The Impact of False Denials on Forgetting and False Memory

Henry Otgaar[1,2,3], Mark L. Howe[1,2], Ivan Mangiulli[3], & Charlotte Bücken[1]

[1]Maastricht University, The Netherlands

[2]City, University of London, UK

[3]Catholic University of Leuven, Belgium

Correspondence should be sent to: Henry Otgaar, Henry.Otgaar@maastrichtuniversity.nl,

Faculty of Psychology and Neuroscience, section Forensic Psychology, Maastricht University.

IN PRESS: ***Cognition***
Accepted May 5, 2020

Abstract

People sometimes falsely deny having experienced an event. In the current experiments, we examined the effect of false denials on forgetting and false memory formation. In Experiment 1, participants were presented with emotionally-negative and neutral associatively related word lists known to engender false memories. After encoding, half of the participants had to falsely deny having seen the words while the other half had to tell the truth. During a final memory test (recall or source monitoring task), participants who falsely denied forgot that they discussed certain words with an experimenter. Furthermore, the act of falsely denying reduced the formation of false memories. These results were partially replicated in Experiment 2 where participants also had to re-learn several words and received a second memory task. This latter design feature diminished the effect of false denials on false memory creation. Our experiments suggest that false denials not only have negative consequences (forgetting), but can have positive ones too (reduction in false memories).

Keywords: False Denial; False Memory; Denial-induced Forgetting; Associative Activation; Inhibition

The Impact of False Denials on Forgetting and False Memory

A traumatic experience can haunt people their entire life. The act of denial is sometimes used as a potent way to cope with such trauma. For example, people might falsely deny having been sexually abused. The origin of denial can be found in the psychoanalytic tradition as an effective defence mechanism to deal with unwanted memories. Coping strategies such as denial might be regarded as salutary for survivors of trauma, yet denial has counterproductive effects as well. In the current experiments, we examined these counterproductive effects on memory, specifically on forgetting and false memories.

Denial and Forgetting

One of the first empirical studies into the effects of denials on memory was performed by Vieira and Lane (2013). In their study, participants viewed several pictures of simple objects (e.g., teacup). Next, participants were instructed to tell the truth or lie about certain objects, which were either already presented or new. Specifically, labels naming the (old and new) objects were shown on a screen and, under each label, participants had to tell the truth or lie by describing the label or by denying the presented label. Two days later, participants received a source memory test. Of importance for the current experiments was the result that participants displayed poor memory for having falsely denied a presented object.

Subsequent research has confirmed that false denials might have adverse effects on memory. Otgaar, Howe, Memon, and Wang (2014) instructed children (6-8 and 10-12-year-olds) and adults to look at a video concerning an electrician stealing some items in a house. Participants then received several questions about what they could still recollect of the video. After this, participants were allocated to three different groups but the most relevant one was the false denial group. In this group, participants were instructed to falsely deny in response to questions by stating that certain details (that were actually present in the video) were not shown in the video (e.g., "The man did not steal anything"). One week later, participants received a source memory test. Crucially, they were asked whether they could remember seeing certain details on the video and whether they could recollect talking about these details in the interview. The chief finding was that participants who had to falsely deny were less likely to remember that they talked about certain details during the interview with the experimenter (i.e., denial-induced forgetting effect, Otgaar et al., 2014). So, this suggests that they could not remember that they denied certain details during the interview.

This denial-induced forgetting effect has been replicated in a variety of related experiments in our lab. Specifically, the effect has been detected using neutral and negative pictures (Otgaar, Howe, Smeets, & Wang, 2016 (Experiment 1)), virtual reality (Romeo, Otgaar, Smeets, Landström, & Boerboom, 2019), and recall memory tasks (Otgaar, Romeo, Ramakers, & Howe, 2018). Taken together, evidence is accumulating that false denials have deteriorating effects on memory in that they can lead to forgetting. However, what is currently missing is to examine whether, besides forgetting, false denials can also have an impact on others memory errors such as false memories. Previous research used stimuli that did not permit the investigation of false memories (e.g., Otgaar et al., 2016). Hence, in the present experiments, we examined whether false denials affected the production of false memories.

Other Forgetting Phenomena

The act of falsely denying and its concomitant consequences are to some extent related to other forgetting phenomena. That is, false denials lead to forgetting and in the literature, several forgetting phenomena are described that are seemingly linked to denial-induced forgetting. To understand in what way denials might undermine memory, it is imperative to know some specifics of other forgetting phenomena. Note that when people falsely deny, they provide an *explicit* response that something did not occur which then results in forgetting. In forgetting-related phenomena, such explicit responses are oftentimes withheld by the experiencer. For example, studies examining the memory undermining effects of feigning amnesia are also relevant for denial-induced forgetting. Specifically, in the classic feigned amnesia for a mock crime paradigm (e.g., van Oorsouw & Merckelbach, 2004), participants are asked to feign memory loss for a mock criminal experience. After a delay, feigners are told to tell the truth. Compared with participants who were initially instructed to report the truth, feigning amnesia participants showed a weaker memory performance for the same event. Furthermore, recent work has also revealed that feigning amnesia also impairs memory for what was discussed (Romeo, Otgaar, Smeets, Landström, & Jelicic, 2019). Thus, feigning amnesia for a mock crime leads to memory impairing effects (e.g., Mangiulli, van Oorsouw, Curci, Merckelbach, & Jelicic, 2018; van Oorsouw & Merckelbach, 2004).

Research on directed forgetting is also related to denial-induced forgetting. In this line of experimentation, participants receive, for example, a series of word lists and are instructed to remember or forget certain lists (i.e., list method) or certain words (i.e., item method). The critical finding is that participants are less likely to remember words from lists, or lists themselves, that had to be forgotten than remembered (MacLeod, 1989, 2012). It has to be noted that a critical distinction between denial-induced forgetting and other forgetting phenomena (e.g., directed forgetting) is that denial-induced forgetting does not affect memory for details of the presented information. What seems to be affected is memory for the interview, wherein participants forget what that previously denied. This finding is related to the forgot-it-all-along effect (Arnold & Lindsay, 2002; Schooler, Bendiksen, & Ambadar, 1997). This effect refers to the result that people forget previous instances of remembering and this seems to occur when the remembrance of past events occurs in different ways on separate times. Collectively, research on the memory deteriorating effects of false denials is connected to other forgetting effects (e.g., directed forgetting).

Potential Mechanisms Underlying Denial-induced Forgetting

A crucial, yet unresolved issue is which mechanism underpins the denial-induced forgetting effect. Research on the effects of lying on memory might provide some clues concerning this issue. That is, the act of false denials can be viewed as an act of lying. Recently, indeed, Otgaar and Baker (2018) reviewed the available literature on how lying impacts memory for the truth. By distinguishing various form of lying (i.e., false denial, feigning amnesia, and fabrication), it was suggested that memory for an event might be differentially affected according to the type of deceptive strategies adopted. Specifically, based on the available evidence, simple lies such as false denials and feigning amnesia have been shown to lead to memory impairing effects while fabrication has been found to foment false memory formation (e.g., Ackil & Zaragoza, 1998; van Oorsouw & Merckelbach, 2006). Otgaar and Baker (2018) proposed that deceptive strategies such as feigning amnesia and falsely denying might lead to a lack of rehearsal of the experienced event. Specifically, when participants are engaged in such deceptive strategies, they are less likely to practice the information that was experienced leading to less successful storage of that information. The net consequence of this is that people using those strategies have impaired memory performance (e.g., forgetting) conmpared with people who are not involved in such deception (but see also Sun, Punjabi, Greenberg, & Seamon, 2009).

