MEMORY, 2006, 14 (2), 197–213

Psychology Press
Taylor & Francis Group

Importing perceived features into false memories

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False memories sometimes contain specific details, such as location or colour, about events that never occurred. Based on the source-monitoring framework, we investigated one process by which false memories acquire details: the reactivation and misattribution of feature information from memories of similar perceived events. In Experiments 1A and 1B, when imagined objects were falsely remembered as seen, participants often reported that the objects had appeared in locations where visually or conceptually similar objects, respectively, had actually appeared. Experiment 2 indicated that colour and shape features of seen objects were misattributed to false memories of imagined objects. Experiment 3 showed that perceived details were misattributed to false memories of objects that had not been explicitly imagined. False memories that *imported* perceived features, compared to those that presumably did not, were subjectively more like memories for perceived events. Thus, perception may be even more pernicious than imagination in contributing to false memories.

False memories are memories for events that never occurred, or did not occur the way we remember them (e.g., Johnson & Raye, 1981; Loftus, 1979). The details people remember about events constitute the episodic content of memories. The episodic content of false and real memories alike may include information about the semantic and perceptual qualities of events, the context in which events occurred (e.g., temporal, spatial), or thoughts and feelings evoked by events (Johnson & Raye, 1981). A diverse body of research shows that false memories may be quite detailed and subjectively compelling (for reviews, see Lampinen, Neuschatz, & Payne, 1998; Payne, Neuschatz, Lampinen, & Lynn, 1997). To take but one of many possible examples, Porter, Yuille, and Lehman (1999) found that false memory reports of childhood events contained, on average, more than 60 distinct pieces of information.

If an event never happened, then how is it possible for people to remember details about the event? In other words, how do false memories get their episodic content? The source-monitoring framework (SMF; Johnson, Hashtroudi, & Lindsay, 1993; Johnson & Raye, 1981) provides a set of ideas for answering this question. A central idea of the SMF is that memories do not "come back" with labels indicating their source that people can simply "read off" (e.g., "These are my memories for my last vacation"). Rather, source is inferred based, in part, on the quality and quantity of information that memories contain. This is possible because memories from different sources typically contain characteristically different kinds of information. For example, compared with memories for imagined events, memories for perceived events tend to include more perceptual information and less information about cognitive operations (e.g., records of retrieving, elaborating on, and organising information relevant to the event; Conway, Pleydell-Pearce, Whitecross, & Sharpe, 2003; Hashtroudi, Johnson, & Chrosniak, 1990; Johnson, Foley, Suengas, & Raye, 1988b; Johnson, Raye, Foley, & Kim, 1982; Suengas & Johnson, 1988). However, although memories from different sources differ, on average, in their

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This research was supported by NIA grant AG09253 to MKJ and a National Science Foundation Graduate Research Fellowship to KBL. The authors thank Elizabeth Marsh and two anonymous reviewers for helpful comments on an earlier version of this paper.

http://www.psypress.com/memory DOI:10.1080/09658210544000060

characteristics, there may be some overlap. For example, some memories for perceived events contain few perceptual details, while some memories for imaginations contain many. Also, judgement processes may be flawed, as when the criteria people use for attributing memories to sources are too lax (e.g., familiarity; see Jacoby, Kelley, & Dywan, 1989), or they give too much weight to one type of information, or they fail to retrieve potentially useful supporting or conflicting information (Mitchell & Johnson, 2000). For these reasons, there is the potential for confusion between memories from different sources.

According to the SMF, many false memories occur because memories for imaginings are erroneously judged to be memories for perceived events (e.g., Johnson & Raye, 1981, 2000). Confusing imagination for perception, and vice versa, is known as *reality-monitoring failure*. All manner of details about events may be imagined, and if there is reality-monitoring failure then these details, or the subset of them that are remembered, will make up the episodic content of false memories. For example, Johnson, Foley, and Leach (1988a) had participants hear and imagine words. Words that were imagined were sometimes later falsely remembered as having been heard. Furthermore, participants were much more likely to falsely remember that Person A said a word if they had imagined Person A saying the word than if they imagined Person B saying the word. Apparently, when asked to imagine Person A saying the word, participants internally generated voice information consistent with hearing Person A say the word, and that information later became part of their false memory of hearing the word.

Reality-monitoring failure has been proposed as at least a partial explanation for the episodic content of false memories in several different contexts. For example, reality-monitoring failure is thought to contribute to the episodic content of false memories in eyewitness suggestibility or misinformation studies. A post-event narrative or questions suggest the presence of objects in an event that actually were not seen (e.g., Lindsay, 1990; Loftus, Donders, Hoffman, & Schooler, 1989; Loftus, Miller, & Burns, 1978). On a later test of memory for the witnessed event, participants falsely remember seeing suggested objects. Although the objects are not described in detail in the post-event suggestion, participants sometimes remember specific features of the objects, such as what they looked like or where they were (Karpel, Hoyer, & Toglia, 2001; Keogh & Markham, 1998; Pickel, 1999; Schooler, Clark, & Loftus, 1988; Schooler, Gerhard, & Loftus, 1986), or give Remember rather than Know ratings (Tulving, 1985) to their recognition judgements (Frost, 2000; Zaragoza & Mitchell, 1996). It is thought that falsely remembered details may be spontaneously imagined by participants while reading or answering questions about the witnessed event and then later misattributed to the event (Belli & Loftus, 1994; Mitchell & Johnson, 2000; Zaragoza & Mitchell, 1996). Reality-monitoring failure has also been implicated in the episodic content of false implanted childhood memories (Hyman & Billings, 1998; Hyman & Pentland, 1996) and false memories for words that are strong associates of actually studied words (Gallo & Roediger, 2003).

Conceptualising false episodic content as internally generated leads to an important expectation about false memories that is widely supported by existing data. Because imaginations contain, on average, fewer and less specific perceptual details than do sensory experiences, false memories should be, on average, less perceptually detailed than real memories. Two kinds of data indicate that false and real memories differ in perceptual detail: the average number of details in descriptions of suggested objects is significantly less than in descriptions of objects that were actually seen (Karpel et al., 2001; Pickel, 1999; Schooler et al., 1986, 1988) and participants rate their false memories as significantly less clear or vivid in perceptual (usually visual or auditory) qualities than real memories (Gallo & Roediger, 2003; Henkel, Franklin, & Johnson, 2000; Henkel, Johnson, & De Leonardis, 1998; Hyman & Pentland, 1996; Lampinen, Odegard, & Bullinton, 2003; Lane, Villa, & Roussel, 2003; Mather, Henkel, & Johnson, 1997; Neuschatz, Payne, Lampinen, & Toglia, 2001; Norman & Schacter, 1997).

