Building False Memories Without Suggestions

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People can come to remember doing things they have never done. The question we asked in this study is whether people can systematically come to remember performing actions they never really did, in the absence of any suggestion from the experimenter. People built LEGO vehicles, performing some steps but not others. For half the people, all the pieces needed to assemble each vehicle were laid out in order in front of them while they did the building; for the other half, the pieces were hidden from view. The next day, everyone returned for a surprise recognition test. People falsely and confidently remembered having carried out steps they did not; those who saw all the pieces while they built each vehicle were more likely to correctly remember performing steps they did perform but equally likely to falsely remember performing steps they did not. We explain our results using the source monitoring framework: People used the relationships between actions to internally generate the missing, related actions, later mistaking that information for genuine experience.

People can come to remember doing things they have never done. Over the past 25 years, scientists have led people to falsely remember performing both simple and complex actions, from tracing over a line drawing to kissing a frog to more complex emotional experiences such as a hot air balloon ride, animal attack, or encounter with bad eggs (Anderson, 1984; Bernstein, Laney, Morris, & Loftus, 2005; Porter, Yuille, & Lehman, 1999; Thomas, Bulevich, & Loftus, 2003; Wade, Garry, Read, & Lindsay, 2002). Regardless of the type of false memory, these studies share one fundamental characteristic: The experimenters used suggestions to cultivate the memories. The question we address in this article is whether people can systematically come to remember performing actions they never really did, in the absence of any suggestion from the experimenter.

False Memories That Arise From Suggestion

We know that when people imagine performing a target action, or even simply observe the action happening, they will come to remember performing actions they never really did. In a classic study, when Anderson (1984) asked people to either trace over, imagine tracing over, or look at various line drawings, they falsely remembered tracing over drawings they had only imagined tracing. More recently, Goff and Roediger (1998) found that when people imagined
performing some simple actions—such as flattening clay—they subsequently falsely remembered having performed those actions. Later, Thomas and Loftus (2002) found similar results, leading people to remember performing bizarre actions such as sharpening a shoelace with a pencil sharpener. Lindner and colleagues found that the same mechanisms thought to drive these effects of imagination also lead people to falsely remember performing actions they have only watched others perform (Lindner, Echterhoff, Davidson, & Brand, 2010). These studies and others show that the same mechanisms thought to drive these effects of imagination also lead people to falsely remember performing actions they have never performed.

Why does suggesting an action lead people to falsely remember doing it? According to the source monitoring framework (SMF; Johnson, Hashtroudi, & Lindsay, 1993; Lindsay, 2008), people come to remember performing actions that were suggested to them when in the course of, say, imagining sharpening a shoelace with a pencil sharpener they generate mental information with qualitative characteristics that rival those of true memories. Ultimately, people mistake internally generated information for genuine experience. But if people falsely remember performing actions that were suggested to them, would they also falsely remember performing actions that were not suggested to them?

**False Memories That Arise From Mere Exposure to Related Information**

There is evidence that simply exposing people to related words, concepts, or sequences causes them to systematically remember seeing or hearing related but nonpresented information. For example, when subjects hear a list of thematically related words (bed, rest, awake, tired, dream) they tend to remember hearing a highly associated but nonpresented word (sleep) (Roediger & McDermott, 1995). Similarly, when people hear a list of related sentences, they tend to remember hearing entire related but nonpresented sentences (Bransford & Franks, 1971). We also know from more recent research that when people see an event missing some key steps, they tend to remember having seen those nonpresented steps (Gerrie, Belcher, & Garry, 2006; Gerrie & Garry, 2007; Hannigan & Reinitz, 2001). All these effects can be understood in the context of the SMF: People use the relationships between items (words, video clips, sentences) to internally generate the missing, related information; at test, they mistake the internally generated information for genuine experience. Taken together, these studies show that even when people are shielded from the target false memory, merely exposing them to related information often leads them to systematically remember it.