An alternative explanation for the memory undermining effect of false denial is that the act of denial suppresses memories entering awareness thereby rendering those memories less likely to be retrieved in subsequent memory tasks. These inhibitory mechanisms have also been proposed to underlie directed forgetting (e.g., Ullsperger, Mecklinger, & Müller, 2000). False denials might also lead to memory undermining effects because they adversely affect the belief in the occurrence of the event(s). Research is accumulating showing that recollection and belief are separate constructs contributing to the experience of remembering (Scoboria, Jackson, Talarico, Hancczakowski, Wysman, & Mazzoni, 2014). In many circumstances, people have a strong recollection of an event and also believe in the occurrence of those events. However, there are also instances in which belief and recollection are dissociated, such as in nonbelieved memories in which people remember events where the belief in those events is reduced (Mazzoni, Scoboria, & Harvey, 2010; for a review see Otgaar, Scoboria, & Mazzoni, 2014). Research has shown that belief is easily impacted by external feedback (e.g., Otgaar, Wang, Fränken, & Howe, 2018; Scoboria, Wysman, & Otgaar, 2012). Recent experimentation has examined whether false denials might act as some form of internal feedback that may affect belief. Although in one of our studies, we did not find evidence for this (Otgaar et al., 2016), Polage (2019) recently found that repeated false denials decreased belief in the truth of events (see also Romeo et al., 2019).

False Denials and False Memories

What could be the consequences of such possible memory mechanisms on other memory phenomena such as false memories? Interestingly, findings in this area have been mixed. Kimball and Bjork (2002) had participants take part in a list-wise directed forgetting paradigm using associatively-related word lists known to successfully engender false memories (i.e., Deese/Roediger-McDermott (DRM) word lists; Deese, 1959; Roediger & McDermott, 1995).

They found that the instruction given to participants to forget certain DRM lists led to increased false memory rates. Howe (2005), by using the same methodology, showed that children exhibited reduced false memory rates for DRM lists that had to be suppressed. In contrast with Kimball and Bjork (2002), however, Marche, Brainerd, Lane, and Loehr (2005) showed that the instruction to forget diminished false memory generation when using an item method directed forgetting procedure.

Several false memory theories might illuminate how false denials impact false memory elicitation. The main precept of associative-activation theory (AAT; Howe, Wimmer, Gagnon, & Plumpton, 2009; Otgaar, Howe, Muris, & Merckelbach, 2019) is that spreading activation through one's mental lexicon might lead to false memory production. Specifically, according to AAT, when people experience an event and encode parts of that experience, concepts in one's knowledge base will be activated that are related and have been experienced earlier, but concepts will also be activated that are related, but were not part of the original experience. It is this latter consequence that might end up creating false memories. Activation-monitoring theory (AMT; Roediger, Balota, & Watson, 2001) also uses the notion of spreading activation, but it also encompasses the idea that false memories are the result of incorrectly monitoring the source of spreading activation. That is, participants confuse items that arise during retrieval that were not presented with those that were presented. The act of denial might be seen as an attempt to suppress memories at retrieval potentially making them less accessible.

If false denials lead to inhibitory effects at retrieval, AAT and AMT would predict that this inhibition would make the critical lure less likely to be retrieved and attributed to a wrong source. If so, this would imply that false denials lower the probability that false memories will be produced during recall or recognition tests. Whatever the mechanism is underlying denial-induced forgetting, the general expectation based on these potential mechanisms is that false denials should lower false memory levels. In other words, apart from the negative effects that denials have on memory (i.e., forgetting), the investigation of false denial effects on false memory might reveal whether false denials might also be linked to more beneficial effects (i.e., lower false memory output rates).

The Present Experiments

The purpose of the present experiments was to examine the effect of false denials on false memory induction. We used a procedure along the lines of previous studies on the denial-induced forgetting effect (e.g., Otgaar et al., 2018; Romeo et al., 2019). However, in the current experiments, we used associatively-related DRM word lists as stimuli to evoke false memories. Specifically, participants were presented with several DRM lists and afterwards received a baseline memory task. Following this, participants received several memory-related questions where one group was instructed to falsely deny while the other group was instructed to answer truthfully. Finally, participants received a memory test.

Experiment 1

In the first experiment, we also explored whether denial-induced forgetting would appear in recall tests; something that we showed before but not with words (see Otgaar et al., 2018). Furthermore, in the first experiment, we used neutral and negatively-charged DRM lists to examine whether the denial-induced forgetting would be of similar size for both valenced lists; a finding that we reported before but only for pictures (Otgaar et al., 2016). We included neutral and emotionally-negative lists for two reasons. First, the act of denial is often linked with the denial of traumatic experiences such as sexual abuse. From a practical perspective, the question arises whether denial has differential memory undermining effects for neutral and negative experiences. Because emotionally-negative experiences are generally better and more vividly remembered than neutral events (Kensinger & Ford, 2020), denial might exert less impact on negative than neutral experiences (but see Otgaar et al., 2016). Second, a plethora of research has shown that emotionally-negative false memories are more likely to be elicited than neutral ones (e.g., Howe, Candel, Otgaar, Malone, & Wimmer, 2010). An empirical question is whether denial also has different memory effects on negative than neutral false memories. Our predictions were the following. First, we expected to find a denial-induced forgetting effect for words. Second, we predicted that false denials would lead to lower false memory levels.

Method

Participants

Using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007), we ran an a priori power analysis for an ANOVA: Repeated measures, between factors. We anticipated a medium effect size ($f = 0.25$) and used a power of 0.80. Furthermore, the number of groups was 4 and number of measurements 2. This power analysis showed that we needed a sample size of 136 participants. One-hundred and forty participants took part in this experiment (44 men, 96 women; no participants were excluded). The age of participants ranged from 18-44 years (M = 24.87, SD = 4.03). Participants were university students who received 1 credit point or financial compensation (7.50 euro) for their participation in the study. The current study was approved by the ethical committee of the Faculty of Psychology and Neuroscience, Maastricht University.

Materials

DRM Word Lists. Participants received 5 neutral (critical lures: chair, fruit, sleep, lion, and sweet) and 5 emotionally-negative (critical lures: lie, cry, thief, alone, and anger) DRM word lists with each list containing 12 words. These lists have been shown to successfully elicit false memories (Howe et al., 2010). An example of a neutral DRM word list with the critical lure "chair" was the following: table, sit, leg, seat, couch, desk, sofa, cushion, sitting, stool, bench, rocking. Importantly, these words were associatively related to the non-presented critical lure (e.g., chair).

