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Cross-Modal Source Monitoring Confusions Between Perceived and Imagined Events

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Two experiments tested the prediction based on the source monitoring framework that imagination is most likely to lead to false memories when related perceived events have occurred. Consistent with this, people were more likely to falsely remember seeing events when the events had been both imagined as seen and actually heard than when they were just heard, just visually imagined, or imagined both visually and auditorily. Furthermore, when people considered potential sources for memories or more carefully evaluated features of remembered events, source errors were reduced. On average, misattributed ("false") memories differed in phenomenal qualities from true memories. Taken together, these findings show that as different qualities of mental experience flexibly enter into source attributions, qualities derived from related perceptual events are particularly likely to lead to false claims that imagined events were seen, even when the event involves a primary modality (auditory) different from the target event (visual).

Complex memories typically integrate information from a variety of sensory modalities and other sources. Your memory of a visit to your friend's office this morning integrates information derived from perceptual processes, such as the appearance of your friend and the sound of his voice, and information arising from reflective processes, such as your thoughts, evaluations, intentions, inferences, and imagination. Because your perceptual experience is embellished with these reflective processes, you may later have trouble determining whether you actually saw your friend turn on his computer or whether you inferred it from something he said or a movement he made. To complicate matters, various perceptual and reflective experiences represented in memory may have thematic or semantic commonalities, even if they are separated by large gaps in time or involve other sources of information. For example, you may have heard a computer being turned on in another office as you walked back to your office. Later when you think about the visit with your friend, your visual image of him turning on his computer may seem all the more real because your recent memory also includes the sound of a computer. In this example, the sound contributes to your certainty about your memory for your friend turning on his computer because you fail to correctly identify the origin of the various components or qualities of what you remember. Thus, people make source monitoring errors or source misattributions about information, leading to "false memories" (e.g., Johnson, 1988).

According to the source monitoring framework of Johnson and colleagues, source monitoring typically relies on qualitative characteristics of memories in conjunction with judgment processes used to assess them (Johnson, Hashtroudi, & Lindsay, 1993; Johnson & Raye, 1981, 1999). Such features include the amount or quality of sensory-perceptual and semantic information; information about one's thoughts, feelings, or reactions; and information about the cognitive operations involved in experiencing an event. Because the features of a given memory are used as cues to determine the memory's source, source misattributions may occur when the features of the memory are more typical on average of memories derived from a different source. For example, if a person's memory for an imagined event has qualities typical of perceived events, such as a high degree of vividness of sensory-perceptual detail or little information about the cognitive processes involved in generating the memory, then he or she may be fooled into believing that the event had been perceived (Johnson et al., 1993).

Of course, qualitative features can be associated with a remembered event by virtue of having been part of the event itself. But in addition, features derived from similar events may be confused across memories, as in the example above with the friend's computer.[1] Many studies show that judg-

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[1] This does not necessarily imply that the multiple versions of similar events are integrated or blended together into one memory

ments about an item's origin can be influenced by similar information that arises from other internally generated or externally perceived experiences (e.g., Johnson, Raye, Wang, & Taylor, 1979; Lindsay, Johnson, & Kwon, 1991; Loftus, Miller, & Burns, 1978; Mather, Henkel, & Johnson, 1998; Raye, Johnson, & Taylor, 1980; Roediger & McDermott, 1995; Zaragoza & Lane, 1994). For example, participants are more likely to claim to have seen an imagined item (e.g., *pants, lollipop*) when they saw an item from the same conceptual category (e.g., *shirt*) or when they saw a physically similar item (e.g., *magnifying glass;* Henkel & Franklin, 1998; Henkel, Johnson, & De Leonardis, 1998). Such studies generally have involved confusions involving one sensory modality, such as confusing something that you read about with something that you saw, confusing something that you imagined seeing with something that you actually saw, or confusing something that you thought about with something that you heard. According to the source monitoring framework, memories derived from similar sources involving one sensory modality would generally have similar types of features (Johnson et al., 1993). Thus, source errors within a single modality would be expected when the features for a particular memory are more typical on average for the features from another class of memories involving that modality, such as when memories derived from visual imagination contain vivid perceptual details about an item's appearance. The present experiments examine the case in which two experiences may become confused although the memory records for the experiences would not necessarily have similar perceptual features and would be likely to include different features. For example, the perceptual features involved in visually based memories (i.e., those either seen or imagined as seen) might include shape, color, and orientation of items, whereas the perceptual features associated with auditorily based memories (i.e., those either heard or imagined as heard) might include volume, pitch, and timbre.