But whether similar effects would occur when people perform actions is not known. That is, can people systematically come to remember performing actions they never really did, in the absence of any suggestion from the experimenter? We addressed this issue, asking people to build some LEGO vehicles in a process comprising nine sequential actions per vehicle. We asked people to perform some of those actions but not others. The next day, they returned to tell us which actions they had performed.

**Memories for Actions**

On one hand, it seems reasonable to expect that the same mechanisms thought to produce the “mere exposure” memories should also produce false memories for actions. Put another way, if the relatedness of words, sentences, and videos can produce false memories—in the absence of external suggestion—then perhaps performing a related set of actions will do likewise (Bransford & Franks, 1971; Gerrie et al., 2006; Roediger & McDermott, 1995). But memories for self-performed actions do not always behave the same way as memories for words, sentences, or videos. Some of the most tenacious effects in memory research—such as the levels-of-processing effect, the primacy effect, and the generation effect—have little or no impact on the recall of self-performed actions (Cohen, 1989; Craik & Lockhart, 1972; Jacoby, 1978; Nilsson & Cohen, 1988; Rundus & Atkinson, 1970; Zimmer & Engelkamp, 1999; for a review see Roediger & Zaromb, 2009). As Roediger and Zaromb (2009) detailed, there are various explanations for this lack of consistency. Most of these explanations focus on encoding and suggest that performing an action elicits more elaborate processing of the task and context than does remembering more conventional stimuli that are the focus of psychology’s classic memory effects (Kormi-Nouri, Nilsson, & Ohta, 2005; Zimmer & Engelkamp, 1999; cf. Bäckman &...
Nilsson, 1985; Engelkamp & Cohen, 1991). Therefore, it is unwise to assume that the “mere exposure” false memories we have described—those found with words, sentences, and videos—would necessarily occur with self-performed actions. And although the research is replete with evidence that people can falsely remember actions, those effects arise when people are exposed to the false event, using instructions known to be suggestive (Goff & Roediger, 1998; Henkel, 2011, Experiment 1; Lindner et al., 2010; Thomas & Loftus, 2002). By comparison, we asked people to simply perform some actions but not others, an instruction that seems relatively benign.

One important aspect of action memories is that they tend to be remembered better than memories for words or pictures (Engelkamp & Zimmer, 1984; Roediger & Zaromb, 2009; Zimmer & Engelkamp, 1999). Engelkamp and Zimmer explained this “enactment effect” as a consequence of independent encoding; that is, when encoding information, we encode motor and nonmotor information independently (Zimmer & Engelkamp, 1999). For example, when asked to “sharpen the shoelace,” people may encode details of what they were told to do and the hand movement used to sharpen the shoelace independently. Importantly, Engelkamp and Zimmer’s independent encoding theory implies that encoding multiple types of information (nonmotor and motor) increases people’s ability to remember what they did.

In our study, we gave some subjects an opportunity to encode additional visual information by allowing them to see the LEGO pieces arranged in sequential order, whereas other subjects were prevented from viewing those pieces. Although Engelkamp and Zimmer (Engelkamp & Zimmer, 1984; Zimmer & Engelkamp, 1999) did not directly examine the impact of visual information, the same nonmotor encoding mechanisms should apply to visual information as well. Subjects who see all the pieces arranged in sequential order may gain additional nonmotor visual information, helping them remember what they did. But what would the additional visual information from seeing not-to-be-performed pieces do? On one hand, knowing what the not-to-be-performed pieces look like may make source monitoring more difficult at test. Because the not-to-be-performed pieces lack accompanying motor information, the conspicuous absence of that information may help people reject those missing steps at test; such a process would decrease the likelihood of falsely saying they had performed those unperformed actions.

**EXPERIMENT**

**METHOD**

**Subjects**

Seventy-two introductory psychology students (32 men, 40 women) completed the experiment as part of a course requirement. Subjects were told that they would be building some LEGO toys and that later they would be asked some questions about the toys they built.