Design and Procedure

This experiment made use of a 2(Valence: Neutral versus Negative) x 2(Condition: False Denial versus Control) x 2 (Test: Source Monitoring versus Recall) mixed design with the first factor being within- and the remaining factors being between-participants. Participants were randomly assigned to the different conditions (False Denial: n = 70, Control: n = 70). DRM word lists (i.e., neutral vs. negative) were counterbalanced within subjects.

Participants were tested in quiet testing rooms at the Faculty of Psychology and Neuroscience, Maastricht University. The entire experiment contained two sessions with the second session occurring the next day. During the first session, after signing informed consent, participants received 5 neutral and 5 negative DRM lists (see Figure 1). Each word (e.g., table) was presented for 2 seconds and between each list a 2 seconds fixation cross was shown. The slide presentation was made using Powerpoint. After the presentation of all lists, participants received a distractor task (playing the computer game Bejeweled) that lasted 5 minutes. Following this, participants' baseline memory performance was measured by asking 50 questions about the DRM word lists (5 items of each list; e.g., "Do you remember that you have seen the word [table]"?). Participants had to respond truthfully. After this, participants were engaged again in a 5-minute distractor task (Bejeweled). Then, participants received 60 memory-related questions of which 40 were already asked during the baseline memory task (e.g., table) and 20 questions pertained to presented words that were not asked yet during the baseline task (e.g., sofa). Before the task started, participants in the false denial group were instructed to (falsely) deny in response to each question (e.g., “Did you see the word [sofa]”?; Answer: “No, I did not see the word [sofa]”) while the control group were told to answer the questions truthfully. Participants in the denial condition were not allowed to just say “no,” but had to deny the entire sentence including the word.

After one day, the second session took place. All participants were instructed to tell the truth and received a memory task. Specifically, one half of the participants received a source monitoring task in which questions were asked referring to 10 critical lures (e.g., chair), 10 words unrelated to the previously presented lists (e.g., glass), 12 words presented at the baseline phase (and manipulation phase; e.g., table), 12 words presented during the manipulation phase (e.g., sofa), and 20 new words (e.g., bench) (words not presented during the previous phases). During the source monitoring task and for each word, participants received two questions. One referred to their memory of the interview that occurred the day before (e.g., “Did you remember that we spoke about the word [fruit] yesterday?”) and the other question referred to their memory of the stimuli (e.g., “When you looked at the slides yesterday, did you see the word [fruit]?”). The other half of participants were asked to recall all the words that they remember they had seen and all the words they remember they had discussed about in the previous session. Both source monitoring and recall lasted 10 minutes. Finally, the participants were debriefed about the purpose of the study.

Scoring

We had several memory indices. For both true and false memory creation, we calculated memory scores for the interview and stimuli separately. Because we had two different memory tests (recall and source monitoring), scores were calculated for each test separately as well.

Specifically, for the source monitoring task, yes-responses to questions pertaining to memory (true and false) for the stimuli (e.g., "Did you remember that we spoke about the word [fruit] yesterday?") were summed and mean total scores were used for the analysis. The same was done for memory for the interview. Furthermore, we also made separate scores for words that were only mentioned in the manipulation phase, words that were mentioned in the baseline memory task and manipulation phase, and new words. For the recall test, we also calculated memory scores for the interview and stimulus presentation separately. That is, we summed all recall responses referring to words that were presented during stimulus presentation and calculated a mean total score. When participants incorrectly recalled the critical lure, these responses were also summed and a mean total score was computed.

Results

All data can be found on the Open Science Framework: https://osf.io/vh9nx/

Baseline Memory Performance

A 2(Valence: Neutral versus Negative) x 2(Condition: False Denial versus Control) repeated measures ANOVA was conducted on the baseline memory data. No statistically significant effects emerged (Fs < 2.49, ps > 0.12).

True Memory

True memory refers to participants correctly remembering items that were discussed (Memory for the Interview) and/or were presented (Memory for the Stimuli). Because the source monitoring and recall data were measured in a different way, we performed separate 2(Valence: Neutral versus Negative) x 2(Condition: False Denial versus Control) repeated measures ANOVAs on the source monitoring and recall data. We will always first present the source monitoring data and then the recall data.

Memory for the Interview. We first performed an analysis on items that were only mentioned during the manipulation phase. A 2(Valence: Neutral versus Negative) x 2(Condition: False Denial versus Control) repeated measures ANOVA was conducted on the true memory data of the source monitoring task. No statistically significant interaction was observed ($F(1, 68) = 0.50$, $p = 0.48$, $\eta^2_p = 0.01$). Importantly, we found that participants who falsely denied were less likely to remember that they falsely denied ($M = 3.59$, 95%CI [3.28, 3.90]) than participants who told the truth ($M = 5.14$, 95%CI [4.84, 5.44]; $F(1, 68) = 51.94$, $p < .001$, $\eta^2_p = 0.43$). We also found that neutral words ($M = 4.61$, $SD = 1.41$) were better recollected than negative words ($M = 4.16$, $SD = 1.47$; $F(1, 68) = 6.55$, $p = .01$, $\eta^2_p = 0.09$).

Our second analysis concerned items that were included in the baseline memory task and the manipulation phase. A 2(Valence: Neutral versus Negative) x 2(Condition: False Denial versus Control) repeated measures ANOVA was conducted on the true memory data of the source monitoring task. No statistically significant interaction was detected ($F(1, 68) = 3.93$, $p = 0.051$, $\eta^2_p = 0.06$). We again found a denial-induced forgetting effect ($F(1, 68) = 31.09$, $p < 0.001$, $\eta^2_p = 0.31$; see Figure 2). Participants in the false denial group ($M = 4.50$, 95%CI [4.18, 4.82] were less likely to indicate that they discussed certain words than the control group ($M = 5.75$, 95%CI [5.44, 6.06]). A valence effect ($F(1, 68) = 10.30$, $p = 0.002$, $\eta^2_p = 0.13$) was also found with neutral words ($M = 5.50$, $SD = 1.55$) being better recollected than negative words ($M = 4.79$, $SD = 1.41$).

To show that the denial-induced forgetting only occurs for items that were falsely denied, we also examined whether this forgetting effect would be absent for words that were not falsely denied. We conducted a 2(Valence: Neutral versus Negative) x 2(Condition: False Denial versus Control) repeated measures ANOVA on true memory performance of new words that were not falsely denied but were asked during the source monitoring task. No denial-induced forgetting effect emerged ($F(1, 68) = 1.03$, $p = 0.31$, $\eta^2_p = 0.02$).

When we examined true recall performance, a 2(Valence: Neutral versus Negative) x 2(Condition: False Denial versus Control) repeated measures ANOVA revealed the following results. A statistically significant Valence x Condition interaction emerged ($F(1, 67) = 31.14$, $p < 0.001$, $\eta^2_p = 0.32$). Simple effect analyses showed that for neutral words, a denial-induced forgetting effect was found ($F(1, 67) = 49.83$, $p < 0.001$) with a lower true recall performance in the denial group ($M = 5.81$, 95%CI [4.64, 6.97]) than in the control group ($M = 12.27$, 95%CI [10.80, 13.75]). This effect was absent for the negative items ($F(1, 67) = 0.45$, $p = 0.51$).