The current experiments explore conditions under which evidence used in judging a memory's source arises or accrues from other experiences, not only when those experiences involve a single sensory modality but also when those other experiences involve different sensory modalities (e.g., visual and auditory). We focus in particular on situations in which people claim to have seen events that were not actually seen but were experienced some other way, as this type of error is not only of theoretical interest but is potentially important in many real-world situations such as eyewitness testimony (e.g., Loftus, 1979) or exploration of memories in therapy (e.g., Lindsay & Read, 1994). In both of the present experiments, participants saw, heard, imagined seeing, and imagined hearing common events, such as a *balloon popping,* a *toilet flushing,* or a *basketball bouncing.* On a given trial, an event was experienced from one of four sources (visual perception, auditory perception, visual imagery, or auditory imagery), and over the course of the trials, some events were experienced from two different sources. Some were, for example, visually imagined and at some other point were actually heard, and others were actually seen and at some other point were auditorily imagined. Suppose, for example, that you experience a basketball bouncing on two occasions: On one trial, you hear the sound of a basketball bouncing, and on another trial at some other point you visually imagine a basketball bouncing. In this case, you have information that the event really happened, that is, was perceived, and you have information about visual aspects of the event's appearance. Such information arises from two separate instances of related events involving two different sources and sensory modalities. Although you never actually see the event, could the evidence for having perceived (i.e., having heard) the basketball bouncing in combination with your visual image of it lead you to falsely believe that you have seen it? Is this false belief greater than if you had only heard the ball, with no visual or other experience of it, or if you had only visually imagined it, with no perceptual experience of it? If indeed information used in judging a memory's source can accumulate across different experiences of similar events—even when those experiences involve different sensory modalities—then when people have evidence that an event really occurred (even though it was heard and not seen) and also have some degree of visual information about that event (based on visually imagining it), they should be likely to falsely believe they had seen such an event.

To determine whether such errors are beyond those that might occur with multiple instances of similar events or with experience of similar events in multiple modalities, source misattributions for events that were both visually imagined and actually heard were compared with cases in which some of the visually imagined events were also imagined as heard and some were imagined as seen a second time. Although similar semantic information is experienced twice in both of these cases (i.e., on two occasions you have experienced a basketball bouncing), fewer source monitoring errors would be expected than when events are both visually imagined and actually heard, based on two factors suggested by the source monitoring framework: (a) There is actual perceptual experience when the event is heard, and thus the total amount or quality of perceptual information should be greatest in this condition; and (b) the incidental visual imagery that may occur when people listen to the sound of events should produce less salient or accessible information about cognitive operations than the intentional visual and auditory imaging that occurs on trials in which events are visually imagined twice or visually and auditorily imagined. The records of such cognitive operations can, in principle, be used as a cue to indicate an imagined source (e.g., Durso & Johnson, 1980; Finke, Johnson, & Shyi, 1988; Rabinowitz, 1990).

Experiment 1

Method

Participants. Fifty-seven undergraduates from the State University of New York at Stony Brook were tested individually. Data

trace or that the more recent experience "overwrites" the earlier one (see, e.g., Belli, 1988; McCloskey & Zaragoza, 1985; Metcalfe, 1990; Schooler & Tanaka, 1991; Tversky & Tuchin, 1989).

from 5 of these participants were eliminated because they failed to return for the second session. Participation was in partial fulfillment of course requirements.

Materials and design. A large set of simple, unrelated events (e.g., a *basketball bouncing,* a *saw sawing*) were video- and audiotaped for 6 s each. Events were selected on the basis of having clear and distinct visual and auditory representations. Items were randomly assigned to one of seven experimental conditions, with nine events for each of the following conditions: (a) event imagined as seen and actually heard, (b) event imagined as seen, (c) event heard, (d) event imagined as seen twice, (e) event imagined as seen and imagined as heard, (f) event imagined as heard, and (g) event seen. (See Appendix A for a list of events and Table 1 for a depiction of the design.) An additional 36 events were used as fillers for visual perception trials to balance the number of perceptual and imagery trials, resulting in 99 unique events each experienced once or twice. Thus, 45 trials were for events that were seen, 45 trials were for events imagined as seen, 18 trials were for events that were heard, and 18 trials were for events that were imagined as heard. To keep the number of conditions and events manageable, rather than following a full factorial design, the experiment was constructed to address in particular people's errors in claiming to have seen things that were not seen, an important theoretical and practical issue, as noted earlier.

The events were presented on videotape with a soundtrack presented on a 20-in. (51-cm) color television monitor. The 126 trials were organized into 20 blocks (14 blocks consisting of 6 trials per block, and 6 blocks consisting of 7 trials per block), with each block consisting of events of one type. For example, in the first block all events were seen, and in the second block all events were imagined as seen. Individual events for each condition were randomly assigned to appropriate blocks. For conditions in which an item was experienced twice (e.g., hear *toilet flushing* and imagine seeing *toilet flushing*), the two instances were separated by a minimum of 20 trials, with the order of the two sources counterbalanced across pairs.

Procedure. Participants were tested individually in two sessions. They were told that they would be presented with a videotape in which sometimes common events would be seen or heard and that sometimes they would be asked to imagine seeing or imagine hearing certain events. They were told that on the imagery trials, they should try to imagine as realistically and as naturally as possible what the event would either look like or sound like if it were actually presented. They were told to imagine the named event in its most typical or common way and to focus their image on the visual appearance or on the sound of the event, as instructed for that block. After each event, they were to rate how well the event was depicted (using response options *poor, fair,* and *good*). Thus, for trials in which they saw an event, they were to indicate how well the video scene depicted the event's appearance. On trials in which they imagined seeing an event, they were to rate how well their visual image depicted what the event would really look like. Likewise, for auditory trials, they rated how well the sound recording or their own auditory image depicted what the event actually sounds like. The rating task was used to ensure participants' attention to the actual and imagined events.

