RUNNING HEAD: FALSE MEMORY

The Positive Ramifications of False Memories using a Perceptual Closure Task

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Abstract

The negative features of false memories are frequently at the foreground of false memory research. However, it has become increasingly apparent that false memories also have positive consequences. In two experiments, we examined the positive consequences of false memories. Participants were visually presented with false memory word lists and received a recognition task. In a modified perceptual closure test, participants received degraded visual representations of words (false, true, and unrelated items) that became clearer over time. Participants had to identify them as fast as possible. Identifications based on false memories were significantly faster than those based on true memories and (un)related items. A roughly similar pattern was observed when no recognition task was used and when critical lures were replaced with other items (Experiment 2). Our results indicate that false memories can be beneficial for problem-solving tasks and counter the standard perspective that false memories are inherently negative in nature.

Keywords: False Memory; Adaptive Memory, Perceptual Closure Task

The Positive Ramifications of False Memories using a Perceptual Closure Task

The imperfections of memory have often served as the cornerstone of current experimental memory research (Loftus, 2005). What most of this research shows is that our memory is prone to the formation of illusions or so-called false memories. The reason that false memories have received so much empirical attention is because of their foreboding reputation in the legal arena. That is, false memories of traumatic events (e.g., sexual abuse) have resulted in legal proceedings in which innocent people were brought to trial (Garven, Wood, Malpass, & Shaw, 1998). The principal purpose of the current experiment was to examine whether false memories can have salutary consequences as well. To address this issue, we made use of a task linked to intelligence (i.e., picture completion).

Although mainstream false memory research has contributed much to the debate on the negative effects of false memories (Otgaar, Sauerland, & Petrila, 2013), less scientific knowledge is available on whether false memories are also positive and adaptive. To examine this hypothesis, some researchers have investigated the link between false memories and priming performance on related memory tasks. In a typical false memory priming experiment, participants are presented with lists of semantic associates (i.e., DRM lists; Deese, 1959; Roediger & McDermott, 1995). After the presentation of the lists, participants receive tasks that tap into implicit memory (e.g., stem completion). The basic result is that the presentation of lists of associates primes the non-presented theme word (i.e., critical lure) on implicit memory tasks and that, therefore, participants completing such tasks report the critical lure (Diliberto-Macaluso, 2005; McDermott, 1997; McKone & Murphy, 2000).

Perhaps somewhat more germane is work that has looked at false memory production and subsequent performance on non-memory, problem-solving tasks. For example, Howe, Garner, Dewhurst, and Ball (2010) presented adults with lists of associatively-related words (e.g., web, insect, bug, fly; DRM lists) known to elicit false memories (i.e., spider). Following presentation of these lists, participants were given a memory test and then had to solve compound remote associate task (CRAT) problems. Here, three words are provided to participants (e.g., widow, bite, house) and they must come up with a single word (in this case, spider) that when combined with each of the first three, provides meaningful phrases. Importantly, the non-presented critical lures of the DRM lists served as the solution to some of these CRATS. The chief finding was that when participants falsely recalled critical lures, CRAT problems were solved more frequently and significantly faster than when problems were not primed by DRM lists. These findings have been replicated with children (Howe, Garner, Charlesworth, & Knott, 2011) and extended to proportional analogies (Howe, Threadgold, Norbury, Garner, & Ball, 2013). Finally, Howe, Garner, and Patel (2013) showed that survival-related false memories serve as better primes for solving problem-solving tasks than neutral false memories.

In the current study, we were interested in whether false memories might have positive ramifications in another unique domain. That is, one limitation of using CRATs is that although they are non-memory-based problem tasks, they still resemble the procedure of a standard DRM procedure. Specifically, in a CRAT, participants also receive words that are related to a non-presented word just as in the DRM procedure. So, our purpose was to examine whether the salutary effects of false memories can also be demonstrated in problems linked to intelligence (e.g., picture completion). To be more specific, we examined whether false memories could prime solutions on an adapted perceptual closure task thereby mirroring a picture completion task. Second, like Howe et al. (2013), our interest was whether this effect would differ when the emotional aspect of the lists was varied. Using this methodology, our study has the potential to deliver novel insight into the adaptive nature of memory illusions and the robustness of earlier findings herein.