Memory for the Stimuli. For the source monitoring data, we did the following. A 2(Valence: Neutral versus Negative) x 2(Condition: False Denial versus Control) repeated measures ANOVA on true memory items which were only asked during the manipulation phase revealed the following results. First, no statistically significant interaction ($F(1, 68) = 2.39$, $p = 0.13$, $\eta^2_p = 0.03$) and valence effect ($F(1, 68) = 1.65$, $p = 0.20$, $\eta^2_p = 0.02$) emerged. Interestingly, we did find that participants in the false denial group ($M = 3.09$, 95%CI [2.63, 3.55]) had lower true memory levels of the encoded stimuli than the control participants ($M = 4.74$, 95%CI [4.29, 5.18]; $F(1, 68) = 26.15$, $p < 0.001$, $\eta^2_p = 0.28$). A similar effect emerged when examining items appearing in the baseline memory task and the manipulation phase ($F(1, 68) = 11.64$, $p = 0.001$, $\eta^2_p = 0.15$). Participants who falsely denied ($M = 4.21$, 95%CI [3.86, 4.55]) remembered fewer words than control participants ($M = 5.03$, 95%CI [4.69, 5.36]). Finally, impaired memory performance because of false denials was also found for new words presented in the source monitoring task ($F(1, 68) = 24.28$, $p < 0.001$, $\eta^2_p = 0.26$; false denial group: $M = 3.52$, 95%CI [2.89, 4.14], control group: $M = 5.67$, 95%CI [5.06, 6.27]).

When we performed a similar analysis on true recall, we found a statistically significant Valence x Condition interaction ($F(1, 68) = 22.80$, $p < 0.001$, $\eta^2_p = 0.25$). For the neutral words, we found a denial-induced forgetting effect ($F(1, 67) = 32.44$, $p < 0.001$). Specifically, participants who falsely denied (*M* = 6.33, 95%CI [4.93, 7.73]) remembered to have seen fewer presented words than the control group (*M* = 13.03, 95%CI [11.05, 15.01]). This effect did not emerge for the negative words ($F(1, 67) = 0.05$, $p = 0.82$).

False Memory

False memory refers to participants remembering items (i.e., critical lures) that were not discussed (False Memory for the Interview) and/or were not presented (False Memory for the Stimuli).

False Memory for the Interview. A 2(Valence: Neutral versus Negative) x 2(Condition: False Denial versus Control) repeated measures ANOVA was conducted on the false memory data of the source monitoring task. We only found a statistically significant main effect of Condition ($F(1, 68) = 15.33$, $p < .001$, $\eta^2_p = 0.18$; see Figure 3) with participants in the false denial group being less likely to indicate that they discussed critical lures (*M* = 2.31, 95%CI [1.98, 2.64]) than participants in the control group (*M* = 3.22, 95%CI [2.90, 3.55]). When we focused on the false recall data, we found a similar pattern in that participants who falsely denied (*M* = 0.29, 95%CI [0.10, 0.49]) recalled fewer false memories than control participants (*M* = 0.89, 95%CI [0.69, 1.10]; $F(1, 67) = 17.69$, $p < .001$, $\eta^2_p = 0.21$; 1 missing value).

False Memory for the Stimuli. A 2(Valence: Neutral versus Negative) x 2(Condition: False Denial versus Control) repeated measures ANOVA was performed on the false memory data of the source monitoring task. The analysis showed that participants who had to falsely deny (*M* = 2.74, 95%CI [2.33, 3.14]) created fewer false memories than participants in the control group (*M* = 3.49, 95%CI [3.10, 3.89]; $F(1, 68) = 7.14$, $p = .009$, $\eta^2_p = 0.10$). We also found that negative false memories (*M* = 3.27, 95%CI [2.96, 3.59]) were more easily elicited than neutral ones (*M* = 2.95, 95%CI [2.62, 3.28]; $F(1, 68) = 4.10$, $p = .047$, $\eta^2_p = 0.06$).

A similar pattern of results was detected when concentrating on the false recall data. Specifically, participants in the false denial group (*M* = 0.38, 95%CI [0.16, 0.60]) had lower false recall rates than control participants (*M* = 1.00, 95%CI [0.72, 1.19]; $F(1, 67) = 13.19$, $p = .001$, $\eta^2_p = 0.17$; 1 missing value). A Valence effect ($F(1, 67) = 12.94$, $p = .001$, $\eta^2_p = 0.16$; 1 missing value) was also found in that neutral false memories (*M* = 0.87, 95%CI [0.65, 1.09]) were more easily evoked than negative false memories (*M* = 0.46, 95%CI [0.29, 0.63]).

Discussion

The current experiment examined the effect of false denials on false memory generation. By using associatively-related word lists as stimulus material, the following findings were observed. First, as in previous studies (e.g., Otgaar et al., 2014, 2016, 2018; Romeo et al., 2019), a denial-induced forgetting effect was detected. That is, in contrast with contols, participants that falsely denied were less likely to remember that they talked about certain items with an experimenter while in fact they did. Importantly, this is the first experiment in which we showed that this effect also occurs with words and not only with videos, pictures, or a virtual reality experience. Furthermore, we also found that false denials made participants less likely to remember having seen the words initially. Such an effect has not consistently been found (but see Romeo et al., 2019). Equally important was our finding showing that the denial-induced forgetting effect emerged for the source monitoring and recall memory tests thereby replicating previous work (Otgaar et al., 2018).

The novelty of the current experiment is that, besides the forgetting effects of false denials, false denials also led to lower false memory rates. Specifically, participants that falsely denied were less likely to remember having talked about a critical lure than participants that consistently had to tell the truth. Furthermore, we also found that false denials resulted in lower false memory rates for the encoding stimuli. Taken together, our experiment presents the first demonstration that false denials can lead to two memory effects: forgetting and reduced false memory formation.

Although we were not primarily interested in the impact of valence on memory, some interesting effects did emerge. In line with previous research (Otgaar et al., 2016), our source monitoring data showed that valence did not interact with the act of denial. However, for true recall, we did find that only for the neutral words, denial led to memory undermining effects. One reason for this is that negative memories are more salient and hence, more protected against the memory undermining effects of denial. Alternatively, a more plausible explanation is that because memory performance was lower for negative words than for neutral ones, denial could not result in even more memory undermining effects. Of course, future research using recall measures might attempt to replicate the current finding.