**Design**

We used a 2 (visibility: visible, not visible) × 3 (clip type: old, missing, control) mixed-factors design. Whether people could see the LEGO vehicles during construction—visibility—was a between-subject factor, and clip type was a within-subject factor.

**Procedure**

People took part in two sessions, 24 hr apart, and participated one at a time.

**SESSION 1.**

People sat in front of a rectangular table, in full view of closed boxes and opposite the experimenter. To avoid errors during construction, all subjects were shown two size A4 (8.3” × 11.7”) posters, each depicting six different angles of a to-be-constructed vehicle in its completed state. Each poster remained visible throughout the construction of that vehicle.

People were randomly assigned to either the visible or not-visible conditions. Those in the visible condition could see all the LEGO pieces, arranged in order, throughout the session; these pieces were hidden from the not-visible subjects by the closed boxes. Once seated, the experimenter read the following instructions to all subjects:

We will be building LEGO vehicles together. You will do most of the building; however, I will help you with some of the pieces. You will start...
SESSION 2.

Three LEGO vehicles were used in this study: a police car, a train, and a biplane. We chose these vehicles because they were markedly different from each other. Each vehicle was composed of 40–60 small pieces, but we partially assembled them so that it took only nine steps to construct each vehicle. Thus, there were 27 possible steps (3 vehicles \( \times \) 9 steps each = 27 steps). However, subjects assembled only two of the three LEGO vehicles, leaving 18 steps performed during Session 1: 12 by the subject to serve as completed steps and 6 by the experimenter to serve as missing steps. Constructing both vehicles took approximately 10 min. The nine steps from the third vehicle were not performed during the session and served as controls.

During Session 1, the experimenter rang the bell six nonconsecutive times (three for each vehicle) between steps two and eight in the construction process, performing the next step while the subject’s eyes remained closed. Importantly, all subjects were instructed to close their eyes during these experimenter-performed steps in order to avoid false recognition due to the suggestibility of observation (Lindner et al., 2010). We counterbalanced vehicles used and steps performed by the experimenter.

RESULTS AND DISCUSSION

Our primary research question was whether people would systematically come to remember performing actions they never really did, in the absence of any suggestion from the experimenter. To address this question, we first calculated the proportion of times each person responded “yes” to the question “Did you perform this step?” for old, missing, and control clips. We classified these responses according to whether people had seen all the pieces (visibility) during the construction phase and display the resulting values in Figure 1a.

Figure 1a shows three important findings. First, the black bars show that people were good at identifying the actions they had actually performed, regardless of whether they had seen all the LEGO pieces during Session 1 or whether those pieces were hidden from view. Second, the very small white bars show that people were very good at identifying the actions that belonged to an entirely novel vehicle. Third, the gray bars show that people systematically reported performing related actions they had not performed when building their vehicles. Put another way, a single-factor (item type) ANOVA showed a significant effect of item type, \( F(2, 142) = 454.47, p < .01, \eta^2_p = .86.\)
Subjects were more likely to remember performing steps they did complete \((M = .87, SD = .17)\) than both missing \((M = .29, SD = .25)\) and control \((M = .01, SD = .01)\) steps, \(t(71) > 17.22, ps < .01\), Cohen’s \(d_s > 4.08\). Most importantly, subjects were much more likely to falsely remember having completed related, experimenter-performed steps than unrelated steps, \(t(71) > 9.19, ps < .01, d = 2.18\). In total, 74\% \((n = 53)\) of people reported performing at least one of the missing actions; these people falsely reported performing 39\% \((SD = 21\%)\) of the missing steps.