Although imagination is one source of false episodic content that has been considered, it is not the *only* source. Features of perceived events are subject to source misattribution as well (Johnson et al., 1993). Several research groups have noted that when people claim to remember details about events that never happened, they may in fact be remembering features of other, actually perceived events. Consider Mather et al.'s (1997) suggestion of one way in which participants may have come to remember which of two speakers said a non-presented critical lure word in a Deese-Roediger-McDermott experiment (Deese, 1959; Roediger & McDermott, 1995; see also Read, 1996). In

Mather et al.'s experiment, associative lists (e.g., *bed*, *rest*, *awake*, etc.) were read by two different speakers and, at test, when participants claimed to remember hearing a word, they were asked which speaker read the word (see also Anastasi, Rhodes, & Burns, 2000, Lampinen, Neuschatz, & Payne, 1999; Neuschatz et al., 2001; Payne, Elie, Blackwell, & Neuschatz, 1996; Roediger, McDermott, Pisoni, & Gallo, 2004). Mather et al. proposed that participants may have attributed critical lures (e.g., *sleep*) to particular speakers because, when critical lures were tested, voice information from memories of related list words may have become activated and participants took the lure words to be the source of the activated, externally derived information.

Lampinen et al. (1999), also attempting to explain how false memories in an associative list study may acquire episodic content, described a *familiarity plus corroboration* account in which the familiarity of critical lures causes participants to ''search their memories for corroborating details'' about the lures, and ''Corroborating details are borrowed from *actually presented items* and are bound to the false memory trace '' (p. 134; emphasis added).

Finally, Reyna and Lloyd (1997), in the context of fuzzy-trace theory, proposed that memories for the surface form of events (i.e., verbatim traces) may disintegrate over time, and fragments of the memories, which are said to include information about specific attributes of events, such as images, emotions, and smells, may become associated with the wrong context (i.e., falsely remembered events).

These accounts have in common the idea that specific feature information in memories for discrete perceived events may be remembered as part of other, non-perceived events. If false memories can acquire details from memories of perceived events, then it means that their episodic content is not constrained by the limits of imagination. Rather, if embellished by features from memories of rich perceptual experiences, false memories should be more likely to approximate true memories in the vividness of perceptual detail, compared to false memories embellished only by imagination.

Henkel and colleagues (Henkel & Franklin, 1998; Henkel et al., 1998) investigated a case in which they argued that features of perceived events were incorporated into false memories. They had participants view and imagine line drawings of objects. Some of the imagined objects had shapes similar to, or belonged to the same functional category as, objects of which participants actually saw drawings. Other imagined objects had no similarity to any of the seen objects. On a later source-monitoring test, on which participants saw the names of objects and indicated whether each had been seen, imagined, or was new, participants sometimes falsely remembered seeing objects that had only been imagined, and this was more likely to occur if they actually had seen a visually or conceptually similar object.

Based on the SMF, Henkel and colleagues (Henkel & Franklin, 1998; Henkel et al., 1998) suggested that the increase in false memories for similar objects occurred because information from similar seen objects sometimes inadvertently became activated upon test of imagined objects and was misattributed to the imagined objects. As the information was characteristic of sensory experience, it increased the likelihood of false seen responses. For example, when tested on the imagined object *lollipop*, shape features of the similar seen object *magnifying glass* may have become activated, in addition to shape information that participants generated about *lollipop*. Based on a combination of imagined and perceived information, participants judged that they had seen *lollipop*.

Although Henkel and colleagues (Henkel & Franklin, 1998; Henkel et al., 1998) reasoned, based on the increase in the rate of false memories caused by seeing a similar object, that participants remembered feature information encoded as part of seen objects when tested on imagined objects, they did not directly examine the episodic content of false memories. Here, we used a variant of the Henkel procedure to test whether specific features that were randomly assigned to seen objects became part of false memories of visually (Experiments 1A and 2) or conceptually (Experiment 1B) similar imagined objects. Each seen object possessed a particular perceptual feature (location in Experiments 1A and 1B and colour in Experiment 2) that participants did not generate for imagined objects. When participants falsely remembered seeing objects that had only been imagined, we asked for the location or colour of the object. We predicted that, if memories of seen objects are inadvertently activated at test and misattributed to imagined objects, then false memories would tend to include feature information congruent with that assigned to visually or conceptually similar seen objects. For example, when tested on *lollipop*, shape features of *magnifying glass* may be activated and additional details that are bound to shape features, such as location or colour, may be activated as well, and misattributed to *lollipop*.

The above prediction is supported by neuroimaging data showing that attempted retrieval of one feature type (e.g., visual) activates—in addition to brain regions associated with memory for that feature type—brain regions associated with other feature types (e.g., auditory) that were part of the same event (Nyberg, Habib, McIntosh, & Tulving, 2000). Furthermore, behavioural research shows that, although it is possible to focus participants relatively more on certain features versus others when making source judgements, thereby increasing the likelihood that participants will retrieve and give weight to those features (e.g., Dodson & Johnson, 1993; Lindsay & Johnson, 1989; Marsh & Hicks, 1998), the relatively automatic and inadvertent retrieval of source features not directly relevant to a particular memory judgement may contribute to the formation of false memories (Henkel et al., 2000).

Assuming that false memories would incorporate specific features from memories of perceived events, we were also interested in how this would affect the subjective quality of false feature information. As described earlier, false memories are typically rated as less clear or vivid than memories of perceived events in terms of perceptual information. When imagined events are falsely remembered as perceived, this difference is to be expected, because participants presumably, on average, self-generate fewer and less specific perceptual details about imagined events than they derive from external, sensory experiences, and this difference is reflected in their memories. However, false memories that acquire additional details from memories of perceived events should be more like real memories. We collected Memory Characteristics Questionnaire (MCQ; Johnson et al., 1988b) ratings of how clearly or vividly participants remembered perceptual features of objects they claimed to have seen and imagined.

EXPERIMENTS 1A AND 1B

Because of their similarity, the methods of Experiments 1A and 1B are described together, after which the results from each experiment are reported separately.

Method

Participants. A total of 24 Yale University students (18 females, 6 males) in Experiment 1A and 22 in Experiment 1B (16 females, 6 males) participated in return for either money or credit in an Introductory Psychology course.

Materials. The stimuli were 80 slides adapted from a pool developed by Henkel and colleagues (Henkel & Franklin, 1998; Henkel et al., 1998). For 40 perception trials, each slide showed a black-and-white line drawing of a common object in one of the four corners of a computer screen, with its name directly below it. Drawings were pseudorandomly assigned to corners, with the restriction that each corner was assigned to one quarter of the objects from similar and control pairs (see below). For 40 imagination trials, only the name of an object appeared on the slide and it always appeared just below the centre of the screen.