Experiment 2

In the second experiment, we attempted to replicate the finding concerning the effect of false denials on false memory formation. However, we changed the following elements in the procedure. First, we used other DRM lists (i.e., only neutral) to show that our results were not driven by the nature of our stimulus. Second, in Experiment 2, we dropped the recall test and only focused on the source monitoring test which has been the standard test in most denial-induced forgetting studies (e.g., Otgaar et al., 2014, 2016). Third, we explored whether the denial-induced forgetting effect would also be observed when certain critical lures had to be denied and whether the denial of critical lures would have consequences on falsely remembering having seen these critical items during encoding. The idea behind this was to explore whether denying critical lures during the interview would have any consequence on the remembrance of critical lures during the word list presentation. A subsidiary aim of Experiment 2 was to examine the stability of the current results. Specifically, the current results imply that false denials inhibit access to true memories thereby decreasing spreading activation to related critical lure words. This is in line with theoretical accounts explaining directed forgetting effects (e.g., Bjork & Bjork, 1996).

One way to become more confident in the idea that inhibition underlies denial-induced forgetting is having participants re-learn word lists but without the instruction to falsely deny these items. Research has shown that exposing participants a second time to the encoded stimuli might serve as a cue to remember the previously suppressed items (e.g., Basden, Basden, & Gargano, 1993; Geiselman & Bagheri, 1985; Goernert & Larson, 1994). The reason that inhibition can be released is that the strength of memories is assumed to be unaffected when those memories are inhibited (Bjork & Bjork, 1996). Consequenly, re-exposing participants to the encoded stimuli would eliminate any memory impairing effects. If true, the prediction in Experiment 2 would be that the denial-induced forgetting effect would vanish when words are re-learned. Thus, the aim of this experiment was to replicate the finding that false denials reduce the susceptibility to create false memories. Furthermore, we explored whether re-exposure to word list items would abolish the denial-induced forgetting effect.

Method

Participants

An a priori power analysis using G*Power (Faul et al., 2007) and an anticipated medium effect size (*d* =0.25) and power of 0.80 showed that we needed a sample size of 128 participants. We tested 128 participants in this experiment (M_{age} = 22.62, *SD* = 4.13; 34 men, range 18-45 years old, 94 women; no participants were excluded). Participants were university students. Participants received 1 credit point or financial compensation (7.50 euro) for their involvement in the experiment. The current study was approved by the ethical committee of the Faculty of Psychology and Neuroscience, Maastricht University. The current experiment was preregistered at the Open Science Framework: https://osf.io/j7fh3/register/5771ca429ad5a1020de2872e `

Materials

DRM Word Lists. Participants received 8 neutral 12-item word lists (critical lures: *needle, sleep, river, mountain, fruit, chair, sweet, lion*) adopted from Howe et al. (2010; *fruit, chair, sweet, lion, needle, sleep*) and Stadler, Roediger, and McDermott (1999; *river, mountain*).

Design and Procedure

The current experiment used a between-participants design. Participants were randomly assigned to the different conditions (False Denial: *n* = 64, Control: *n* = 64). Participants were tested in quiet rooms at the Faculty of Psychology and Neuroscience, Maastricht University. After signing informed consent, participants were presented with 8 DRM word lists in a pseudo-random order. Each word was presented for 2 seconds. After each list presentation, a message was shown stating “End of list [number of list]” for 2 seconds. After the lists presentation, participants engaged in a 5-min distractor task (playing Tetris). Following this, participants’ baseline memory performance was tested by asking them whether they remembered certain words previously displayed during list presentation (i.e., 24 words, three from each list, and other 24 words which were not part of the DRM lists). Next, participants were involved again in another 5-min distractor task (playing Bejeweled). In the next phase, participants again received a memory test and half of the participants were instructed to falsely deny having seen certain words while the control group had to tell the truth. This memory test included 24 words from the initial DRM lists which did not contain words that were asked during the baseline memory test, 24 new words, and 4 critical lures.

After this manipulation phase, participants were engaged in another distractor task for 5 min (circling the letters “n” and “s”). Then, participants were involved in a source monitoring test including 56 words (16 words from the manipulation phase (8 were mentioned only in the manipulation phase, 8 were mentioned in the manipulation phase and were part of the DRM lists), 8 from only the DRM lists, 8 critical lures, and 24 new words). During this task, all participants were instructed to tell the truth. For each word, participants were asked whether they remembered discussing the word during the manipulation phase and whether they remembered seeing the word during the word list presentation.

After the source monitoring test, a short distractor task was inserted for 5 min (i.e., finding the difference between two highly similar pictures). Next, participants were re-exposed to the same 52 words that they received during the manipulation phase. After a 5-min distractor task (Tetris), a final source monitoring task was presented (56 words). Finally, all participants received a debriefing.

Results

All data can be found on: https://osf.io/kp2j4/.

Baseline Memory Performance

An independent samples Welch t-test showed that the two groups did not statistically differ from each other in terms of baseline memory performance ($t(123.2) = 0.62$, $p = 0.53$, $d = 0.11$).

True Memory

Memory for the Interview. An independent samples Welch t-test revealed a denial-induced forgetting effect ($t(123.7) = 9.81$, $p < 0.001$, $d = 1.73$). Specifically, participants in the denial group ($M = 8.48$, $SD = 2.75$) were more likely to say that they could not remember having talked about certain words than control participants ($M = 12.95$, $SD = 2.39$).

Memory for the Stimuli. An independent samples Welch t-test did not reveal a statistically significant effect ($t(122.3) = 0.80$, $p = 0.43$, $d = 0.14$).

False Memory

False Memory for the Interview. An independent samples Welch t-test on the total false memory levels showed that participants in the denial group were less likely to indicate that they talked about critical lures ($M = 1.91$, $SD = 1.51$) than participants in the control group ($M = 3.61$, $SD = 1.44$; $t(125.8) = 6.53$, $p < 0.001$, $d = 1.15$). This effect was likely driven by critical lures being denied during the manipulation phase. Indeed, when we focused on these critical lures, we found that false denials led to lower false memories ($t(125.2) = 7.76$, $p < 0.001$, $d = 1.37$). This effect was, however, absent when we conducted an analysis on critical lures that were not denied ($t(124.6) = 1.19$, $p = 0.24$, $d = 0.21$).

False Memory for the Stimuli. When we conducted an independent samples Welch t-test on the false memory rates for the list presentation, no statistically significant effects were detected (ts < 0.67, ps > 0.25).

Exploratory Analyses

A subsidiary aim of Experiment 2 was to examine the denial-induced forgetting effect when list items had to be re-learned and a second source monitoring task was presented. A 2(Condition: False Denial versus Control) x 2(Session 1 versus Session 2) mixed ANOVA was performed with Session as within-participant variable. We first looked at true memory scores for what was discussed during the manipulation phase. First, no statistically significant interaction was found ($F(1, 126) = 0.65$, $p = .42$, $\eta^2_p = 0.01$). Overall, we did find participants remembered having discussed more words during the second ($M = 13.16$, 95%CI [12.60, 13.71]) than first source monitoring test ($M = 10.72$, 95%CI [10.26, 11.17]; $F(1, 126) = 70.33$, $p < 0.001$, $\eta^2_p = 0.36$). We also found a denial-induced forgetting effect on both source monitoring tasks ($F(1, 126) = 100.65$, $p < 0.001$, $\eta^2_p = 0.44$; false denial: $M = 9.82$, 95%CI [9.23, 10.41]; control: $M = 14.06$, 95%CI [13.46, 14.65]). No statistically significant effects were observed when looking at the true memory scores for what was remembered from the list presentation.