Examining false memory priming effects in the realm of intelligence is interesting because intelligence has been considered to be essential for survival (Kanazawa, 2012; Roth & Dicke, 2005). Intelligence can be broadly defined as the speed at which species solve problems in their environment. It is obvious from this definition that examining the positive effects of false memories can be fruitful when relating it to intelligence. If one were to find positive consequences of false memories on tasks linked to intelligence, it would generalize the finding that false memories can have positive effects in a substantial manner. Our intent was to examine this question by using a perceptual closure task (Snodgrass & Kinjo, 1998). Perceptual closure refers to the process where a person fills in missing parts of a degraded stimulus in order to complete an image and create a clear object. In a perceptual closure task, participants are presented with degraded stimuli that become less degraded over time. Participants are asked to indicate as soon as possible what the stimuli represent. Of significance for the current experiment is that this task parallels subtasks in certain intelligence tasks (e.g., Luteijn & Barelds, 2004). That is, in certain intelligence subtests (i.e., picture completion), participants have to identify degraded pictures as fast as possible. In our experiment, we made use of this idea and developed an adapted perceptual closure task. Participants were presented with DRM lists and received a recognition task. After the recognition task, participants were shown degraded non-presented and presented words. Their instruction was to indicate if they recognized the word and state which word it entailed. Our expectation was that false memories would result in equally fast or even faster solution rates relative to true memories (Howe et al., 2013).

Furthermore, in the present methodology, we included both neutral and negative DRM lists. Negatively-charged material is often more susceptible to false memory creation than more mundane material (Otgaar, Candel, & Merckelbach, 2008) and, hence, one could expect that false memory priming effects are larger for negatively-laden material.. However, one could also anticipate that negative false memories are not better primes on a perceptual closure task than neutral false memories. That is, research shows that affective information can lead to a reduction in false memories, which might lead to smaller priming effects (e.g., Storbeck & Clore, 2005). According to this scenario, a reduction in negative false memories might make them less available to be used during the perceptual closure task, thereby leading to slower solution rates.

Experiment 1

Method

Participants

A total of 43 adult participants (M_{age} = 20.50, *SD* = 1.60; range: 18-27 years; 6 male) were involved in the current experiment. Students were awarded course credits or a financial compensation for their participation (€7.50). As a requirement, participants were not allowed to have participated in a similar memory-related study. The experiment was approved by the standing ethical committee of the Faculty of Psychology of Neuroscience, Maastricht University.

Materials and Tasks

In the current experiment, presentation of the DRM words in all tasks (perceptual closure and recognition) was done visually. All tasks were digitalized on a Microsoft Windows computer, and presented with E-Prime 2.0 software. Single words from each wordlist were recreated as digital representations that contained a white background with the word centered in black. These representations were created using Adobe Photoshop CS6, with the words displayed in font “Calibri”, size “125pt”. All words were presented in Dutch.

All participants were presented with three consecutive tasks: (1) a digitalized DRM wordlist task including 10 counterbalanced standard DRM lists (5 neutral and 5 negative) with 10 words each (e.g., *baker, butter, crust, grain*) and each list was associated with a non-presented critical lure (i.e., *bread*). These lists have been used in previous research (e.g., Otgaar, Peters, & Howe, 2012). List items were chosen from the Dutch word association norms (Van Loon-Vervoorn & Van Bekkum, 1991) and were shown in order of backward associative strength, from strongest to weakest. We also guaranteed that the mean word frequency of the neutral and emotional critical lures did not differ, $t(8) = 0.22$, $p > .05$, by using the CELEX lexical database (Baayen, Piepenbrock, & Gulikers, 1995). Also, the mean backward associative strength between the neutral list words and their critical lures and the mean backward associative strength between the negative items and their critical lures did not differ, $t(8) = 1.69$, $p > .05$. Words were presented for 1500 ms and between each word a fixation cross appeared for 1 s., (2) a digitalized DRM recognition task, consisting of 78 words in total, of which 40 were studied during the presentation of the DRM lists (4 from each list), 10 critical lures (1 from each list), 10 non-presented related words (i.e., words related to the lists, not presented during encoding) and 18 non-presented and unrelated words. Words were presented for 1500 ms and after each word a white slide appeared for 200 ms, followed by a pop-up window in which participants had to answer “yes” or “no” in a self-paced manner, and (3) a digitalized perceptual closure task, containing 80 words in total of which 40 overlapped with the first task (of these 20 overlapped with the second task), 10 critical lures, 10 non-presented and related words and 10 non-presented and unrelated words that were also presented in the second task, and another 10 non-presented and unrelated words that were completely new. The words were displayed as visual representations containing a blur filter that became clearer over time. We included 10 gradual gradations of blurs (see Appendix). Each blur was presented for 1 s. The PCT task measured a button press response from participants as soon as the words were recognized. After the button press, a pop-up window appeared in which participants had to write the word they had seen in a self-paced manner.