After a short practice session to familiarize participants with the task, the experimental trials were presented on videotape. At the start of each block, participants were told whether that block consisted of events they would see, hear, imagine seeing, or imagine hearing. To ensure that events were not ambiguous and were easily identifiable, the name of the event (e.g., *basketball bouncing*) appeared in block letters on the screen for 4 s prior to each trial. Following this was a 6-s presentation of the event. For visual perception trials, the event itself was shown with no soundtrack. For auditory perception trials, the screen was blank with the soundtrack playing. For all imagery trials, the screen was blank with no soundtrack. A verbal prompt ("response") followed each trial, and participants then had 3 s to judge out loud how well the presentation or their image depicted the named event. After the presentation, participants were told to return 2 days later to complete the experiment, at which time they would be asked to make different kinds of judgments about various events.

To test how well participants could discriminate between what they had seen and what they had imagined seeing, participants returned 2 days later for a surprise source monitoring task in which

Table 1
Basic Design of Single- and Two-Source Conditions for Experiments 1 and 2

Source(s)	Experiment 1: Number of unique events	Experiment 1: Number of trials	Experiment 2: Number of unique events	Experiment 2: Number of trials
Imagined as seen and heard[a]	9	18	9	18
Imagined as seen[a]	9	9	9	9
Heard[a]	9	9	9	9
Imagined as seen twice[a]	9	18	9	18
Imagined as seen and imagined as heard[a]	9	18	9	18
Imagined as heard	9	9	9	9
Seen	9	9	9	9
Seen (filler)	36[b]	36	12	12
Seen twice			9	18
Seen and imagined as seen			9	18
Seen and heard			3	6
Heard and imagined as heard			3	6
Seen and imagined as heard			3	6
Total seen		45		54
Total imagined as seen		45		54
Total heard		18		24
Total imagined as heard		18		24
Total	99	126	102	156

[a]Items for these events were counterbalanced across different tapes for Experiment 2. [b]Twenty-seven of these items were randomly selected for the memory test.

108 event names were listed, and participants were to indicate for each whether they had actually seen it during the first session, whether they had imagined seeing it during the first session, or whether it had been neither seen nor visually imagined. They were instructed that the category of "neither" consisted of new items not included in the first session as well as events that they had heard or imagined hearing but that had not been seen or imagined visually.

The test items were randomly ordered, with 36 from the four visual imagery conditions (9 each from events visually imagined once, visually imagined twice, visually imagined and actually heard, and visually imagined and auditorily imagined), 36 from visual perception trials (9 from the condition in which events were seen and 27 randomly selected from the visual perception filler trials), and 36 items for which the correct response was "neither" (9 from heard-only trials, 9 auditorily imagined, and 18 new). After the memory test, participants completed a brief questionnaire in which they rated the frequency with which they created visual and auditory imagery during the stimuli presentation.

Results and Discussion

An alpha level of .05 was used for all analyses, and all post hoc analyses were Newman–Keuls t tests. Mean ratings of the quality of depiction (made during the first session) were not significantly different for seen events ($M = 2.59$), visually imagined events ($M = 2.71$), heard events ($M = 2.41$), or auditorily imagined events ($M = 2.59$; all ts < 1; *poor* = 1, *fair* = 2, and *good* = 3). Hence, there were no obvious differences in terms of difficulty in imagining events either visually or auditorily, and furthermore, images were subjectively as good as events that were actually presented.

Source monitoring errors: Claiming to have seen events. The primary measure of interest was the rate at which participants erroneously claimed to have seen events that were not seen but were experienced in some other way. Source error rates were calculated for each condition as the proportion of events erroneously claimed as seen out of the total number of events for that condition. Error rates in claiming to have seen items that were not actually seen were examined for seven conditions: events that were imagined visually and actually heard, imagined visually only, heard only, imagined visually twice, imagined visually and imagined auditorily, imagined auditorily only, or new (see Figure 1 and Table 2). A one-way analysis of variance (ANOVA) examining source error rates across these seven conditions showed a significant main effect, $F(6, 306) = 27.17$, $p < .0001$, $MSE = 0.01$.[2] Post hoc tests revealed that source errors were significantly higher when an event was visually imagined and also heard (.25) relative to each of the other six conditions. Error rates were also higher for items that had been heard (.13) than for those imagined visually twice (.08) or imagined as heard (.05), whereas there was no difference in error rates when the event was only heard, was imagined visually (.09), or was imagined visually and auditorily (.10). All of these error rates, except for items imagined as heard, were significantly higher than errors for new items (.02). For new items, participants were significantly less likely to erroneously claim they had been seen (.02) than to claim they had been visually imagined (.06), $F(1, 51) = 10.07$, $p = .002$, $MSE = 0.03$. Thus, participants did not simply have a bias to guess "seen" for items that were not familiar.