Our second question was whether making the pieces visible during construction would affect people’s ability to remember what they did and did not do. Figure 1a shows two important findings related to this question: First, the difference between the black bars shows that having the LEGO pieces visible made people better at remembering what they really did do; second, the difference in the gray bars shows that having the LEGO pieces visible did not affect people’s likelihood of falsely remembering steps they did not do. In short, a \(2 \times 3\) (visibility) ANOVA revealed a significant interaction, \(F(2, 140) = 3.43, p = .03, \eta^2_p = .05\). Follow-up tests revealed that subjects in the visible condition were just as accurate as subjects in the not-visible condition when it came to both control and missing steps, all \(t(70) < 1.26, ps > .21, ds < 0.30\), but were more likely to accurately remember the steps they did complete, although this result was only marginally significant, \(t(70) = 1.89, p = .06, d = 0.45\). In summary, making the pieces visible during construction helped people remember what they did but did not affect people’s ability to reject false memories for steps they did not do.

Was the ability to distinguish between true and false memories related to people’s visuospatial skills? The answer is no. For each subject, we calculated the proportion of “yes” responses to old, missing, and control clips and conducted Pearson correlations between these proportion scores and rMRT scores. The results showed no relationships, all \(|r| (70) < .15\), all \(ps > .19\).

**Recognition and Confidence**

Although these analyses tell us about the accuracy of people’s memories, they tell us nothing about the phenomenological qualities of those memories. To address this issue, we examined people’s confidence in two ways: First, we examined people’s overall confidence for each of the three clip types, regardless of their response; second, we examined people’s confidence for items they claimed to have performed.

**Overall Confidence**

Figure 1b shows three important findings about people’s overall confidence. First, the height of the bars shows that overall, subjects were confident about their responses. Second, the relative heights of the white, black, and gray bars shows that regardless of whether the LEGO pieces were visible, subjects were most confident about their responses to control clips \((M = 4.91, SD = 0.24)\), then old clips \((M = 4.42, SD = 0.42)\), and then missing clips \((M = 4.13, SD = 0.62)\). Third, the higher bars on the left half of the graph suggest that subjects for whom the LEGO pieces were not visible were more confident about their responses \((M = 4.56, SD = 0.30)\)—despite being less accurate—than subjects for whom the LEGO pieces were visible \((M = 4.42, SD = 0.32)\).

**FIGURE 1.** (a) Mean proportion of “yes” responses to video clips by clip type and visibility. (b) Mean overall confidence estimates of all responses, regardless of accuracy, to video clips by clip type and visibility. Error bars represent ±1 standard error
In other words, a 2 (visibility: visible, not visible) × 3 (clip type: old, missing, control) mixed-factor ANOVA revealed a significant effect for clip type and a marginal effect for visibility, $F(2, 140) = 74.25, p < .01, \eta^2_p = .52$, and $F(1, 70) = 3.89, p = .05, \eta^2_p = .05$, respectively. To illuminate the effect of clip type, we conducted follow-up $t$ tests and found that subjects were more confident in their responses to control clips than either old clips or missing clips, $t(71) > 8.79, ps < .01, ds > 2.08$. We also found that people were more confident in their responses to old clips than to missing clips, $t(71) = 4.61, p < .01, d = 1.10$. The marginal effect for visibility was driven by marginally higher confidence scores from subjects in the not-visible condition than in the visible condition. There was no interaction between clip type and visibility, $F(2, 140) = 2.13, p = .12, \eta^2_p = .03$.