Although objects were presented individually on perception and imagination trials, for the purpose of constructing the slide sequence each object was "paired" with a single other object that appeared elsewhere in the slide sequence. There were two pair types in each experiment: visually similar and control in Experiment 1A and conceptually similar and control in Experiment 1B. In each pair one object was seen on a perception trial and one object was imagined on an imagination trial. In visually similar pairs, the imagined object was similar in shape, but otherwise unrelated, to the seen object (e.g., *lollipop* and *magnifying glass*). In conceptually similar pairs, the imagined object was from the same category as the seen object but not similar in shape (e.g., *banana* and *apple*). Control pairs were arbitrary pairings of seen and imagined objects that were neither similarly shaped nor from the same category (e.g., *belt* and *feather*). As in prior experiments by Henkel and colleagues (Henkel & Franklin, 1998; Henkel et al., 1998), which pair member was seen and which imagined was invariant across participants. Henkel and colleagues assigned objects to visually similar pairs on the basis of physical-resemblance ratings, and to conceptually similar pairs on the basis of consensus of trained judges. Henkel and colleagues also collected normative data showing that the objects assigned to the three pair types do not differ, on average, in the ease with which they can be imagined or their physical complexity. There were 20 visually similar and 20 control pairs in Experiment 1A and the same number of conceptually similar and control pairs in Experiment 1B. Slides were pseudorandomly ordered with a minimum of 10 trials between pair members. For a random half of the pairs of each type, the seen member occurred first in the order of trials, and for the other half, the imagined member occurred first. Two orderings were constructed such that each object appeared before and after its pair member for an equal number of participants.

The source memory test consisted of the names of 80 old objects (i.e., 40 seen and 40 imagined) and 40 new objects in one pseudorandomised order. The new objects were selected, as far as possible, to have no visual or conceptual similarity to any of the old objects. Pair members from visually similar and conceptually similar pairs were tested at least eight trials apart. For a randomly chosen half of the pairs of each type, the imagined object from the pair was tested first and for the other half the seen object was tested first.[1] Next to each object name were the response options perceived, imagined, or new. The perceived option was followed by the four location response options of upper left, lower left, upper right, or lower right.

The appearance vividness ratings form was separate from the source memory test and included the same list of object names. As in the MCQ developed by Johnson et al. (1988b), the scale ranged from 0 = *no memory* to 5 = *extremely clear or vivid memory*.

Procedure. Each slide was presented for 7 seconds. On perception trials, participants first stated the corner in which the object appeared, and then estimated how long it would take them to reproduce the drawing (Experiment 1A) or rated how well the drawing depicted the named object (fair, good, or very good) and gave a common function of the object (Experiment 1B). On imagination trials, participants imagined a simple line drawing of the object whose name appeared just below the centre of the screen. They were told to imagine the drawing appearing directly above the name of the object, just as real drawings appeared above the names of objects on perception trials. After imagining the drawing, they estimated how long it would take them to draw what they imagined (Experiment 1A) or rated how well the drawing they imagined depicted the object (fair, good, or very good) and gave a common function of the object (Experiment 1B). All responses during the slide sequence were made verbally and recorded by the experimenter. The particular orienting task used during the slide presentation was chosen to increase the likelihood that participants would encode the features that seen and imagined objects in visually similar and conceptually similar pairs had in common.

Participants returned to the lab 2 or 3 days after the slide presentation. At that time, they were given the surprise source memory test and then the appearance vividness questionnaire. After making appearance vividness ratings, participants were asked whether they noticed any similarities or relationships between objects, used any strategies when making location judgements, or detected any patterns in which objects appeared in which corners. These questions indexed how salient the similarity between objects in visually similar and conceptually similar pairs was to participants, and whether awareness of similarity affected location attributions (e.g., in the absence of memory for a particular object's location, was the location attribution for that object based on memory for where a similar object appeared?) or gave rise to a sense of illusory patterns (e.g., that similarly shaped objects were in the same location).

All reported differences in all experiments were significant at the $p < .05$ level, unless otherwise stated.

Experiment 1A: Results and discussion

Source monitoring. Table 1 shows the proportion of objects attributed to the incorrect source (i.e., imagined objects called seen or vice versa), given correct recognition of the objects as old. We conducted a 2 (source: seen or imagined) $\times$ 2 (pair type: visually similar or control) within-participants analysis of variance (ANOVA) with proportion source errors as the dependent variable. The only significant effect was an interaction between source and pair type, $F(1, 23) = 7.84$, $MSe = .04$. Planned comparisons indicated that the proportion of imagined objects wrongly identified as seen was significantly greater in visually similar pairs ($M = 0.25$) than control pairs ($M = 0.18$) $t(23)$

[1] In all experiments, the order in which pair members were tested and, where applicable, presented in the slide sequence did not reliably influence the effects of interest in this paper, therefore those two variables are not discussed further.

TABLE 1
Mean proportion source-monitoring errors (with standard errors) as a function of source and pair type

Experiment	Source	*Pair type* Similar	Control	*X*
1A	Imaged	.25 (.03)	.18 (.03)	.22
	Seen	.17 (.03)	.18 (.03)	.18
	X	.21	.18	
1B	Imagined	.31 (.03)	.28 (.05)	.30
	Seen	.12 (.02)	.10 (.02)	.11
	X	.22	.19	
2	Imagined	.13 (.02)	.09 (.02)	.11
	Seen	.16 (.03)	.13 (.03)	.15
	X	.15	.11	

= 2.57, but the proportion of seen objects erroneously called imagined was about the same in visually similar pairs (M = 0.17) and control pairs (M = 0.18). Thus, Experiment 1A replicated Henkel and colleagues (Henkel & Franklin, 1998; Henkel et al., 1998) in showing that imagined objects were more likely to be falsely remembered as seen when they had shapes similar to seen objects. This finding suggests that information about similar seen objects was activated when participants were tested on imagined objects. The remaining analyses are aimed at characterising the nature of this information.

Location attributions. When imagined objects were falsely remembered as seen, to which corner of the computer screen were the objects attributed? Table 2 shows the percentage of falsely remembered objects attributed to the corner of the object's seen pair member (i.e., congruent attributions). There were four corners—thus, by chance alone, one in four (25%) attributions should be congruent. Indeed, of the imagined objects from control pairs that were falsely remembered as seen, 26.7% (n = 20/75) were attributed to the corner of an arbitrarily chosen seen pair member, a percentage not reliably different from chance, $\chi^2(1)$ = 0.11. In contrast, 42.7% (n = 44/103) of attributions for false memories of imagined objects from visually similar pairs were congruent, which is significantly more than chance predicts, $\chi^2(1)$ = 17.25. For the 23 participants who gave at least one perceived response to a similar-imagined object, the mean percentage of congruent attributions per participant was 43.8%. For comparison, for the same participants, the mean percentage of seen objects attributed to the correct corner, given that they were remembered as seen, was 57.0%. The central point is that the location information in false memories of imagined objects tended to correspond to that assigned to similar seen objects, indicating that false memories incorporated a specific detail from memories of perceived events.