The results show that people were more likely to mistakenly claim to have seen events when the events had been experienced from some other source relative to events that they had not experienced at all (i.e., new items). More important, as expected, error rates were highest when events had been both visually imagined and actually heard, that is, when people had both visual information about an event (from having visually imagined it) and evidence that the event actually happened (from having heard the event). Thus, although simply hearing an event resulted in more errors than not having experienced it at all, error rates for events that were only heard were not as high as for those that were both heard and imagined visually. Furthermore, visually imagining an event did not by itself produce error rates as high as hearing and visually imagining it, nor did experiencing an event twice if neither involved perception.

Additional analyses compared the false "seen" responses in the two-source conditions with the sum of the respective two single-source conditions. That is, is the rate of false attributions when an event is experienced twice (e.g., when an event is both heard and imagined as seen) greater than what would be expected on the basis of false attribution rates for each individual experience (e.g., when an event is just heard plus just imagined as seen, minus the probability that a "seen" response came from both sources simultaneously)? The findings show that errors for events that were both heard and imagined as seen (.25) were significantly higher than what would be expected on the basis of the error rates for events just heard once and those just imagined as seen once (.20), $t(51) = 1.97$, $p = .055$. This elevated rate for the two-source condition, above and beyond what would be expected from the contributions of the two individual sources, was not found for the other two-versus-one conditions. Consider the combined versus individual effects of imagining seeing and imagining hearing events. Error rates from imagining seeing and imagining hearing the same event (.10) were not significantly higher than the individual contributions of imagining seeing an event once and imagining hearing an event once (.12), $t(51) = 1.30$. In fact, error rates for events experienced twice from the same source showed the opposite effect; that is, error rates for events visually imagined twice (.08) were significantly lower than what would be expected on the basis of the individual effects of each source (.15), $t(51) = 2.96$, $p = .004$. To facilitate comparisons across the three crucial two-source conditions, the difference in the proportion of false "seen" responses between each two-source condition and the sum of the respective two individual sources (minus the probability that

[2] No significant effects of order were found. That is, for items that were both visually imagined and heard, error rates in claiming to have seen the items did not differ when the visually imagined version preceded (.28) or followed (.23) the heard version during the presentation of stimuli, $t(51) = 1.74$. Likewise, for events both visually and auditorily imagined, error rates did not differ when the visual event preceded (.10) or followed (.09) the auditory event, $t(51) < 1$.