Design and Procedure

A 2 (Type: false memory vs. hits) x 2 (Valence: neutral vs. negative) within-subject design was used. Participants were tested individually and were presented with all three tasks in the same order in a 40-45 minute session. First, participants were shown 5 neutral and 5 negative DRM word lists that they had to remember. The order of this was counterbalanced. Next, participants engaged in the recognition task in which words were subsequently presented and they were required to digitally input whether they recognized the words from the first task, by typing in "yes" or "no". Finally, participants engaged in the perceptual closure task, during which they were required to press a button as soon as they recognized the blurred words that were subsequently presented, followed by digitally typing what they believed the word should be. Input results and reaction times were measured using the E-Prime 2.0 software. In between each task participants were given a filler task (i.e., play Tetris for five minutes).

Results and Discussion

Perceptual Closure Task

Hits vs. false memories We start by reporting the most important findings of our experiment. The reaction time data are reported in milliseconds (i.e., ms). When we analyzed the reaction times of the hits and false memories, we employed the following procedure for our analysis. First, for exploratory reasons, we filtered the data and removed cases that were incorrectly recognized in the perceptual closure task. That is, they pressed the button indicating that they recognized the word (e.g., bake), but then filled in an incorrect response (i.e., lake). No significant interaction between Type and Valence was detected ($F(1, 42) = 0.38$, $p = .54$, $\eta_{\text{partial}}^2 = .01$). We did find a significant main effect of Valence. That is, neutral items (hits: $M = 5116$, $SD = 714$; false memory: $M = 4541$, $SD = 848$) were solved faster on the perceptual closure task compared to negative items (hits: $M = 5301$, $SD = 726$; false memory: $M = 4819$, $SD = 882$; $F(1, 42) = 10.83$, $p = .002$, $\eta_{\text{partial}}^2 = .21$). More interestingly, we found that participants were faster at solving degraded stimuli representing false memories than hits (main effect Type: $F(1, 42) = 40.77$, $p < .001$, $\eta_{\text{partial}}^2 = .49$).

In our final analysis, we excluded the cases that were incorrectly recognized in the recognition task (i.e., for studied items: saying "yes" to words that were not presented and saying “no” to words that were presented; for critical lures, only “yes” responses to critical lures were included) and perceptual closure task.[1] Again, we found no evidence for a significant Type x Valence interaction ($F(1, 42) = 0.23$, $p = .63$, $\eta_{partial}^2 = .005$). We did find a main effect of Valence ($F(1, 42) = 11.93$, $p = .001$, $\eta_{partial}^2 = .22$), with neutral items (hits: $M = 4866$, $SD = 822$; false memory: $M = 4453$, $SD = 937$) being recognized significantly faster than negative items (hits: $M = 5301$, $SD = 726$; false memory: $M = 4819$, $SD = 882$). Also, results showed that false memories were significantly faster than hits (main effect Type: $F(1, 42) = 11.88$, $p = .001$, $\eta_{partial}^2 = .22$; see Figure 1). On average, this indicates that false memories were detected at the fifth blur filter, while hits were recognized on average at the sixth filter.

(Un)related We also included unrelated (old and new) and related items in the perceptual closure task. When we performed a repeated measures ANOVA on all different memory categories (Type: hits, false memory, related, unrelated (old), and unrelated (new), a significant effect of Type appeared ($F(4, 168) = 32.48$, $p < .001$, $\eta_{partial}^2 = .44$). Post-hoc analyses using Bonferroni correction showed that solution speeds were significantly faster for false memories than for any of the other memory categories (all *p*s < .05). More importantly, related, and unrelated new items were significantly slower solved than hits and false memories (all *p*s < .001). Solution rates for unrelated old items were significantly higher than for false memories ($p < .001$; see Figure 2).

Hits and False recognition

A 2 (Type: Hits vs. false memory) x 2 (Valence: Neutral vs. negative) repeated measures ANOVA on hits and false recognition was conducted. No significant effects emerged (all *p*s > .05).

This experiment showed that when using a perceptual closure task, identifications based on false memories were statistically faster than those based on true memories. This is in line with the idea that false memories might serve as better primes to solve problems.

However, although these results are promising, two lingering issues need to be addressed. First, the inclusion of a recognition task might have affected our findings as participants might have processed critical lures and presented items differently on this task thereby leading to carry-over effects on the perceptual closure task. Howe and colleagues (2011) have addressed this issue before and they did not find that an intervening memory test influenced their false memory-priming effects (see also Howe, Threadgold, Wilkinson, Garner, & Ball, in press). Nonetheless, because we used a new paradigm to test the positive consequences of false memories (i.e., perceptual closure), it is possible that our effects might have been due to the use of an intervening recognition task. Second, our results are silent about the possibility that critical lures could differ in important ways from presented items thereby resulting in our observed effects.