MCQ ratings. Subjectively, were false memories of imagined objects more like real memories of seen objects if participants had seen a similar object than if they had not? To answer this question, we looked at data from only the 20 of 24 (83.3%) participants who gave at least one perceived response on the source memory test to each of the following types of object: new, control-imagined, similar-imagined, and seen.[2] The average appearance vividness rating that each participant gave to each of the four object types, given a perceived response, was entered as the dependent variable in a one-way within-participants ANOVA (see Table 3). There was a significant main effect of object type, $F(3, 57) = 22.69$, MSe = .60. Tukey HSD tests for post-ANOVA comparisons indicated that ratings for similar-imagined objects (M = 2.9) were significantly higher than for control-imagined objects (M = 2.1) and not significantly lower than for seen objects (M = 3.2). Ratings for new objects (M = 1.4) were significantly lower than for the other three object types. Thus, imagining objects evidently produced perceptual information that was subsequently misremembered as externally derived but, judging from the comparison of appearance ratings for control-imagined and seen objects, this information was, on average, less vivid than that in memories of seen objects. Important for present purposes, when participants not only imagined objects, but also saw similar objects, they developed false memories that were subjectively very much like memories of seen objects in terms of perceptual content.

It is also interesting that, given a correct imagined response to imagined objects, the same participants included in the preceding analysis of perceived responses did not give higher appearance vividness ratings to objects from visually similar

[2] In all experiments, subjective ratings for seen objects were very similar for all pair types. Thus, for ease of exposition, we report average ratings for seen objects collapsed across pair type.

TABLE 2
Percentage falsely remembered objects attributed to feature of seen pair member (congruent attributions) and percentage correct feature attributions for seen objects

Experiment	*Feature*	*Source*	*Pair type*	*Percentage congruent attributions*	*Percentage correct attributions for seen objects*
1A	Location	Imagined	Similar	42.7*	57.0*
			Control	26.7	
1B	Location	Imagined	Similar	33.7*	62.2*
			Control	25.0	
2	Colour	Imagined	Similar	38.2*	40.4*
			Control	24.4	
3[a]	Location	New	Similar	35.4*	51.7*
			Control	19.4	

[a] Artist condition only.
* Differs significantly from chance (i.e., 25%).

pairs ($M = 3.1$, $SE = .26$) than control pairs ($M = 3.2$, $SE = .22$) $t(19) = 0.64$. There was no difference presumably because these are the similar-imagined objects to which participants did not misattribute features of seen objects; if they had, the objects likely would have been called seen.[3]

Post-test questioning. When asked about similarities or relationships between objects, only 4 of 24 (16.7%) participants mentioned any of the visually similar pairs of objects. The mean number of pairs these participants noticed was 1.8 out of 20 (9.0%). No participants reported using any strategies when making location attributions or thinking that visually similar objects appeared in the same corner. Thus, participants apparently were rarely aware of the experimentally manipulated similarity between seen and imagined objects and were unaware that the features of some of their (false) memories may have ‘‘belonged’’ to memories of other objects.

Recognition. We conducted a 2 (source: seen or imagined) × 2 (pair type: visually similar or control) within-participants ANOVA on the proportion of objects correctly identified as old,

TABLE 3
Mean MCQ ratings given perceived responses to different object types (with standard errors) in Experiments 1A, 1B, and 2

		Object type			
Experiment	*Rating*	*Cont-imag*	*Sim-imag*	*Seen*	*New*
1A	Appearance	2.1 (.27)	2.9 (.27)	3.2 (.18)	1.4 (.24)
1B	Appearance	2.8 (.25)	2.6 (.24)	3.3 (.20)	—
2	Shape	1.9 (.29)	2.6 (.36)	3.3 (.24)	—
	Colour	.51 (.25)	.86 (.24)	1.3 (.21)	—

Note: Cont-imag = Control-imagined, Sim-imag = Similar-imagined. Appearance and shape vividness rating scales ranged from 0–6. The colour confidence rating scale ranged from 0–3.

[3] As stated in the main text, appearance vividness ratings were as high for imagined objects correctly remembered as imagined ($M = 3.2$ collapsed across pair type) as for seen objects correctly remembered as seen ($M = 3.2$). This may at first seem contrary to the SMF's claim that memories for sensory events contain, on average, more and more specific perceptual detail than do memories for imagined events. However, the most perceptually vivid memories of imagined events may be the ones that also include information about cognitive operations, and therefore are correctly identified as imagined. Alternatively, memories of imagined objects that are correctly attributed to imagination may be those that are most likely to include cognitive operations information, and appearance vividness ratings may have been based, not only on perceptual information, but also on the record of cognitive operations. The combination of these two kinds of information may have resulted in vividness ratings that were, on average, as high as those for the perceptual information in memories of seen objects.

regardless of correct source identification. There was a significant effect only of source, $F(1, 23) = 74.92$, $MSe = .02$, whereby recognition was higher for imagined objects ($M = 0.88$) than seen objects ($M = 0.64$). The mean proportion of false alarms to new objects was .18.

Experiment 1B: Results and discussion

One participant in Experiment 1B gave a number of perceived responses to new objects that was more than 3 SD above the mean, causing us to question the basis for the participant's perceived responses to imagined objects. Therefore, that participant's data were not included in any of the analyses reported below.

Source monitoring. The data from Experiment 1B were analysed in the same way as those from Experiment 1A. The analysis of internal–external source confusions yielded a significant effect only of source, such that, given recognition of the objects as old, a greater proportion of imagined objects ($M = 0.30$) than seen objects ($M = 0.11$) were attributed to the incorrect source, $F(1, 20) = 23.67$, $MSe = .03$ (see Table 1). There was no main effect of pair type, $F(1, 20) = 1.01$, $MSe = .01$, and no interaction, $F(1, 20) = 0.20$, $MSe = .01$, thus there was no evidence that the proportion of source errors for imagined objects from conceptually similar pairs ($M = 0.31$) was reliably greater than that for imagined objects from control pairs ($M = 0.28$). Although, as noted in the Introduction, Henkel and Franklin (1998, Experiment 2) found that conceptual similarity to seen objects significantly increased source confusion about imagined objects, Henkel et al. (1998) found only an insignificant increase, as did we, among college-age adults. This weak effect on the rate of false memories might be taken to suggest that information about the conceptually similar seen object was not activated when its imagined pair member was tested. However, evidence to the contrary is discussed next, as participants tended to attribute the location of conceptually similar seen objects to imagined objects that were falsely remembered as seen.