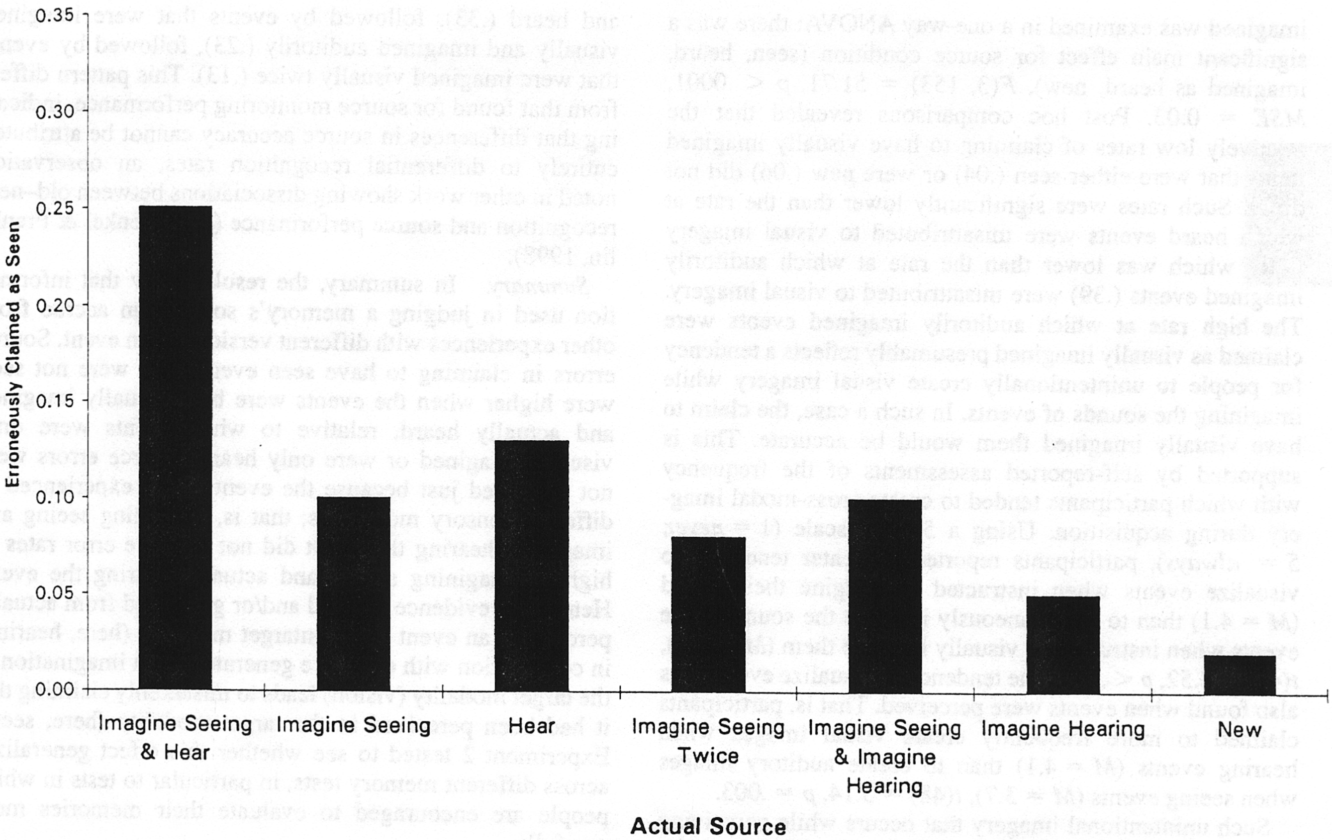

Figure 1. Source error rates in claiming to have seen events in Experiment 1.

the erroneous "seen" response came from both sources simultaneously) was calculated. A one-way ANOVA revealed a significant main effect of source condition, $F(2, 102) = 17.45$, $p < .0001$, $MSE = 0.01$. The difference score for the heard–imagined as seen condition (.05) was significantly higher than the imagined as seen–imagined as heard condition (−.03), which in turn was higher than the imagined as seen twice condition (−.07). Thus, the direction and magnitude of the difference between the two-source experiences versus the sum of the corresponding single-source experiences was greater for events that were heard and imagined as seen. For this condition, the two independent sources were not merely additive by independently contributing to the proportion of incorrect "seen" responses. Having both heard and imagined seeing the same event led to higher errors than would be expected on the basis of the separate contributions of each experience. These analyses lend additional strength to the argument that having visual information for an event (from having imagined seeing it) in combination with having evidence that the event really occurred (from having heard it) gives rise to higher erroneous claims that the event was seen than having just visually imagined the event, just having heard the event, just having experienced the event more than once, or just having experienced the event from two different sources.

Other source monitoring errors. Although this study was designed to examine what experiences may lead people to falsely claim to have seen events, other source errors are reported here for the sake of completeness (see Table 2). Overall, people were more likely to mistake imagined events for perceived than vice versa, an asymmetry found in other source monitoring studies (see, e.g., Johnson & Raye, 1981). That is, source errors for visually imagined items (.13, averaged across all conditions involving visual imagery) were significantly higher than for visually perceived items (.04), $F(1, 51) = 25.47$, $p < .0001$, $MSE = 0.001$.

The proportion of events erroneously judged as visually

Table 2
Proportion of Responses Given on Memory Test in Relation to Actual Source for Experiment 1

Source(s)	Response S	IS	N
Imagined as seen and heard	.25	.42	.33
Imagined as seen	.09	.46	.45
Heard	.13	.28	.59
Imagined as seen twice	.08	.79	.13
Imagined as seen and imagined as heard	.10	.67	.23
Imagined as heard	.05	.39	.56
Seen	.88	.04	.07
New	.02	.06	.92

Note. S = seen; IS = imagined as seen; N = neither.

imagined was examined in a one-way ANOVA; there was a significant main effect for source condition (seen, heard, imagined as heard, new), $F(3, 153) = 51.71$, $p < .0001$, $MSE = 0.03$. Post hoc comparisons revealed that the relatively low rates of claiming to have visually imagined items that were either seen (.04) or were new (.06) did not differ. Such rates were significantly lower than the rate at which heard events were misattributed to visual imagery (.28), which was lower than the rate at which auditorily imagined events (.39) were misattributed to visual imagery. The high rate at which auditorily imagined events were claimed as visually imagined presumably reflects a tendency for people to unintentionally create visual imagery while imagining the sounds of events. In such a case, the claim to have visually imagined them would be accurate. This is supported by self-reported assessments of the frequency with which participants tended to create cross-modal imagery during acquisition. Using a 5-point scale (1 = *never*, 5 = *always*), participants reported a greater tendency to visualize events when instructed to imagine their sound ($M = 4.1$) than to simultaneously imagine the sound of the events when instructed to visually imagine them ($M = 3.3$), $t(48) = 5.52$, $p < .001$. The tendency to visualize events was also found when events were perceived. That is, participants claimed to more frequently create visual images when hearing events ($M = 4.1$) than to create auditory images when seeing events ($M = 3.7$), $t(48) = 3.14$, $p = .003$.

Such unintentional imagery that occurs while perceiving and imagining undoubtedly contributes to source confusions. In fact, according to the source monitoring framework, incidental imagery can be more misleading than intentional imagery (Johnson et al., 1993). That is, whatever visual imagery participants inadvertently created when they actually heard events would have resulted in poorer cues about cognitive operations than would have the visual imagery that occurred when they purposefully created visual images.

Forgetting events: Claiming old items were new. The proportion of events that were erroneously called "new" (i.e., misses) was significantly higher for visually imagined (.29) than for seen (.07) events, $F(1, 51) = 67.64$, $p < .0001$, $MSE = 0.02$. This finding is consistent with research on the picture superiority effect, which shows an advantage in recognition memory for pictorial stimuli over visual verbal stimuli such as words (e.g., Weldon & Roediger, 1987). Of course the present stimuli were more complex than simple pictures or photographs in comparison to verbal labels, and certainly the relative rates of memory depend not only on the stimuli themselves but also on the type of processing engaged in (see, e.g., Durso & Johnson, 1980). Nonetheless, here we found fewer misses for visually presented events than for visually imagined events.

