli, I., & de Tauzia, R. (2020). Adopting a fictitious autobiography: Fabrication inflation or deflation? *Memory, 28*, 741–752. https://doi.org/10.1080/09658211.2020.1771371

Rogers, R. D., & Monsell, S. (1995). Costs of a predictible switch between simple cognitive tasks. *Journal of Experimental Psychology: General, 124*, 207–231. https://doi.org/10.1037/0096-3445.124.2.207

Romeo, T., Otgaar, H., Smeets, T., Landstrom, S., & Boerboom, D. (2018). The impact of lying about a traumatic virtual reality experience on memory. *Memory & Cognition, 47*, 485–495. https://doi.org/10.3758/s13421-018-0885-6

Romeo, T., Otgaar, H., Smeets, T., Landström, S., & Jelicic, M. (2019). The memory-impairing effects of simulated amnesia for a mock crime. *Applied Cognitive Psychology, 33*, 983–990. https://doi.org/10.1002/acp.3508

Salthouse, T. A., Berish, D. E., & Siedlecki, K. L. (2004). Construct validity and age sensitivity of prospective memory. *Memory & Cognition, 32*, 1133–1148. https://doi.org/10.3758/BF03196887

Scoboria, A., Mazzoni, G., Kirsch, I., & Relyea, M. (2004). Plausibility and belief in autobiographical memory. *Applied Cognitive Psychology, 18*, 791–807. https://doi.org/10.1002/acp.1062

Smith, E. E., & Jonides, J. (1999). Storage and executive processes in the frontal lobes. *Science, 283*, 1657–1661. https://doi.org/10.1126/science.283.5408.1657

Spector, A., & Biederman, I. (1976). Mental set and mental shift revisited. *The American Journal of Psychology, 89*(4), 669. https://doi.org/10.2307/1421465

Sun, X., Punjabi, P. V., Greenberg, L. T., & Seamon, J. G. (2009). Does feigning amnesia impairsubsequent recall? *Memory & Cognition, 37*, 81–89. https://doi.org/10.3758/MC.37.1.81

Takarangi, M. K. T., Parker, S., & Garry, M. (2006). Modernising the misinformation effect: Thedevelopment of a new stimulus set. *Applied Cognitive Psychology, 20*, 583–590. https://doi.org/10.1002/acp.1209

Thomas, A. K., Bulevich, J. B., & Loftus, E. F. (2003). Exploring the role of repetition and sensory elaboration in the imagination inflation effect. *Memory & Cognition, 31*, 630–640. https://doi.org/10.3758/BF03196103

Thorell, L. B. (2007). Do delay aversion and executive function deficits make distinct contributions to the functional impact of ADHD symptoms? A study of early academic skill deficits. *Journal of Child Psychology and Psychiatry, 48*, 1061–1070. https://doi.org/10.1111/j.1469-7610.2007.01777.x

Unsworth, N., Miller, J. D., Lakey, C. E., Young, D. L., Meeks, J. T., Campbell, W. K., & Goodie, A. S. (2009). Exploring the relations among executive functions, fluid intelligence, and personality. *Journal of Individual Differences, 30*, 194–200. https://doi.org/10.1027/1614-0001.30.4.194

Van Oorsouw, K., & Giesbrecht, T. (2008). Minimizing culpability increases commission errors ina mock crime paradigm. *Legal and Criminological Psychology, 13*, 335–344. https://doi.org/10.1348/135532507X228539

Van Oorsouw, K., & Merckelbach, H. (2004). Feigning amnesia undermines memory for a mockcrime. *Applied Cognitive Psychology, 18*, 505–518. https://doi.org/10.1002/acp.999

Van Oorsouw, K., & Merckelbach, H. (2006). Simulating amnesia and memories of a mock crime. *Psychology, Crime & Law, 12*, 261–271. https://doi.org/10.1080/10683160500224477

Verigin, B. L., Meijer, E. H., Bogaard, G., & Vrij, A. (2019). Lie prevalence, lie characteristics and strategies of self-reported good liars. *PLoS ONE, 14*, Article e0225566. https://doi.org/10.1371/journal.pone.0225566

Verigin, B. L., Meijer, E. H., Vrij, A., & Zauzig, L. (2019). *The interaction of truthful and deceptive information*. Psychology: Crime & Law. Advance online publication. https://doi.org/10.1080/1068316X.2019.1669596

Vieira, K. M., & Lane, S. M. (2013). How you lie affects what you remember. *Journal of Applied Research in Memory and Cognition, 2*, 173–178. https://doi.org/10.1016/j.jarmac.2013.05.005

Vrij, A., & Ganis, G. (2014). Theories in deception and lie detection. *Credibility Assessment*, 301–374. https://doi.org/10.1016/b978-0-12-394433-7.00007-5

Vrij, A., Granhag, P. A., & Porter, S. (2010). Pitfalls and opportunities in nonverbal and verbal lie detection. *Psychological Science in the Public Interest, 11*, 89–121. https://doi.org/10.1177/1529100610390861

Vrij, A., Mann, S. A., Fisher, R. P., Leal, S., Milne, R., & Bull, R. (2008). Lie detection questionnaire. In *PsycTESTS dataset*. https://doi.org/10.1037/t38017-000

Walczyk, J. J., Harris, L. L., Duck, T. K., & Mulay, D. (2014). A social-cognitive framework for understanding serious lies: Activation-decision-construction-action theory. *New Ideas in Psychology, 34*, 22–36. https://doi.org/10.1016/j.newideapsych.2014.03.001

Watson, J. M., Bunting, M. F., Poole, B. J., & Conway, A. R. A. (2005). Individual differences in susceptibility to false memory in the Deese-Roediger-McDermott paradigm. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 31*, 76–85. https://doi.org/10.1037/0278-7393.31.1.76

Zaragoza, M. S., Payment, K. E., Ackil, J. K., Drivdahl, S. B., & Beck, M. (2001). Interviewing witnesses: Forced confabulation and confirmatory feedback increase false memories. *Psychological Science, 12*, 473–477. https://doi.org/10.1111/1467-9280.00388