Location attributions. As shown in Table 2, of the similar-imagined objects falsely remembered as seen, 33.7% (n = 35/104) were attributed to the location of a seen pair member, which is significantly more than the 25% predicted by chance, $\chi^2(1) = 4.15$. All 21 participants gave at least one perceived response to a similar-imagined object and the mean percentage of congruent attributions per participant was 32.4%. This finding indicates that the feature of location from memories of seen objects was misattributed to false memories of conceptually similar imagined objects. In contrast, only 25% (n = 24/96) of attributions for control-imagined objects were congruent. The mean percentage of seen objects attributed to the correct corner, given that they were remembered as seen, was 62.2%.

We have argued that misattributing features of seen objects to imagined objects should increase false seen responses to imagined objects. Yet in Experiment 1B, even though participants misattributed the location of seen objects to similar-imagined objects, false memories were not significantly more common for similar-imagined than control-imagined objects. One explanation is that location information was activated only when participants had to make location attributions, which occurred *after* the perceived/imagined/new judgement.[4]

A second explanation is that location information from memories of seen objects was activated when participants made perceived/imagined/new judgements about similar-imagined objects, but location was not given much weight in the judgements relative to other activated features, such as shape. On average, the vividness of shape information should be equal for imagined objects from conceptually similar and control pairs, because neither pair type had a seen-pair member with similar shape features. Location information may have been considered primarily during location judgements that followed perceived responses. If shape information dominates the perceived/imagined/new judgements, this would also explain why conceptual similarity produced only a weak effect on source judgements.

MCQ ratings. Next, we compared average appearance vividness ratings for objects called seen on the source memory test. Unlike in Experiment 1A, we do not report comparisons involving appearance vividness ratings for new objects because few participants gave seen responses to new objects and, in any event, false

[4] We thank an anonymous reviewer for suggesting this possibility.

memories of new objects were not of primary interest to us in Experiments 1A and 1B. Of 21 participants, 19 (90.5%) gave a perceived response to at least one control-imagined, similar-imagined, and seen object. There was a significant main effect of object type, $F(2, 36) = 11.62$, $MSe = .28$ (see Table 3). Tukey HSD tests indicated that ratings for similar-imagined ($M = 2.6$) and control-imagined objects ($M = 2.8$) did not differ from one another but were significantly lower than for seen objects ($M = 3.3$). These ratings are consistent with the idea that appearance vividness ratings, perhaps like perceived/imagined/new responses, as suggested above, were largely based on shape information. In Experiment 3, we assess the subjective quality of location information separately from that of shape information, and expect to see higher location ratings for false memories that incorporate location from conceptually similar seen objects than for false memories of control objects.

Post-test questioning. Only one participant mentioned any of the conceptually similar pairs of objects, identifying 5 of the 20 (25.0%) pairs. No participants reported using any strategies when making location attributions or thinking that conceptually similar objects appeared in the same corner. Thus, as with visual similarity in Experiment 1A, participants seemed to have low awareness of the experimental manipulation of conceptual similarity.

Recognition. The analysis of recognition memory yielded no significant main effects or interactions. The mean proportion of hits for old objects was .83 and the mean proportion of false alarms to new objects was .10.

EXPERIMENT 2

In the SMF, location is just one of many possible features of complex events that may be inadvertently activated and misattributed to similar events. Thus, Experiment 2 was a replication and extension of Experiment 1A; each seen object appeared in one of four colours, instead of locations. Also, instead of collecting global appearance vividness ratings, in Experiment 2 participants rated separately how clearly or vividly they remembered the shape of objects and, for objects remembered as seen, how confident they were about the object's colour. If testing imagined objects from visually similar pairs causes shape features of seen pair members to become activated, due to the similarity of shape features in the paired objects, and if colour information is activated along with shape, then false memories of similar imagined objects should be more like memories of seen objects in terms of both shape and colour, compared to false memories of imagined objects from control pairs.

Method

Participants. Participants were 28 Yale University students (18 females, 10 males), who either were paid or received course credit for participating.

Materials and procedure. The materials and procedure were the same as in Experiment 1A, with the following exceptions. For each perception trial, an object name and line drawing appeared in the centre of the screen and the drawing was in one of four colours: red, yellow, green, or blue. Colours were pseudorandomly assigned to objects with the restriction that objects did not have colours with which they were commonly associated or with which their pair member was commonly associated (e.g., *heart* was assigned a colour other than red). Participants stated the colour of the drawings. On imagination trials, participants were not instructed to imagine a particular colour, nor were they explicitly told not to do so.

On the surprise source memory test a day later, the perceived option was followed by the options red, yellow, green, or blue. For objects called seen, participants indicated the colour of the object. Test order was counterbalanced such that each object was tested before and after its pair member an equal number of times. The test was given 24, instead of 48, hours later, because pilot testing indicated that memory for colour was poorer than for location.

After the source memory test, participants rated on a separate MCQ response form how clearly or vividly they remembered the shape of each drawing or mental image they claimed to have seen or generated. For objects called seen, participants also rated how confident they were about their colour attribution. Shape vividness was rated on a scale from 0 = *no memory* to 5 = *extremely clear or vivid memory*. Confidence in colour attributions was rated on a 4-point scale with 0 = *Not at all confident/Guessing*, 1 = *More than a guess but more unsure than sure*, 2 = *More confident than not*, and 3 = *Extremely confident/As sure as I can be*.

Results and discussion

Source monitoring. The analysis of internal–external source confusions yielded a significant effect only of pair type, $F(1, 27) = 5.41$, $MSe = .01$ (see Table 1) such that objects from visually similar pairs ($M = 0.15$) were more likely to be attributed to the wrong source than objects from control pairs ($M = 0.11$). Unlike in Experiment 1A, but consistent with some previous work with this paradigm (Henkel & Franklin, 1998, Experiment 2), source errors for seen objects from visually similar pairs ($M = 0.16$) were numerically, but not significantly, more likely than for control-seen objects ($M = 0.13$) $t(27) = 1.19$; additional research is needed to better understand when and how imagining similar events might affect source judgements about perceived events. Central to the present investigation, false memories for imagined objects from visually similar pairs ($M = 0.13$) were significantly more common than for control-imagined objects ($M = 0.09$) $t(27) = 2.35$.

Location attributions. As shown in Table 2, the percentage of congruent attributions for false memories of similar-imagined objects was 38.2% ($n = 26/68$), which is greater than chance predicts (i.e., 25%) $\chi^2(1) = 6.35$, versus 24.4% ($n = 10/41$) for objects from control pairs, which is consistent with chance, $\chi^2(1) = 0.01$. Participants were not instructed in any way about including colour in their imagery, therefore one might suggest that similar-imagined objects were attributed to the colour of seen pair members because they were imagined in that colour after similar objects were seen. However, even for objects that were imagined *before* similar pair members were seen, the percentage of congruent attributions was 41.5% ($n = 17/41$), which is greater than chance predicts, $\chi^2(1) = 5.93$. For the 22 participants who gave at least one perceived response to a similar-imagined object, the mean percentage of congruent attributions was 43.1%. For the sake of comparison, for the same participants, the mean percentage of seen objects attributed to the correct colour, given that they were remembered as seen, was 40.4%.