To tackle these issues, we conducted a second experiment. Participants were randomly assigned to groups in which they received or did not receive a recognition task. Furthermore, participants received the same DRM lists as in Experiment 1 or were presented with DRM lists in which critical lures that we used in Experiment 1 were now included as part of presented items during the DRM list presentation and in which certain presented items in Experiment 1 were now used as critical lures (see Method section). In this way, we could examine whether our effects were due to the nature of false memories or of the characteristics of critical lures.

Experiment 2

Method

Participants

In this experiment, 80 undergraduate participants (mean age = 21.27, *SD* = 1.76; 7 male students[2]) were involved. They were recruited from classes taught by the Faculty of Psychology and Neuroscience, Maastricht University. They received a financial compensation for their participation (7.50 euro).

Materials and Tasks

In the control procedure, participants received the same DRM lists as in Experiment 1. However, in the adapted condition, participants received modified DRM lists. That is, in these lists, the critical lure was replaced with the first or second word in the list (i.e., from 5 lists the first word was changed and from the other 5 the second word was replaced). These words acted in the adapted lists as critical lures and the previous lures served as presented items.

Design and Procedure

The present study made use of a 2 (Condition: Standard vs. Adapted) x 2 (Recognition task: Yes vs. No) x 2 (Valence: Neutral vs. Negative) split-plot design with the latter factor being a within-subjects variable. Participants were randomly assigned to the 4 different groups (n = 20 in each group).

A roughly similar procedure as in Experiment 1 was followed except that half of the participants did not receive a recognition task and received after the DRM wordlist presentation first a filler task (Tetris for five minutes) and then the perceptual closure task. Also, half of the participants were presented with the adapted DRM lists.

Results and Discussion

Perceptual Closure Task

Studied items vs. critical lures. Because half of the participants did not receive a recognition task, meaning that we had no knowledge concerning their memory performance, the terms “hits” are changed to “studied items” and “false memory” to “critical lures.” We performed a 2 (Condition: Standard vs. Adapted) x 2 (Recognition task: Yes vs. No) x 2 (Valence: Neutral vs. Negative) mixed ANOVA on our data. Again, we filtered our data[3] and excluded cases in which participants did not have a false memory on the recognition task (i.e., this could only be done on one half of the participants as only one half received a recognition task) and in which participants incorrectly recognized items on the perceptual closure task (see above). We did not conduct the exploratory analysis in which we only filtered the data removing incorrect responses on the PCT. Experiment 1 showed that this exploratory analysis did not provide extra information above the final analysis. We found a statistically significant four-way interaction ($F(1, 72) = 8.48$, $p = .005$, $\eta_{partial}^2 = .11$; 4 missing values). Simple effects revealed the following (see also Table 1).

Our results were generally in line with what we found in Experiment 1. Specifically, in the group where participants received the standard DRM lists and irrespective of receiving a recognition task or not, critical lures were statistically faster recognized than studied items on the perceptual closure task ($F(1, 38) = 19.67$, $p < .001$, $\eta_{partial}^2 = .34$). For the participants that received the adapted DRM lists, results were slightly different. That is, in the recognition task group, critical lures were again faster recognized relative to studied items ($F(1, 15) = 29.42$, $p < .001$, $\eta_{partial}^2 = .66$). In the group in which participants did not receive any recognition task, only neutral critical lures were statistically faster recognized than neutral studied items ($F(1, 19) = 38.33$, $p < .001$, $\eta_{partial}^2 = .67$)

(Un)related items. A 2 (Condition: Standard vs. Adapted) x 2 (Recognition task: Yes vs. No) mixed ANOVA on the different memory categories (studied items, critical lures, related, unrelated) was also conducted. We found a statistically significant two-way interaction ($F(3, 225) = 6.69$, $p < .001$, $\eta_{partial}^2 = .08$). For the group receiving a recognition task, we again found that critical lures served as better primes relative to the other memory categories ($F(3, 111) = 56.70$, $p < .001$, $\eta_{partial}^2 = .61$). In the group that was not presented with a recognition task, studied items from the adapted lists ($M = 5201$, $SD = 723$) and critical lures from the adapted lists ($M = 5132$, $SD = 747$) did not statistically differ from each other ($p > .05$). For the control lists, critical lures were faster recognized than the other memory categories ($F(3, 57) = 152.65$, $p < .001$, $\eta_{partial}^2 = .89$).