The percentage of misses was examined for the four visual imagery conditions in a one-way ANOVA, yielding a significant main effect, $F(3, 153) = 30.54$, $p < .0001$, $MSE = 0.03$. Post hoc comparisons showed that rate of misses was highest for events that were visually imagined once (.45), followed by events that were imagined visually and heard (.33), followed by events that were imagined visually and imagined auditorily (.23), followed by events that were imagined visually twice (.13). This pattern differs from that found for source monitoring performance, indicating that differences in source accuracy cannot be attributed entirely to differential recognition rates, an observation noted in other work showing dissociations between old–new recognition and source performance (e.g., Henkel & Franklin, 1998).

Summary. In summary, the results show that information used in judging a memory's source can accrue from other experiences with different versions of an event. Source errors in claiming to have seen events that were not seen were higher when the events were both visually imagined and actually heard, relative to when events were only visually imagined or were only heard. Source errors were not increased just because the events were experienced in different sensory modalities; that is, imagining seeing and imagining hearing the event did not produce error rates as high as imagining seeing and actually hearing the event. Hence, the evidence derived and/or generated from actually perceiving an event in a nontarget modality (here, hearing) in conjunction with evidence generated from imagination in the target modality (vision) leads to mistakenly claiming that it had been perceived in the target modality (here, seen). Experiment 2 tested to see whether this effect generalizes across different memory tests, in particular to tests in which people are encouraged to evaluate their memories more carefully.

Experiment 2

The source monitoring framework proposes that judgment processes are not fixed but are flexible; they vary with goals, strategies, social context, time available, and so forth. (Johnson et al., 1993; Johnson & Raye, 1999; Mitchell & Johnson, 2000; see also Ceci & Bruck, 1993; Ross, 1997). Furthermore, different memory tasks may shift the features or processes people use in judging a memory's source (see, e.g., Jacoby, 1991; Marsh & Hicks, 1998; McCloskey & Zaragoza, 1985; Raye, 1976; Tversky & Tuchin, 1989). For example, when memory is assessed using standard old–new recognition tests (e.g., "Did you encounter this item or not?"), participants may base judgments on the item's familiarity rather than on consideration of information about the source of its familiarity. Errors often decrease when participants are asked to consider or to identify the potential sources of their memories, and hence presumably move from a familiarity-based (or single-feature-based) response to one in which more features or more specific features are evaluated (Dodson & Johnson, 1993; Lindsay & Johnson, 1989; Multhaup, 1995; Zaragoza & Koshmider, 1989; Zaragoza & Lane, 1994; see also Raye et al., 1980). When participants are required to carefully evaluate various phenomenal characteristics of their memories while indicating the source, source errors are likewise reduced (Mather et al., 1998).

We conducted Experiment 2 to replicate the finding of cross-modal confusions found in Experiment 1 and to determine whether this is influenced by the set that participants adopt in evaluating the origin of their memories. In addition, the inclusion of a condition in which participants rate various features of their memories (Johnson, Foley, Suengas, & Raye, 1988) allows us to examine differences in the phenomenal qualities of true and false memories (e.g., Mather et al., 1998; Norman & Schacter, 1998).

Method

Participants. Participants were 127 undergraduates from Princeton University and from the State University of New York at Stony Brook, 6 of whom failed to complete the experiment. Of the remaining 121 participants, 63 were tested at Princeton and 58 at Stony Brook. Participation was in partial fulfillment of course requirements. At both institutions, participants were randomly assigned to conditions.

Materials and design. The visual and auditory events were selected on the same basis as in Experiment 1. Five stimulus presentation tapes were made, counterbalancing the items used for five critical experimental conditions (i.e., imagined visually and heard, imagined visually once, heard, imagined visually twice, and imagined visually and imagined auditorily). There were 9 events for each condition. Other stimuli were randomly assigned to the remaining conditions, with 9 events in each of the following conditions: imagined as heard, seen, seen twice, and seen and imagined as seen (see Appendix B for a list of events and Table 1 for a depiction of the design). To ensure that participants could not deduce other source information by remembering one source of an event, 3 events were randomly assigned to each of the following conditions: seen and heard, heard and imagined auditorily, and seen and imagined auditorily. An additional 12 items were used for visual perception trials as fillers to balance the number of seen and visually imagined trials. Thus, there were 102 unique events, resulting in 156 trials (54 for seen events, 54 imagined as seen, 24 for heard events, and 24 imagined as heard). Trials were organized into 26 blocks, each consisting of 6 events of one type (e.g., within a block, all events were seen).

As in Experiment 1, each trial consisted of one event in one particular modality, and for conditions in which an event was experienced twice, the two instances of the event were separated by a minimum of 20 trials, with the order of the two sources counterbalanced across pairs.