**Confidence for Items That Subjects Claimed to Perform**

How confident were people when they claimed to have performed an action? To answer this question, we calculated people’s mean confidence ratings for items they claimed to perform, omitting the 19 people who did not report performing any missing steps (12 in the visible condition, 7 in the not-visible condition). The 53 remaining subjects were confident when they falsely claimed to have completed a missing step ($M = 3.86, SD = 0.93$) and more confident in these false memories when the LEGO pieces were not visible than when they were, $M = 4.08, SD = 0.73$ vs. $M = 3.58, SD = 1.09$. When subjects correctly claimed to have completed an old step (true memories), the visibility of the LEGO pieces did not matter. Subjects were similarly confident when they could see the pieces as when they could not, $M = 4.56, SD = 0.42$ vs. $M = 4.47, SD = 0.41$. In other words, a two-way ANOVA between visibility and clip type revealed a marginally significant interaction, $F(1, 51) = 3.18, p = .08, \eta^2_p = .06$. Follow-up $t$ tests showed that when the LEGO pieces were not visible, subjects were marginally less confident about their false memories than subjects for whom the LEGO pieces were visible, $t(51) = 1.99, p = .05, d = 0.56$. However, whether the pieces were visible or not had no effect on subjects’ confidence in their true memories, $t(51) = .80, p = .43, d = 0.22$.

Taken together, our findings demonstrate that merely performing related actions can lead people to falsely remember having performed actions that they had not performed. These results extend research showing that merely exposing people to related words, concepts, or sequences causes them to falsely remember seeing or hearing related but non-presented information (Bransford & Franks, 1971; Hannigan & Reinitz, 2001; Roediger & McDermott, 1995). They also fit with the SMF, a mechanism in which people internally generate missing information that they confuse at test with actual experience.

We also found that people who saw the pieces during construction were better able to remember steps they completed but equally likely to falsely remember both related and unrelated steps they did not complete. How should we understand such a finding? We predicted that subjects who saw the pieces would be more likely to correctly remember steps they had completed, but we had competing hypotheses for steps they did not complete (Johnson et al., 1993; Lindsay, 2008). Our findings showed a marginally significant increase in true memories for people who saw the pieces but no difference in falsely recognizing missing steps. However, the pattern of results suggests that people who saw the pieces laid out may have been less likely to falsely recognize those missing steps. Although our data show a nonsignificant trend, this pattern of results is not uncommon. Other research using the Deese–Roediger–McDermott (DRM; Roediger & McDermott, 1995) paradigm, in which a list of semantically related words is presented, has found similar increases in true memories—accompanied by decreases in false memories—by manipulating the speed at which items are presented during study (McDermott & Watson, 2001). More specifically, when McDermott and Watson varied the presentation rate of DRM words, they found that longer exposure to the related words made people better able to recognize words they had seen and reject words they had not. McDermott and Watson suggested that their exposure effects were caused by a monitoring component used during study. Our data lead us to suggest a similar explanation. Having the pieces visible during construction may be analogous to a longer presentation time, giving subjects more time to engage in strategic monitoring during construction.

Future research could examine evidence for this hypothesis by having some steps in the process not completed at all and later having subjects complete a source monitoring test, asking them to report which
steps were completed by them, completed by the experimenter, or not completed at all. If having the pieces visible allows better monitoring at study, then subjects who saw all the pieces should be better able to differentiate between steps that the experimenter completed and steps that were not completed at all. In addition, the generalizability of these findings outside our method should be examined further. More specifically, it may be that using a video recognition test led subjects to rely less on their memories for motor information and more on the familiarity of steps. Future research could examine the evidence for this hypothesis by asking some subjects to act out the motor actions at test before indicating whether they had completed that action.

On a more practical level, our results demonstrate that the relationships between actions—that is, the relationships present in most daily activities—can lead to errors in memory. And although self-performed actions are better remembered than witnessed events, they remain vulnerable to the same memory errors. Our results demonstrate that doing something does not confer immunity from false memories; even in the absence of suggestion, people can falsely remember having done things they simply have not done.

Notes
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1. Pilot testing demonstrated that subjects made very few errors; when they did make errors, those errors were almost exclusively in the first step of constructing each vehicle. Accordingly, these pieces never served as critical items in the experiment proper, and we did not record their errors.

2. There was no significant difference between visibility conditions in the number of people who falsely remembered performing at least one missing step, λ(1) = 1.79, p = .18.

REFERENCES