Hits and False recognition

We also examined whether hit rates and false recognition rates differed between the control and adapted lists. Of course, we could only examine this for the participants receiving the recognition task (n = 40). A 2 (List: Control vs. adapted) x 2 (Valence: Neutral vs. negative) mixed ANOVA was conducted separately on hit rates and false recognition rates. For hit rates, we found the following. No significant interaction emerged (F(1, 38) = 0.15, p = .70, $\eta_{partial}^2$ = .004). We did find that the control lists resulted in statistically higher hit rates (F(1, 38) = 8.17, p = .007, $\eta_{partial}^2$ = .18; M = 0.72, SD = 0.16) than the adapted ones (M = 0.64, SD = 0.19). No valence effect emerged (p > .05). For the false recognition, no statistically significant interaction was detected (F(1, 38) = 1.67, p = .21, $\eta_{partial}^2$ = .04). Our results did reveal a statistically significant list effect (F(1, 38) = 6.75, p = .01, $\eta_{partial}^2$ = .15) with more false memories being produced for the adapted (M = 0.87, SD = 0.18) than the control lists (M = 0.73, SD = 0.24). No valence effect was detected (p > .05).

The findings from Experiment 2 nicely show that even when participants were not presented with a recognition task or critical lures were replaced with presented items, critical lures (i.e., false memories) served as more efficient primes to correctly recognize degraded stimuli than studied items. Although on certain occasions, studied items and critical lures did differ in terms of solution rates, the overall pattern is that false memories are processed faster than true recollections. These findings are in line with previous research showing that an intervening memory test did not mitigate the observed false memory-priming effects (Howe et al., 2011, in press).

We also found that false memories were more easily elicited for participants receiving the adapted than the standard DRM lists. One reason for this finding might be that the switching of critical lures and presented items with each other resulted in new lists in which the associative links from the presented items to the new critical lures became stronger and hence, resulted in more false memories (Roediger et al., 2001). This finding did not likely affect our PCT results as we found in both the control and adapted lists and for those who received the recognition task that critical lures were recognized faster than hits.

For the participants that received the adapted lists but no recognition task, we only found that neutral critical lures were recognized faster than neutral studied items. Although we have no clear explanation for this result, one reason might lie in the use of the adapted lists. That is, we found that for those participants that did receive a recognition test, hit rates were lower for the adapted than for the control lists. This means that the production of true memories is lower for adapted than the control lists. This could imply that for the group that was not presented with the recognition task, chances were even lower that true *and* false memories of the lists would develop. If true and false memories are less likely to develop, then this might affect the PCT performance resulting in that only neutral critical lures were faster recognized than neutral studied items. Of course, this remains speculative and future studies could dig into why neutral material is more likely to find this false memory priming effect when no recognition task is provided.

General Discussion

Our experiments were centered on the issue of whether false memories might have beneficial outcomes on tasks related to measures of intelligence. We used an adapted perceptual closure task as a rough analogue of a commonly used subtask of intelligence (i.e., picture completion). We found that when participants were presented with word lists known to engender robust levels of false memories, perceptual closure problems based on false memories were solved significantly faster than those based on true memories. This finding presents a novel contribution to the growing literature on adaptive memory, one that shows that false memories might be even better for problem-solving tasks linked to intelligence than true memories (see Otgaar & Howe, 2014).

In our first experiment, participants were first presented with DRM lists and then received a recognition task. Finally, they had to, as quickly as possible, identify degraded pictures of DRM words. That our finding was robust can be seen in the fact that in our two filtered data sets, false memories consistently served as faster primes in solving the perceptual closure problem than did true memories. What this shows, perhaps counterintuitively, is that false memories are superior to true ones when solving certain complex problems. This result corresponds with recent research that also revealed that false memories were more effective in problem solutions than true memories (Howe et al., 2013). The reliability of our core finding can also be traced back to our results showing that false memories were solved faster than even unrelated and related items. Thus, our effect can be solely attributed to processes associated with false memories.

Even more, we also conducted a second experiment in which we examined whether the inclusion of a recognition task might have affected our results. In general, we still found that false memories had faster solution rates than hits. Also, when we used adapted DRM lists in which critical lures were replaced with presented items thereby creating new critical lures, we overall found that false memories served as the most efficient primes. If the adapted lists or the exclusion of a recognition test did have any effects on solution rates, then these changes might have only resulted in no statistical differences between hits and false memories in terms of solution rates in a minority of cases.

What might be the reason that complex problems are faster disentangled by false than true memories? According to Howe et al. (2013), one potential explanation for the superiority of false memories in priming solutions on complex problems is that false memories are self-generated and that self-generated information (i.e., spontaneous false memories) is better retained than other-generated information (i.e., experimenter-presented true memories; Howe, Wilkinson, & Monaghan, 2012). If priming effects are mainly attributed to the strength of a memory representation, then one might indeed expect false memories being more advantageous in solving problems relative to true memories.