Moreover, we conducted a 2(Condition: False Denial versus Control) x 2(Session 1 versus Session 2) mixed ANOVA on the total false memory scores of what was remembered from the interview. A statistically significant interaction was detected ($F(1, 126) = 9.94$, $p = 0.002$, $\eta^2_p = 0.07$). Simple effect analyses using independent samples Welch t-tests showed the following. Although fewer false memories were found in the false denial than control group for both sessions, this effect was much larger for the first (false denial: $M = 1.91$, $SD = 1.51$, control: $M = 3.61$, $SD = 1.44$; $d = 1.15$) than for the second session (false denial: $M = 5.56$, $SD = 1.66$, control: $M = 6.23$, $SD = 1.40$; $d = 0.45$).

We explored this effect in more depth and found that this effect was caused by critical lures that were inserted in the manipulation phase and the source monitoring task. Indeed, when focusing our analyses on these items, we also found a statistically significant interaction ($F(1, 126) = 29.95$, $p < 0.001$, $\eta^2_p = 0.19$) with simple effects showing that the false denial-false memory effect was also much smaller at the second ($d = 0.48$) than at the first source monitoring task ($d = 1.37$). Such a statistically significant interaction was not found when focusing on critical lures that were only included in the source monitoring task ($F(1, 126) = 0.16$, $p = 0.69$, $\eta^2_p = 0.001$). Also, no statistically significant effects were observed when we performed a mixed ANOVA on the false memory levels of what was remembered from the list presentation (Fs < 2.54, ps > 0.11).

Discussion

The results of Experiment 2 can be summarized as follows. We replicated the denial-induced forgetting effect for words that had been found in Experiment 1. That is, participants in the false denial group remembered having discussed fewer words than participants in the control group. We also showed that perhaps as a result of this effect, lower false memory rates for the interview were found in the false denial group than in the control group. Finally, although we did not find that the denial-induced forgetting effect vanished when participants re-learned several words, our results did demonstrate that our false memory effect vanished after re-exposure.

General Discussion

What happens with memory when people falsely deny having experienced an event? This has been the primary impetus for conducting the current experiments. The main goal was to examine whether false denials might lead to the forgetting of words and simultaneously effect the production of false memories. Based on the results of two experiments, we showed that false denials made participants less likely to remember what they discussed than when participants had to tell the truth. Furthermore, false memory rates were reduced in participants that falsely denied having seen certain words.

The first important and most consistent result in both experiments was a denial-induced forgetting effect. The act of false denials made participants forget that they falsely denied. This effect was first reported in Otgaar and colleagues' (2014) study (but see also Vieira & Lane, 2013). However, this study and other subsequent studies (e.g., Otgaar et al., 2016, 2018; Romeo et al., 2019) have used videos, pictures, or even a virtual reality scene to examine the impact of false denials on memory performance. Although such stimuli might approximate the events that we encounter in daily life and create ecologically valid studies, it is imperative to demonstrate the robustness of the denial-induced forgetting effect even using simple stimuli such as words. This is what was done in the current experiments. Several well-known memory effects such as directed forgetting, retrieval-induced forgetting, memory suppression, and the DRM false memory illusion have frequently relied on the use of word stimuli (e.g., Anderson, Bjork, & Bjork, 2000; Gallo, 2010; Levy & Anderson, 2002; MacLeod, 1999). The reason for using word stimuli is straightforward. By using them, researchers have often more control over several features of the stimuli (e.g., valence, arousal), duration of the stimuli, and retrieval tasks, all of which benefits the interpretation of the results.

The second important finding was that false memory levels were lowered in people who falsely denied. Specifically, in both experiments, compared with control participants, participants who falsely denied were less likely to (falsely) remember having talked about the critical lure words. Importantly, in the first experiment, no critical lure words were inserted in the manipulation, but still false denials diminished false memory levels for the interview. However, in Experiment 2, participants also had to falsely deny critical lures and for these critical lures, it was shown that they were less likely to remember them during the first source monitoring task. This methodological difference is relevant to mention as it shows that, especially in Experiment 1, the act of falsely denying impairs the formation of false memories of the interview.

Moreover, the results from Experiment 1 demonstrated that participants in the false denial group falsely remembered fewer critical lure words from the word lists than control participants. This result is line in with another finding in Experiment 1, namely, that false denials led to impaired memory performance for what was experienced. This effect was not found in Experiment 2 and also not consistently found in previous studies (e.g., Otgaar et al., 2014, 2016). The only study in which false denials also undermined memory for what was *actually* experienced was the study conducted by Romeo and colleagues (2019). That study, however, used a virtual reality scene (airplane crash) as stimuli and hence, it is difficult to establish the reason for this discrepant finding. For now, it seems to be the case that the most reliable finding is the denial-induced forgetting effect. Future work should attempt to examine the size of the effect that false denials might have on the forgetting of the actual experience.

What could be the mechanism behind the denial-induced forgetting effect and the concomitant reduction of false memory rates? In the second experiment, we attempted to explore the possibility that inhibition might underlie these effects. The rationale was that the re-learning of some words would release inhibition thereby potentially eliminating the denial-induced forgetting effect and perhaps also the effect that denials reduced false memory creation (Bjork & Bjork, 1996). We found partial support for this idea. That is, we did not find that the denial-induced forgetting effect was eliminated after re-exposure of list words. On the contrary, we found that even after re-exposure of list words, the denial-induced forgetting effect persisted. However, we did find that the impact of false denials on false memory formation was strongly reduced at the second source monitoring task. This does suggest that, to some extent, the re-learning of certain words released inhibition thereby making the remembrance of critical lures more likely. Of course, an alternative explanation for these findings is that the re-learning of the words acted as an extra rehearsal opportunity that especially benefited the denial condition and that hence, the false memory effect disappeared.

Note that, however, our work differs on many dimensions from other inhibition-based paradigms (e.g., directed forgetting). For example, the list-wise directed forgetting procedure provides participants with an instruction to forget after the encoding of several words while in the current experiments, participants had to deny after each word. To some degree, our design is related to the item-by-item directed forgetting procedure in which cues to forget or remember are presented after each word. Importantly, research has suggested that the directed forgetting effect which takes place in the item-by-item methodology might also be caused by differential encoding and rehearsal of words that have to remembered or forgotten (e.g., Basden et al., 1993; Bjork, Bjork, & Anderson, 2013). It might well be the case that such processes underlie denial-induced forgetting as well.