MCQ ratings. Next we analysed separately the subjective quality of shape and colour information. We looked only at data from the 12 of 28 (42.9%) participants who gave at least one perceived response on the source memory test to each of the following types of object: control-imagined, similar-imagined, and seen (as in Experiment 1B, new objects are not included in this comparison because few participants gave at least one perceived response to new objects). There was a marginally significant effect of object type on shape vividness, $F(2, 22) = 5.06$, $MSe = 1.03$, $p = .06$, and a significant effect on colour confidence, $F(2, 22) = 5.57$, $MSe = .35$ (see Table 3). Tukey HSD tests indicated that object type affected shape vividness and colour confidence in much the same way. Shape vividness and colour confidence were significantly higher for seen objects (*M*s = 3.3 and 1.3, respectively) than control-imagined objects (*M*s = 1.9 and .51, respectively). Similar-imagined objects received intermediate ratings for both shape vividness ($M = 2.6$) and colour confidence ($M = 0.86$); these ratings did not differ reliably from those given to either of the other two object types. Thus, as predicted, false memories of imagined objects were more like memories of seen objects in terms of both shape and colour when a similarly shaped object had been seen.

When imagined objects were correctly remembered as imagined, shape vividness ratings were no higher for objects from visually similar ($M = 3.2$, $SE = .26$) than control pairs ($M = 3.4$, $SE = .22$) $t(11) = 1.00$, and were about equal to ratings for seen objects remembered as seen (see Footnote 3).

Post-test questioning. Of 28 participants, 5 (17.9%) reported noticing at least one pair of similar objects; the average number of similar pairs noted per participant was 2.4 out of 20 (12.0%). No participants reported using any strategies when making colour attributions or thinking that similarly shaped objects appeared in the same colour.

Recognition. As in Experiment 1A, the analysis of recognition memory indicated a significant effect of source, $F(1, 27) = 88.06$, $MSe = .03$, such that the proportion of hits was higher for imagined objects ($M = 0.93$) than seen objects ($M = 0.63$). Unlike in Experiment 1A, there was also a significant interaction between source and pair type, $F(1, 27) = 6.62$, $MSe = .01$. Recognition memory was significantly higher for imagined objects from visually similar pairs (M = 0.94, SE = .02) than control pairs (M = 0.91, SE = .02) $t(27)$ = 3.40, despite the fact that source memory was worse for the former than the latter. This is consistent with the idea that source and recognition judgements depend on different aspects of memories (Lindsay & Johnson, 1991). Recognition memory did not differ reliably for seen objects from visually similar (M = 0.61, SE = .04) and control pairs (M = 0.65, SE = .03) $t(27)$ = 1.54. The mean proportion of false alarms to new objects was .10.

EXPERIMENT 3

Experiments 1A, 1B, and 2 concerned the episodic content of false memories of events participants had been asked to imagine. But prior explicit imagination is not necessary to produce false memories (e.g., Bransford & Johnson, 1973; Lampinen, Copeland, & Neuschatz, 2001; Reinitz, Lammers, & Cochran, 1992). In Experiment 3 we demonstrate that whenever there is a possibility for memories of perceived events to be activated due to feature similarity during memory attributions, features of those memories may be incorporated into false memories.

Henkel and Franklin (1998, Experiment 1) showed that new objects that had typical shapes similar to previously seen objects were more likely to be falsely remembered as seen than were control objects that were not similar to seen objects. This fits with many previous findings showing that similarity between targets and lures results in false recognition (e.g., Anisfeld & Knapp, 1968; Cramer, 1965; Deese, 1959; Underwood, 1965). Building on this phenomenon, here we required participants to explicitly attribute a perceptual feature (in this case location) to objects remembered as seen and to rate the subjective quality of the shape and location information in their memories. Thus, we assessed not only whether similarity to a previous perception increased the rate of false memories, but also whether it affected episodic characteristics of false memories.

Method

Participants. Participants were 32 Yale University students (18 females, 14 males), who were paid for participating.

Materials and procedure. Each of 60 slides showed the name of an object, with a line drawing of the object directly above it, in one of the four corners of a computer screen for 7 seconds. Each corner was pseudorandomly assigned to a roughly equal number of objects from each pair type. Participants first stated out loud the location of the object. What participants did next depended on which of two orienting task conditions they were assigned to (e.g., Durso & Johnson, 1980). A random half of the participants were assigned to estimate how long it would take them to reproduce the drawing (i.e., the artist task), while the other half were assigned to state the most common function of the object (i.e., the function task). This between-participants manipulation of orienting task was included to encourage participants given the artist task to encode shape features of seen objects at study and to consider them at test, and to encourage participants given the function task to do the same with conceptual features.

Each object that was seen as a drawing was "paired" with another object used as a new object on the memory test. There were three pair types. Visually similar pairs (n = 15) were taken from the pool in Experiment 1A and conceptually similar pairs (n = 15) were taken from the pool in Experiment 1B. Control pairs (n = 30) were arbitrary pairings of new objects with seen objects that were neither visually nor conceptually similar. As in Henkel and Franklin (1998, Experiment 1), which pair member was seen and which was new was invariant across participants. Seen objects from each of the three pair types were presented in a randomly intermixed order. Two presentation orders were constructed and an equal number of participants viewed each ordering.

Twenty-four hours later participants were given a surprise memory test. Participants indicated on a response sheet whether each object had been seen or was new and, for objects called seen, in which corner of the screen the object had appeared. The memory test consisted of the names of the 60 seen objects and 60 new objects presented in a pseudorandomly intermixed order. Pair members from similar pairs were tested at least 16 trials apart; the seen object was tested first and the new object second, and vice versa for an equal number of pairs. Two test orders were constructed such that each object from similar pairs was tested before and after its pair member an equal number of times. After the memory test, participants were given a response sheet with the same list of object names as the memory test on which to make shape vividness and location confidence ratings. These rating scales were the same as in Experiment 2, except that the confidence scale referred to location, instead of colour. Finally, participants answered the same post-test questions as in Experiment 1A.