What mechanism(s) might underlie the salutary consequences of false memories? Since our findings are closely related to studies showing that false memories facilitate performance on explicit and implicit memory tasks (McDermott, 1997; McKone & Murphy, 2000), we propose that a likely candidate could be spreading activation (Anderson, 1983; Howe, Wimmer, Gagnon, & Plumpton, 2009; Otgaar, Howe, Peters, Sauerland, & Raymaekers, 2013; Roediger, Watson, McDermott, & Gallo, 2001). That is, the interpretation of false memory priming effects is that studied items, through associative activation, trigger false recollections that can also influence performance on other related tasks. This idea can be directly applied to our findings as well. That is, it is probable that the encoding of studied items resulted in the activation of non-presented items (i.e., false memories) and that this spreading activation impacts other related tasks (e.g., picture completion). Specifically, spreading activation theories postulate that when studied items are encoded, activation spreads rapidly and automatically to interrelated nodes designating non-presented items (i.e., critical lures; Howe et al., 2009). What we argue is that when such nodes are activated and self-generated, their activation levels may impact activation levels of other domains that are linked to memory. In our experiment, this domain referred to identifying degraded stimuli; a domain intimately related to memory performance.

We also found that perceptual closure problems based on neutral false memories were solved faster than negative false memories. Although this might be seen in contrast with the study by Howe and colleagues (2013) who found survival-related false memories to be better primes than neutral ones, it does resemble research showing that survival-related information material is more likely to give rise to memory aberrations than negative and neutral information (e.g., Howe & Derbish, 2010; Otgaar, Howe, Smeets, & Garner, 2014). Research suggests that negative information contains more interrelated concepts relative to neutral information (Talmi, Luk, McGarry, & Moscovitch, 2007) and this could imply that there is more spreading activation and that it takes longer to solve problems that are negative in nature. Furthermore, although survival-related material might often include negatively-laden details (e.g., death), this is not necessarily always the case. Survival-related information can also refer to other types of more mundane details (e.g., blind; see Howe et al., 2013). That is, any type of information that might have direct consequences for your survival and reproductive success could be regarded as fitness-relevant.

One could argue that our problem-solving task is a far stretch from being a rough equivalent of a picture completion that is often used in intelligence tasks. Of course, it is undeniable that a standard picture completion test varies on many dimensions compared to ours. However, it is our contention that the most important characteristic of picture completion tests is the presentation of degraded stimuli and the identification of these stimuli. It is obvious that our adapted perceptual closure meets this important demand. Nonetheless, future research could, for example, examine whether DRM lists consisting of pictures instead of words could still lead to positive consequences of false memories.

Practical implications

Our findings have important implications. Our study provides novel evidence that false memories can have beneficial outcomes on tasks known to tap intelligence. Our experiment thereby supplements the rapidly increasing field of research showing that our memory and its illusions have functional properties. Previous research on the positive effects of false memories has sometimes been criticized by using tasks that were highly related to the DRM procedure (Howe et al., 2014). In our experiments, we however used a task (perceptual closure task) that in which the responses were probably not so much based on associative processes such as in CRATs but more in the identification of degraded stimuli. .

Also, our experiments dovetail nicely with recent research showing that false memories induced by suggestion can have negative or positive behavioral consequences. In these studies, participants received false feedback suggesting that in their childhood they became sick after eating a specific food. The main message of these studies is that inducing false memories for food-related experiences (e.g., getting sick after eating egg salad) can lead to decreased consumption of that particular food (Bernstein & Loftus, 2009). Interestingly, it has even been shown that this false feedback procedure can also lead to positive consequences. That is, in a study conducted by Laney, Morris, Bernstein, Wakefield, and Loftus (2008), participants were falsely suggested that they loved asparagus the first time they tried it when they were a child. This positive false feedback made participants who believed in the false suggestion more likely to prefer asparagus and pay more for it at a grocery story. It nicely shows that on a general level, false memories, both spontaneous *and* suggestion-induced, do not only have a downside, but depending on the context can also lead to salutary effects.

Of course, it is a far stretch to argue that our findings can be directly transferred to a real life situation. Although the current work and previous work by Howe and colleagues (2013, in press) indicate that false memories can rapidly prime solutions on tasks that are not directly linked to the DRM procedure (i.e., perceptual closure, analogies), it is true that in real life situations, certain types of false memories can often have drastic consequences. Think about the following. You are reading a book about the Second World War and you will be examined about the contents of this book. During the reading, you spontaneously think about related, but false, details of the book (e.g., that Italy was part of the allied forces). When you are examined about the contents of the book and the teacher coincidentally asks a question about the allied forces, you might incorrectly recall that Italy was part of them.