Because we used associatively-related word lists known to evoke false memories, false memory theories might illuminate the mechanisms behind the observed findings. For example, spreading activation theories such as AAT (Howe et al., 2009; Otgaar et al., 2019) would predict that the instruction to falsely deny would impede the retrieval of critical lure. Specifically, AAT postulates that false memories occur during encoding and our results imply that the act of false denials stopped these false memories entering conscious awareness. It is obvious that this cascade of events might have occurred in the current experiments. Also, this interpretation nicely explains why in Experiment 1 lower false memory rates were found in the false denial group for both the stimuli *and* the interview. That is, if the instruction to deny blocked false memories entering conscious awareness then when during the retrieval task (e.g., source monitoring task), participants were asked whether they saw or discussed certain critical lures, these critical lures were inhibited *in general* and that is why lower false memory rates were found for the interview and stimuli. The fact that only in Experiment 2, critical lures had to be denied might explicate why the findings from Experiment 2 only showed lower false memory rates for those specific critical lures.

Our false memory results are, however, more difficult to explain with alternative false memory theories such as fuzzy-trace theory (FTT; Brainerd, Reyna, & Ceci, 2008). This theory postulates that people store two independent memory traces when experiencing an event: a verbatim trace capturing the specific details of an event and a gist trace involving the underlying semantic structure of an event. According to this theory, the reduction of true memories as evinced in the denial-induced forgetting effect would lead to reliance on gist traces thereby amplifying false memory rates. We found the reverse which shows that the current results are better accommodated by spreading activation theories such as AAT.

Of importance, the current results are broadly in line with the Memory and Deception framework (Otgaar & Baker, 2018), wherein simple acts of lying, such as false denials, might lead to forgetting. Furthermore, in that framework, inhibition was suggested as a possible mechanism underlying denial-induced forgetting effect. The current findings are the first to imply that inhibition might indeed be considered as a possible mechanism underpinning denial-induced forgetting. Alternatively, it has been suggested that false denials might affect people’s belief of what was encoded and discussed (e.g., Otgaar et al., 2016). Specifically, false denials might reduce people’s belief about what they can still remember and because of this reduction, have higher omission rates of the experienced event.

Finally, one other possible explanation for the effects of denials on memory is that denials affect the belief in the occurrence of events. Specifically, the act of denial might make people less likely to believe that a certain event took place. Although Otgaar and colleagues (2016) did not find evidence for this, Polage (2019) recently showed that repeated denials of experiences made people decrease their belief in the occurrence of these experiences. Also, Romeo and colleagues (2019) recently showed that feigning memory loss -which can be seen as some form of denial-also reduced belief in the occurrence of an experienced event.

It might be tempting to generalize the current findings to situations where, for example, victims of sexual abuse falsely deny being abused. However, the current design precludes us from making strong claims about what may happen when victims falsely deny their horrendous experiences. Clearly, although there is work showing that word-list methodologies might bear relevance to situations where autobiographical memories are of importance (Brainerd et al., 2008), in general, words are a far stretch from the experiences that we encounter in real life. However, it must be stressed that the denial-induced forgetting effect has been observed with more realistic stimuli such as a virtual reality experience (Romeo et al., 2019). Whether false denials might also adversely affect the production of autobiographical false memories is an empirical question that needs careful examination using false memory paradigms that mimic more the experiences in daily life (e.g., misinformation paradigm; Loftus, 2005; see also Polage, 2019).

To conclude, the present experiments have shown that the denial-induced forgetting effect is a stable phenomenon which is also present when using words as stimuli. Furthermore, we have presented the first evidence that false denials might have some positive effects as well. That is, because false memories are oftentimes regarded as a negative memory phenomenon as it might lead to false accusations of abuse (e.g., Howe & Knott, 2015), the current experiments imply that the act of false denials might have a positive side in that it reduces the people's susceptibility to false memories.

References

Abbe, A., & Brandon, S.E. (2012). The role of rapport in investigative interviewing: A review. *Journal of Investigative Psychology and Offender Profiling, 10*, 237-249.

Ackil, J. K., & Zaragoza, M. S. (1998). Memorial consequences of forced confabulations: Age differences in susceptibility to false memories. *Developmental Psychology, 34*, 1358–1372.

Anderson, M. C., & Green, C. (2001). Suppressing unwanted memories by executive control. *Nature, 410*, 366–369.

Anderson, M.C., & Levy, B.J. (2009). Suppressing unwanted memories. *Current Directions in Psychological Science, 18*, 189-194.

Arnold, M. M., & Lindsay, D. S. (2002). Remembering remembering. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 28*, 521–529.

Basden, B.H., Basden, D.R., & Gargano, G.J. (1993). Directed forgetting in implicit and explicit memory tests: A comparison of methods. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 19, 603-616.

Bjork, E.L., & Bjork, R. (1996). Continuing influences of to-be-forgotten information. *Consciousness and Cognition, 5,* 176-196.

Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate recall. *Journal of Experimental Psychology, 58*, 17–22.

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.

Geiselman, R. E., & Bagheri, B. (1985). Repetition effects in directed forgetting: Evidence for retrieval inhibition. *Memory and Cognition, 13*, 57-62.

Goernert, P.N., & Larson, M.E. (1994). The initiation and release of retrieval inhibition. *The Journal of General Psychology, 121,* 61-66.

Gongola, J., Scurich, N., & Lyon, T.D. (in press). Effects of the putative confession instruction on perceptions of children's true and false statements. *Applied Cognitive Psychology.*

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.

Howe, M.L. (2005). Children (but not adults) can inhibit false memories. *Psychological Science, 16*, 927-931.

Howe, M. L., Candel, I., Otgaar, H., Malone, C., & Wimmer, M. C. (2010). Valence and the development of immediate and long-term false memory illusions. *Memory*, *18*, 58-75.

Howe, M.L., & Knott, L.M. (2015). The fallibility of memory in judicial processes: Lessons from the past and their modern consequences. *Memory, 23*, 633-656.

Howe, M. L., Wimmer, M. C., Gagnon, N., & Plumpton, S. (2009). An associative-activation theory of children's and adults' memory illusions. *Journal of Memory and Language, 60,* 229–251.

Kensinger, E.A., & Ford, J.H. (2020). Retrieval of emotional events from memory. *Annual Review of Psychology, 71,* 251-272.

Kimball, D.R., & Bjork, R.A. (2002). Influences of intentional and unintentional forgetting on false memories. *Journal of Experimental Psychology: General, 131,* 116-130.

Levy, B.J., & Anderson, M.C. (2002). Inhibitory processes and the control of memory retrieval. *Trends in Cognitive Sciences, 6,* 299-305.

Lyon, T. D. (2007). False denials: Overcoming methodological biases in abuse disclosure research. In M.-E. Pipe, M. E. Lamb, Y. Orbach, & A. C. Cederborg (Eds.), *Disclosing abuse: Delays, denials, retractions, and incomplete accounts* (pp. 41–62). Mahwah, NJ: Erlbaum.

MacLeod, C.M. (1989). Directed forgetting affects both direct and indirect tests of memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15*, 13-21.

MacLeod C.M. (2012) Directed Forgetting. In: Seel N.M. (eds) Encyclopedia of the Sciences of Learning. Springer, Boston, MA.

Mangiulli, I., van Oorsouw, K., Curci, A., Merckelbach, H., & Jelicic, M. (2018). Feigning amnesia moderately impairs memory for a memory crime video. *Frontiers in Psychology*, *9*, 1–9.