Results and discussion

Recognition. The proportion of new objects incorrectly called seen (i.e., false alarms) was submitted to a 3 (pair type: visual, conceptual, or control) × 2 (orienting task: artist or function) mixed design ANOVA in which the first factor was within-participants and the second factor was between-participants. There was a significant main effect of pair type, $F(2, 60) = 3.44$, $MSe = .01$, qualified by a significant interaction between pair type and orienting task, $F(2, 60) = 3.09$, $MSe = .01$ (see Table 4). The effect of visual similarity was dependent on orienting task, in that the proportion of false alarms was higher for new objects from visually similar pairs ($M = 0.22$) than control pairs ($M = 0.13$) given the artist orienting task, $t(15) = 2.46$, but not the function task ($M = 0.03$ for objects from both pair types). False alarms for new objects from conceptually similar pairs tended to be more common than for new objects from control pairs given both orienting tasks: *M*s = 0.18 vs 0.13, respectively, given the artist task, $t(15) = 1.87$, $p = .08$, and *M*s = 0.06 vs 0.03, respectively, given the function task $t(15) = 1.84$, $p = .09$. Collapsed across orienting task, the difference between conceptually similar ($M = 0.12$, $SE = .02$) and control pairs ($M = 0.08$, $SE = .02$) met the $p = .05$ standard for significance, $t(31) = 2.64$.

Visual similarity between seen and new objects increased false memories when participants were oriented towards the shape of objects (artist task) but not when they were oriented towards the function of objects (function task). In contrast, conceptual similarity between seen and new objects increased false memories regardless of orientation. The present pattern suggests that, in making old/new judgements, conceptual information was considered after both orienting tasks, but visual information was considered only after the artist task. This is consistent with the idea that the search and/or evaluation weights assigned to different types of information are flexible, and depend on orienting task and which features are considered diagnostic for a particular judgement (Johnson, Kounios, & Reeder, 1994; see also Geraci & Franklin, 2004). Note that, because all objects were perceived during the slide sequence in Experiment 3, participants presumably would have taken conceptual information as evidence that an object was perceived. In contrast, in Experiment 1B, some objects were perceived and others imagined, so conceptual information could have been evidence of either prior perception or imagination. This difference may explain why conceptual similarity reliably increased false memories in Experiment 3 but not in Experiment 1B.

We analysed hits for seen objects in the same manner as false alarms for new objects. The analysis yielded a significant effect only of orienting task, $F(1, 30) = 22.15$, $MSe = .05$; hits were more common given the function task ($M = 0.87$) than the artist task ($M = 0.68$) (see Table 4).

Overall, the proportion of false alarms was much smaller given the function task ($M = 0.04$) than the artist task ($M = 0.18$) $F(1, 30) = 16.85$, $MSe = .05$. This is important because the primary research questions in Experiment 3 concerned the episodic content of false memories of new objects. Therefore, subsequent analyses were restricted to data from participants who performed the artist task.

TABLE 4
Mean proportion false alarms and hits (with standard errors) as a function of pair type and orienting task in Experiment 3

		Orienting task	
Pair type		*Artist*	*Function*
Visually similar	FAs	.22 (.03)	.03 (.01)
	Hits	.61 (.05)	.86 (.03)
Conceptually similar	FAs	.18 (.04)	.06 (.02)
	Hits	.66 (.05)	.84 (.03)
Control	FAs	.13 (.03)	.03 (.01)
	Hits	.61 (.04)	.85 (.03)

Location attributions. Given a false memory in the artist condition, did the memory include the location of the seen pair member? Across all participants, of the new objects from visually similar and conceptually similar pairs that were falsely remembered as seen, 35.2% ($n = 19/54$) and 35.7% ($n = 15/42$), respectively, were attributed to the location of a seen pair member. As seen in Table 2, collapsing across the two types of similar pair, the percentage of congruent attributions was 35.4% ($n = 34/96$), which is greater than chance predicts, $\chi^2(1) = 5.56$. The mean percentage of congruent attributions per participant for objects from similar pairs was 36.6%. In contrast, of the new objects from control pairs falsely remembered as seen, only 19.4% (n = 12/62) were attributed congruently, which is not different from chance, $\chi^2(1) = 1.05$. For comparison, the mean percentage of seen objects attributed to the correct location, given that the objects were remembered as seen, was 51.7%.

MCQ ratings. We next analysed average shape vividness and location confidence ratings for objects called perceived on the memory test for participants who gave at least one perceived response to each object type (i.e., seen objects and new objects from visually similar, conceptually similar, and control pairs; see Table 5). Of 16 participants, 13 (81.3%) gave at least one perceived response to each object type, but preliminary analysis indicated that one participant's average shape and location ratings for conceptual-new objects were 2 or more standard deviations above the mean for that object type. Therefore, that participant was excluded from the following analysis, leaving us with data from 12 of 16 (75%) participants. The analysis of shape vividness ratings yielded a significant main effect, $F(3, 33) = 15.16$, $MSe = .53$. Tukey HSD tests showed that average ratings were significantly higher for new objects from visually similar pairs ($M = 2.3$) than control pairs ($M = 1.5$). Ratings for new objects from conceptually similar pairs ($M = 2.1$) were not significantly higher than for control-new objects. Ratings for seen objects ($M = 3.5$) were significantly higher than for any of the new object types. Thus, false memories of new objects from visually similar pairs were more like memories of seen objects in terms of shape vividness than were false memories of control-new objects, mirroring the pattern with imagined objects in Experiment 2. However, there was a significant difference in shape vividness between false memories of new objects from visually similar pairs and memories of seen objects, whereas the difference in shape vividness ratings for false memories of imagined objects from visually similar pairs and seen objects was not significant in Experiment 2.

The four object types also received significantly different location confidence ratings, $F(3, 33) = 18.03$, $MSe = .11$. According to Tukey HSD tests, the only significant contrasts were between seen objects ($M = 1.3$) and each of the three types of new object. However, visual inspection of the descriptive statistics revealed that, as would be expected, average confidence ratings were higher for new objects from visually similar ($M = 0.50$) and conceptually similar pairs ($M = 0.55$) than from control pairs ($M = 0.33$). Collapsing across the distinction between visual and conceptual similarity, ratings for new objects from similar pairs ($M = 0.54$, $SE = .10$) were reliably higher than control pairs ($M = 0.33$, $SE = .10$), according to a simple uncorrected t-test, $t(11) = 2.23$. Therefore, there was at least some evidence that, as expected, location confidence was higher for false memories that were more likely to contain location information from memories of seen objects.

Post-test questioning. Given the artist task, 5 of 16 (31.3%) participants reported awareness of at least one visually similar or conceptually similar pair. The average number of visually similar pairs detected was 1.6 out of 15 (10.7%), and the average number of conceptually similar pairs detected was 1.2 out of 15 (8.0%). Given the function task, one participant noticed two and another noticed one of the conceptually similar pairs; neither noticed any of the visually similar pairs. No participants in either group reported using any strategies to make location attributions, or thinking that similar objects appeared in the same location. Thus, awareness of the experimental manipulation of visual or conceptual similarity between seen and

TABLE 5
Mean MCQ ratings given perceived responses (with standard errors) to different object types in Experiment 3

	Object type			
	Control-new	*Conceptual-new*	*Visual-new*	*Seen*
Shape	1.5 (.30)	2.1 (.20)	2.3 (.21)	3.5 (.13)
Location	0.33 (.10)	0.55 (.15)	0.50 (.11)	1.3 (.15)

The shape vividness rating scale ranged from 0–6. The location confidence rating scale ranged from 0–3.

new objects in Experiment 3 was low. Accordingly, participants did not suspect that the content of their false memories came from memories of similar seen objects.