Nonetheless, there are real life examples in which certain types of false memories might be beneficial. For example, imagine that a 12-year-old boy looks at a photograph in which he was carrying a soccer ball when he was 4 years old. The child then imagined what happened and misremembers that he loved to play soccer when he was 4 years old. During gym at school, the teacher asks what the children enjoy doing in the gym class. The boy then erroneously responds that he loves soccer that might ultimately lead to more exercise in this sport. Interestingly, such an example can easily be tested. Using the false feedback approach and using doctored photographs falsely depicting the participants with a ball (Wade, Garry, Read, & Lindsay, 2002), participants might be led to falsely remember that they were good at a certain sport which might lead to more interest in that particular sport.

There are also examples that illustrate the positive consequences of other types of false memories, ones that are more related to the findings observed in the current experiments. We have previously reported that false memories based on more associative processes might be adaptive in survival-related contexts (Otgaar & Howe, 2014). For example, imagine that someone is in a possibly dangerous situation. That is, there are obvious signs of nearby predators (e.g., fresh animal tracks). The person who incorrectly associates seeing the predator and thus, falsely recollects witnessing the predator is less likely to visit that location and more likely to survive (Howe & Derbish, 2010; Otgaar & Smeets, 2010). Taken together, although it is undeniably true that false memories are harmful in a plethora of situations, there are circumstances in which false memories might have positive consequences as well. What makes this issue appealing is that many of these examples can be experimentally tested (e.g., doctored videos) and future research should therefore focus on the investigation of the positive effects of false memories using a wide array of paradigms and situations.

Interestingly, the view that false memories can have positive consequences is intrinsically related to the work on the adaptive nature of memory and false memory. Recently, there is considerable interest in the adaptive value of memory (Howe & Otgaar, 2013; Nairne, Thompson, & Pandeirada, 2007). This work shows that memory can be superior under conditions that trigger survival-related processing. For example, when participants are asked to imagine a survival-relevant situation (i.e., stranded on the grasslands of a foreign country) and asked to rate a list of unrelated words for their relevance to that scenario, performance on subsequent memory tests show better retention of those concepts than ones rated for non-survival scenarios (Nairne & Pandeirada, 2008; see various chapters in Schwartz, Howe, Toglia, & Otgaar, 2014).

The work on adaptive memory comes close to earlier conceptualizations on memory in which was suggested that both true and false memories originate from the adaptive nature of human cognition (Johnson & Raye, 1998). In this view, the efficient and rapid way of how our memory works frequently comes at a cost in that errors are produced as well. Still, such memory errors are likely to provide critical information about the functioning of memory (Roediger, 1996). For example, the finding that the encoding of related information produces false recollections of non-related details tells us that processes such as spreading activation might be actively involved in the encoding, storage, and retrieval of memory traces.

Intriguingly, this work on adaptive memory spurred the idea that false memories might have adaptive and positive consequences too. This idea was mainly catalyzed by findings demonstrating that survival processing not only heightened true memory performance, but also elevated false memory performance in both children and adults (Otgaar et al., 2014; Otgaar & Smeets, 2010; see also Howe & Derbish, 2010). These findings suggested that false memories are not simple by-products of a flexible memory system, but, like true memories, may have positive effects including guiding future behaviors and being related to creativity (Dewhurst, Thorley, Hammond, & Ormerod, 2011; Howe, 2011; Schacter, Guerin, & St. Jacques, 2011). Although one might argue that such an interpretation is unlikely, it parallels work on the adaptive nature of misbeliefs where it has been suggested that false beliefs may have evolved to serve positive purposes (McKay & Dennett, 2009).

Conclusion

To recap, our findings have the potential to revise the default assumption that false memories are intrinsically sinister and can lead only to wrongful convictions. Our results contribute to a more balanced view about memory in which it becomes clear that the reconstructive nature of memory ultimately leads to false memories and that the context in which false memories surface determines whether these memory errors are considered positive or negative.

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Footnote

[1]Filtering took place on item level. In the filtering process of the recognition data, 845 items of a total of 3354 items were deleted (43 participants x 78 items). For the PCT data, 235 items were incorrectly recognized deleted from a total of 3340 (43 x 80).

[2]No ages were recorded from 36 participants

[3]For the recognition data, 607 items of a total of 3120 items (40 x 79) were deleted. We deleted also 252 items from the PCT data (total of 6400 items).