Marche, T.A., Brainerd, C.J., Lane, D.G., & Loehr, J.D. (2005). Item method directed forgetting diminishes false memory. *Memory, 13,* 749-758.

Marshall, W,L., Thornton, D., Marshall, L.E., Fernandez, Y., & Mann, R. (2001). Treatment of sexual offenders who are in categorical denial: A pilot study. *Sexual Abuse: A Journal of Research and Treatment, 13*, 205-215.

Mazzoni, G. A. L., Scoboria, A., & Harvey, L. (2010). Nonbelieved memories. *Psychological Science, 21,* 1334–1340.

McElvaney, R. (2015). Disclosure of child sexual abuse: Delays, non-disclosure and partial disclosure. What the research tells us and implications for practice. *Child Abuse Review, 24,* 159-169.

Otgaar, H., & Baker, A. (2018). When lying changes memory for the truth. *Memory, 26*, 2-14.

Otgaar, H., Candel, I., Smeets, T., & Merckelbach, H. (2010). "You didn't take Lucy' skirt off": The effect of misleading information on omissions and commissions in children's memory reports. *Applied Cognitive Psychology, 15*, 229-241.

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*, 718–31. doi.org/10.1002/bsl.2148

Otgaar, H., Howe, M.L., Muris, P., & Merckelbach, H. (2019). Associative activation as a mechanism underlying false memory formation. *Clinical Psychological Science, 7,* 191-195.

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

Otgaar, H., Romeo, T., Howe, M.L., & Ramakers, N. (2018). Forgetting having denied: The "amnesic" consequences of denial. *Memory & Cognition*, *46.* 520-529.

Otgaar, H,. Scoboria, A., & Mazzoni, G. (2014). On the existence and implications of nonbelieved memories. *Current Directions in Psychological Science, 23,* 349-354.

Otgaar, H., Wang, J., Fränken, J., & Howe, M.L. (2018). Believing does not equal remembering: The effects of social feedback and objective evidence on belief in occurrence, belief in accuracy, and recollection. *Acta Psychologica, 191*, 271-280.

Polage, D. (2019). Liar, liar: Consistent lying decreases belief in the truth. *Applied Cognitive Psychology, 33*, 527-536.

Roediger, H. L., III, Balota, D. A., & Watson, J. M. (2001). Spreading activation and the arousal of false memories. In H. L. Roediger, III, J. S. Nairne, I. Neath, & A. M. Surprenant (Eds.), *The nature of remembering: Essays in honor of Robert G. Crowder* (pp. 95–115). Washington, DC: American Psychological Association.

Roediger, H. L., III, & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*, 803–814.

Romeo, T., Otgaar, H., Smeets, T., Landström, S., & Boerboom, D. (2019). The impact of lying about a traumatic virtual reality experience on memory. *Memory & Cognition*, *47*, 485-495.

Romeo, T., Otgaar, H., Smeets, T., Landström, S., & Jelicic, M. (in press). The memory-impairing effects of simulated amnesia for a mock crime. *Applied Cognitive Psychology.*

Schooler, J.W., Bendiksen,M.,&Ambadar, Z. (1997). *Taking themiddle line: Can we accommodate both fabricated and recovered memories of sexual abuse*? In M. A. Conway (Ed.), Recovered memories and false memories (pp. 251–292). New York, NY: Oxford University Press.

Scoboria, A., Jackson, D., Talarico, J., Hanczakowski, M., Wysman, L., & Mazzoni, G. (2014). The role of belief in occurrence within autobiographical memory. *Journal of Experimental Psychology: General, 143*, 1242–1258.

Scoboria, A., Wysman, L., & Otgaar, H. (2012). Credible suggestions affect false autobiographical beliefs. *Memory, 20*, 429 – 442.

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

Ullsperger, M., Mecklinger, A., & Müller, U. (2000). An electrophysiological test of directed forgetting: The role of retrieval inhibition. *Journal of Cognitive Neuroscience, 12*, 924-940.

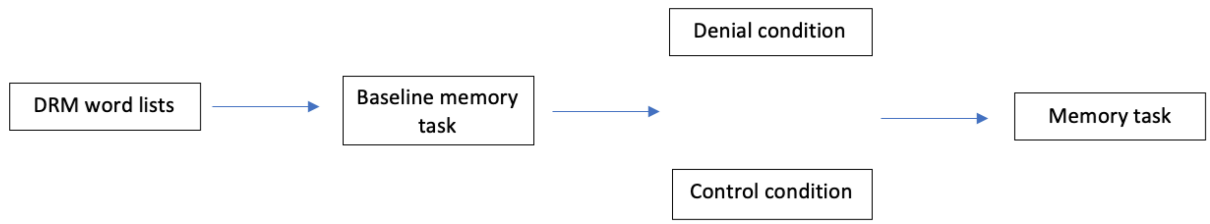
Van Oorsouw, K., & Merckelbach, H. (2004). Feigning amnesia undermines memory for a mock crime. *Applied Cognitive Psychology*, *18*, 505–518. https://doi.org/10.1002/acp.999

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

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.

Wright, D. B., Loftus, E. F., & Hall, M. (2001). Now you see it; now you don't: Inhibiting recall and recognition of scenes. *Applied Cognitive Psychology, 15*, 471–482.

Figure 1. A schematic description of the basic procedure in Experiments 1 and 2



Note. In Experiment 1, the final memory tasks was a source monitoring or recall task, while in Experiment 2, only a source monitoring task was used

Figure 2. *Memory for the interview (denial-induced forgetting) as a function of Condition (error bars represent 95% CI) for words shown in the baseline memory task and manipulation phase*

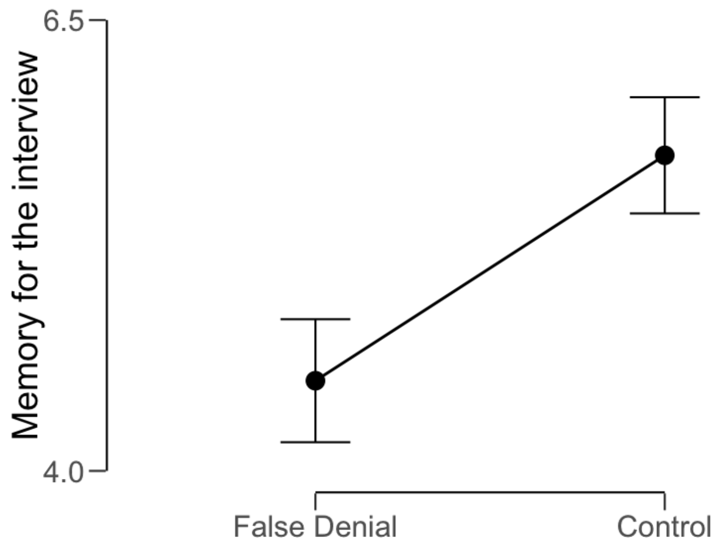


Figure 3. *False memory (critical lures of the source monitoring task) for the interview as a function of Condition (error bars represent 95% CI)*