Procedure. Each participant was randomly assigned one of the five videotapes. The procedure for the encoding phase was the same as in Experiment 1, except that for each trial, the name of the event appeared for 3 s rather than 4 s. When participants returned 2 days later for a surprise source monitoring task, they were randomly assigned one of three different memory tests. The same random ordering of 102 old events and 50 new events was used for each test. In one condition, participants were to indicate for each named event whether it was one that they remembered actually seeing during the first session (by circling "yes") or whether it was an event that they did not see (by circling "no"). They were told that some of the items for which they would circle "no" had been heard, imagined visually, or imagined auditorily, and some were new.

In the second condition, source memory was tested using a multioption checklist in which each event could be judged as having been "seen," "imagined as seen," "heard," "imagined as heard," and "new." For each named event, participants were told to circle whatever versions they remember of that event from the first day, that is, whether they remember seeing, hearing, visually imagining, or auditorily imagining the event. They were told that they could circle one or more options and to circle "new" for events that they did not remember experiencing at all in the first session. The memory test in the third condition consisted of the same yes or no visual perception memory task as the first condition. After circling "yes" for an event that they remembered seeing, they were to rate their confidence in their yes or no judgment, using *very sure, fairly sure,* and *guessing* as their options, as well as rate various features of their memories: the overall vividness of their visual memory for the event, the extent to which they remembered specific visual information about the event, the extent to which they remembered their feelings or reactions when the event was seen, the extent to which they remembered information about associations or what they thought about while seeing the event, and the extent to which they remembered thinking about the event since the first session. A 5-point scale was used for the ratings, in which 1 was low on the scale and 5 was high. No such ratings were made for items they did not remember seeing (i.e., those for which they circled "no"). This was a modified memory characteristics questionnaire (MCQ) derived from Johnson et al. (1988).

Results and Discussion

An alpha level of .05 was used for all analyses. As in Experiment 1, we found that the ratings made during the audiovisual presentation in which participants assessed the quality of depiction did not differ for the four sources: imagined as seen (2.67), seen (2.58), imagined as heard (2.42), and heard (2.24), all $ts < 1$. Self-reported assessments of the frequency with which imagery was created during acquisition also replicated the findings from Experiment 1. Participants reported a greater tendency to visually imagine events while trying to imagine their sound ($M = 3.9$) than to imagine their sound while trying to visually imagine them ($M = 3.3$), $t(118) = 4.69$, $p < .001$. Additionally, participants more frequently claimed to create visual images while hearing events ($M = 3.9$) than to create auditory images while seeing events ($M = 3.5$), $t(118) = 3.12$, $p = .002$.

Source monitoring errors: Claiming to have seen events. Our primary interest was in the extent to which participants erroneously claimed to have seen events that were experienced in some other way and whether the type of source test influenced such errors. The proportion of events within each source condition that people identified as seen was calculated for each of the three memory tests (see Table 3). The proportion of events incorrectly claimed as seen for each source was examined in a two-way ANOVA; the independent variables were source condition (items imagined visually and heard, imagined visually once, heard, imagined visually twice, imagined visually and imagined auditorily, and new) and test format (yes or no test, checklist test, MCQ test). Mean proportion of events falsely claimed as seen for the various conditions are shown in Figure 2.

A significant main effect for source condition was found, $F(5, 590) = 41.25$, $p < .0001$, $MSE = 0.01$, and post hoc t tests revealed that error rates in claiming to have seen events were significantly higher when the events had been both

Table 3
Proportion of Responses Given on Each Memory Test in Relation to Actual Source for Experiment 2

	Response									
	Yes or no test		MCQ test		Checklist test					
Source(s)	S	N	S	N	S	N	IS	H	IH	New
Imagined as seen and heard	.29	.71	.15	.85	.21	.79	.27	.72	.43	.03
Imagined as seen	.12	.88	.08	.92	.09	.91	.43	.04	.19	.33
Heard	.16	.83	.05	.95	.08	.92	.07	.69	.17	.17
Imagined as seen twice	.19	.80	.11	.89	.15	.85	.66	.10	.34	.09
Imagined as seen and imagined as heard	.16	.84	.12	.88	.11	.89	.52	.16	.63	.06
Imagined as heard	.07	.93	.02	.98	.02	.98	.08	.08	.65	.23
Seen	.84	.16	.86	.14	.86	.14	.07	.04	.06	.09
Seen twice	.94	.06	.95	.05	.95	.05	.14	.08	.11	.02
Seen and imagined as seen	.93	.07	.96	.04	.91	.09	.43	.08	.19	.03
Seen and heard	.93	.07	.93	.07	.85	.15	.16	.62	.21	.00
Heard and imagined as heard	.12	.87	.03	.97	.01	.99	.08	.92	.68	.00
Seen and imagined as heard	.91	.09	.91	.09	.89	.01	.26	.11	.35	.03
New	.02	.98	.01	.99	.00	1.0	.02	.00	.01	.96

Note. For the checklist condition, events were classified as N for any events not judged as seen. Because multiple responses were allowed, the proportion of events judged as S, IS, H, IH, or New do not sum to 1. MCQ = memory characteristics questionnaire; S = seen; N = not seen; IS = imagined as seen; H = heard; IH = imagined as heard.