GENERAL DISCUSSION

The four experiments reported here demonstrate that false memories may acquire episodic content via the inadvertent activation and misattribution of features from memories of perceived events. In all experiments, we attempted to reduce the likelihood that particular features (i.e., location, colour) of false episodic content were previously imagined. For example, in Experiments 1A and 1B, we had participants imagine objects in the centre location, yet participants subsequently falsely remembered the objects as appearing in locations previously occupied by visually or conceptually similar objects. Also, in Experiment 3 it is unlikely that participants imagined test lures in particular locations during the study sequence, yet they showed the same systematic misattribution of falsely remembered location information as in Experiments 1A and 1B.

Of course, reality-monitoring failures might occur for details generated spontaneously at test. Researchers have suggested that participants may imagine (Gallo & Roediger, 2003) or ‘‘confabulate’’ (Neuschatz, Lampinen, Preston, Hawkins, & Toglia, 2002) features of events at test in order to help them remember the events. While this could contribute to feature attributions for false memories, and may be a primary source of feature information in the control conditions when participants had not seen similar objects, it cannot explain the above-chance congruent attributions of location or colour when similar objects were seen. Spontaneous imagining of location or colour for the first time at test should lead to random feature attributions, as was observed for control objects, given that all features occurred equally often. In addition, if reality-monitoring failure about features generated at test were the origin of the feature information in false memories of both control and similar objects, then we would expect the subjective quality of the information to be the same for false memories of both types. In fact, participants were more confident about the features of similar than control objects in Experiments 2 and 3.

Our results are superficially reminiscent of those from studies in which participants report that falsely remembered critical lures came from the same source (e.g., modality, voice) as their associated list (Gallo, McDermott, Percer, & Roediger, 2001; Gallo & Roediger, 2003; Mather et al., 1997; Roediger et al., 2004; but see Payne et al., 1996). One explanation for that effect is that, when tested on the critical lure, associated list words come to mind, along with information about how the words were presented, and participants consciously infer that if, for example, many *sleep*-related words were presented in a particular manner, then *sleep* itself probably was too (Gallo et al., 2001; Gallo & Roediger, 2003). According to the SMF, such conscious reasoning is one mechanism by which false memories acquire specific features. However, it is unlikely that participants consciously inferred the features of falsely remembered objects in our experiments based on memory for features of pair members, because post-test screening in all experiments showed that participants had low awareness that similar objects were in the list.

The explanation we favour for the present studies is an extension of the SMF mechanism described by Henkel and colleagues (Henkel & Franklin, 1998; Henkel et al., 1998). They proposed that, at test, object names activate (or *reactivate*; Johnson & Hirst, 1993) information that is associated with the objects (e.g., shape and conceptual information) and this information, which sometimes comes from similar objects, may be misattributed. We furthermore argue that features of seen objects such as location or colour that are bound to features that are similar to the test object (see Chalfonte & Johnson, 1996, for a discussion of feature binding in memory) may be reactivated as well. The test object plausibly could have possessed the reactivated features, thus participants misattribute them to the test object. In other words, features of seen objects that are bound together may be reactivated and misattributed together. For short, we refer to this inadvertent reactivation and misattribution of features as the *importation* of features from one event into memory for another event. Although Lampinen et al. (1999) used the metaphor of ‘‘borrowing’’, we prefer importing, to connote a longer-lasting effect.

Why doesn’t the fact that a feature ‘‘goes with’’ a perceived event (Event A) keep it from being imported into a false memory (Event B)? There are at least two possible reasons that are not mutually exclusive. First, as suggested by Henkel et al. (1998), the reactivated features of seen objects may not have included, due to insufficiently strong binding, features that distinguished between similar objects. For example, shape and conceptual features of seen objects may not have been strongly bound to each other, facilitating the importation of shape (and other) features into false memories of visually similar but conceptually dissimilar objects, or conceptual (and other) features into false memories of conceptually similar but visually dissimilar objects. Second, the fact that a feature goes with Event A does not necessarily preclude that it goes with Event B (see Zaragoza & Mitchell, 1996).

The idea of feature importation readily accommodates recent findings by Lampinen (2004; see also Lampinen, Meier, Arnal, & Leding, in press). He had participants study associative lists while thinking out loud. On a subsequent recognition memory test, participants made Remember/Know judgements (Tulving, 1985). If they claimed to remember a word, they were required to say what exactly they remembered about the word's presentation. Participants often explained Remember responses to list words by citing what they had thought about or said when studying the words. Of greatest interest, however, were explanations for Remember responses to critical lures. About two-thirds of the time, participants mentioned things they had said, or variants of things they had said, when studying related list words.

We suggest that presenting critical lures at test activated semantic features of related list words. The semantic features may have been bound to a record of the cognitive operations engaged at study, but not strongly bound to other features (e.g., phonological features). As a result, the semantic features and the cognitive operations associated with the list words were misattributed to critical lures. Thus, Lampinen's findings dovetail with ours in showing that false memories may be embellished, not only by the perceptual details of sensory events, as our experiments show, but also by the thoughts elicited by sensory events.

The demonstration that false memories may import features from memories of perceived events requires us to qualify one of the most well-known characterisations of false memories: that, on average, they contain less perceptual information than do real memories. This may depend on the source of perceptual information in memories. For example, in Experiments 1A and 2, we found a significant difference in appearance and shape information, respectively, as indexed by subjective ratings, between false and real memories only when participants had imagined objects but not seen a similarly shaped object. When a similar object had been seen, the information in false memories were rated as not significantly less vivid than that in memories of seen objects. Thus, when false memories contain information from both prior imagination and a similar perceptual experience, the subjective quality of their perceptual information may be very like that of real memories.

In sum, any particular false memory may contain details that were previously imagined or perceived. Understanding the origin of false episodic content is important, because specificity in memory may make one confident about one's own memory (Johnson, Nolde, & De Leonardis, 1996) and make one's memory believable to others (Bell & Loftus, 1988, 1989; Ceci, Huffman, Smith, & Loftus, 1994; Johnson, Bush, & Mitchell, 1998). Perceived events may be a particularly dangerous source of false episodic content because they tend to contain more numerous and specific perceptual features than do imaginations (Conway et al., 2003; Hashtroudi et al., 1990; Johnson et al., 1988b; Johnson et al., 1982; Suengas & Johnson, 1988), thus they may contribute to particularly embellished false memories.

Manuscript received 28 June 2004
Manuscript accepted 28 February 2005
PrEview proof published online 9 August 2005

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