Table 1. *Means (and standard deviations) of studied items and critical lures as a function of Valence, Condition, and Recognition task (Experiment 2).*

		Studied items		Critical lures	
		Neutral	Negative	Neutral	Negative
Control	RT yes	5054 (358)	5219 (332)	4271 (775)	5010 (871)
	RT no	5023 (544)	5092 (439)	4781 (679)	4869 (653)
Adapted	RT yes	4883 (549)	5054 (365)	3745 (874)	4320 (870)
	RT no	5306 (789)	5039 (770)	4723 (936)	5653 (901)

Note: RT = Recognition task.

Figure 1. Reaction times of the different memory categories (false memory and hits) as a function of valence (errors bars represent standard error of mean (SEM))

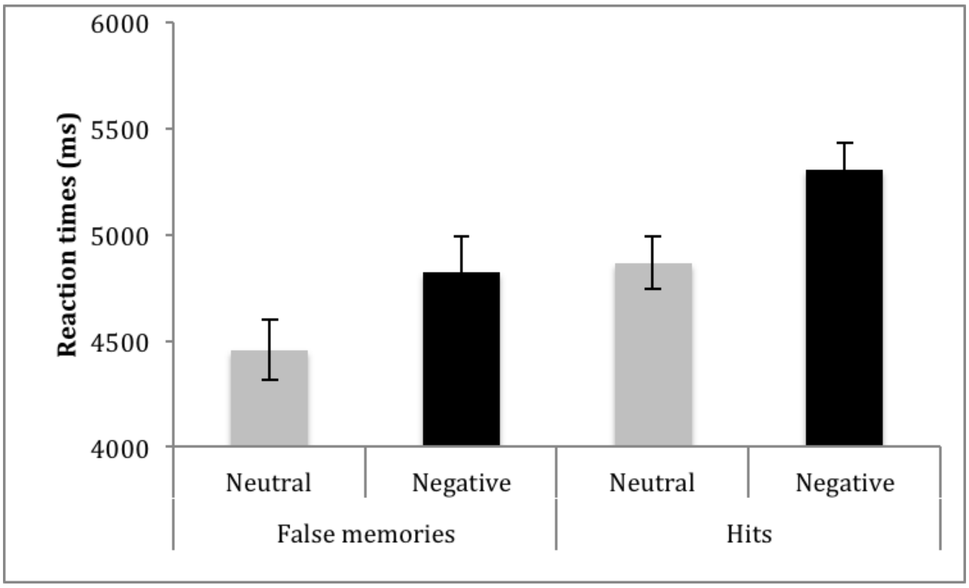
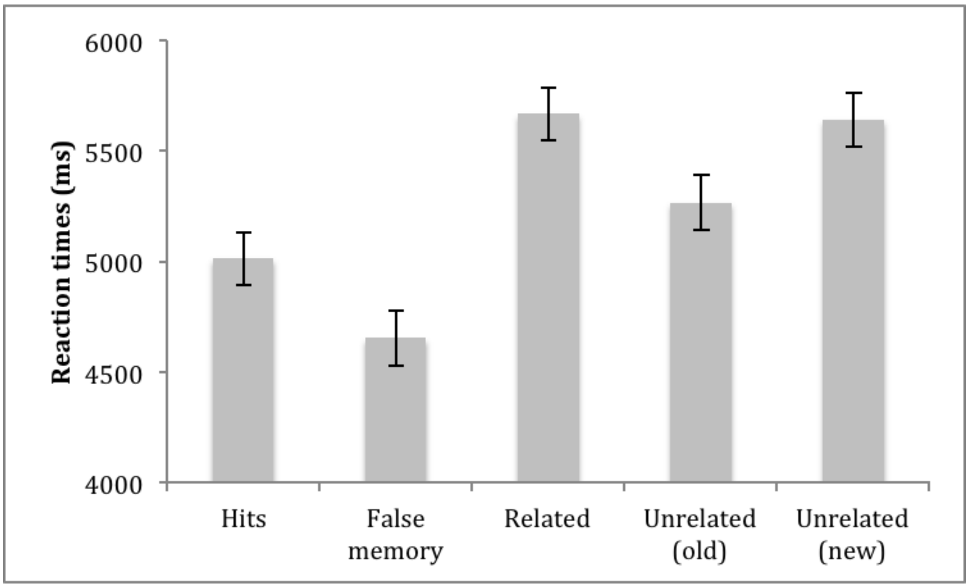


Figure 2. Reaction times of the different memory categories (errors bars represent standard error of mean (SEM))



Appendix

Example of degraded visual representatation of the words in the perceptual closure task (*brood* = *bread*)