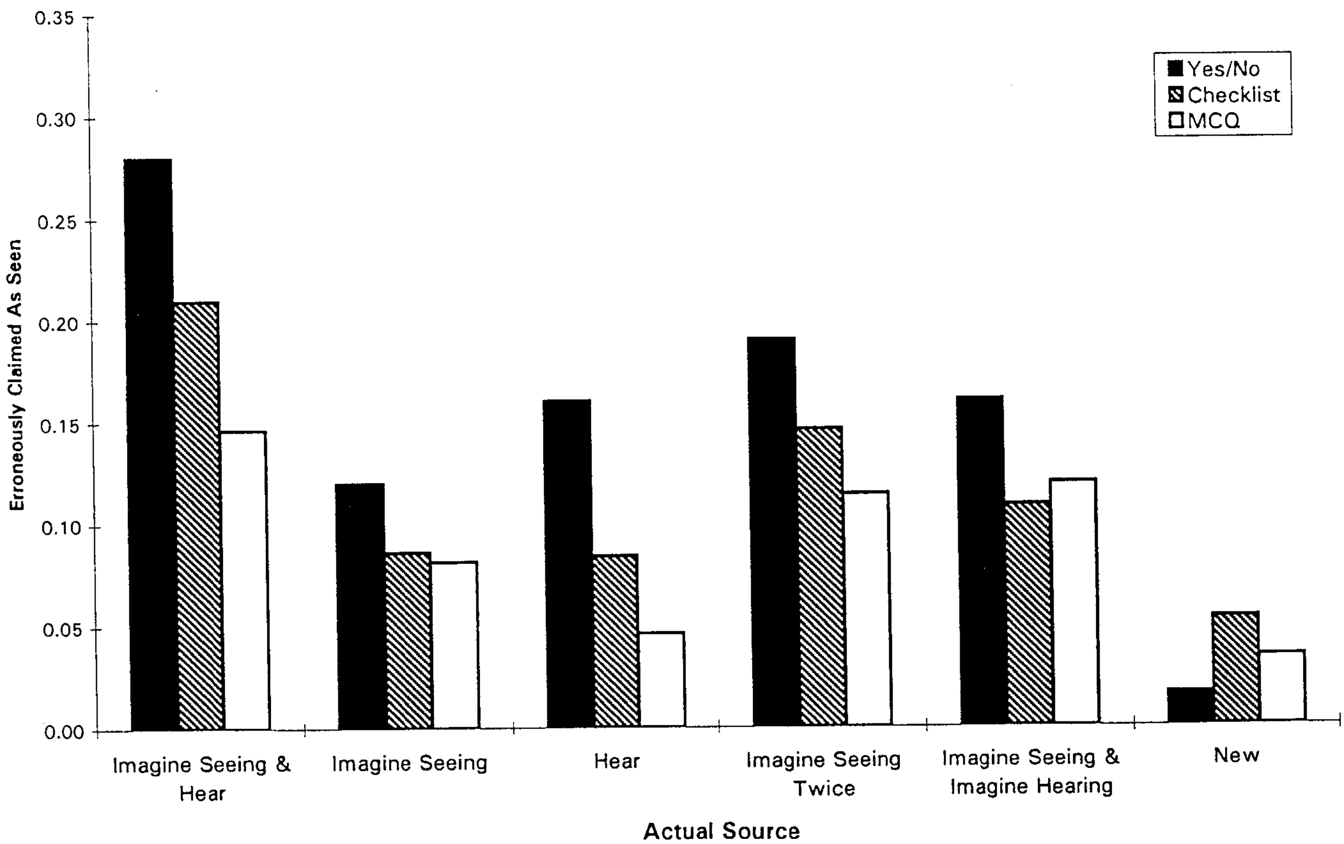

Figure 2. Source error rates in claiming to have seen events for different memory test formats in Experiment 2. MCQ = memory characteristics questionnaire.

imagined visually and actually heard (.21),[3] relative to when events were imagined visually twice (.15) or imagined both visually and auditorily (.13). Such errors were significantly higher than when events were experienced only once or when they were heard (.10) or imagined visually (.09), and these errors in turn were more frequent than falsely claiming to have seen new items ($< .01$). These results replicate the main finding of Experiment 1, namely, that information used in source monitoring may accumulate across related experiences from different sensory modalities.

As in Experiment 1, additional comparisons between the two-source conditions in relation to the sum of the respective two single-source conditions revealed that having both heard and imagined seeing the same event lead to higher errors (.21) than would be expected on the basis of the separate contributions of each experience (.16), $t(120) = 2.64$, $p = .009$. As before, the two other two-versus-one comparisons did not show this effect: Error rates from imagining seeing and imagining hearing the same event (.13) were not significantly higher than what would be expected on the basis of the individual contributions of imagining seeing an event once and imagining hearing an event once (.12), $t(120) < 1$, nor were error rates for events visually imagined twice (.15) significantly higher than the individual effects of each source (.16), $t(120) < 1$. An ANOVA on the difference in the proportion of false "seen" responses between each two-source condition and the estimate based on the respective two individual sources revealed a significant main effect of the three crucial two-source conditions, $F(2, 236) = 6.64$, $p = .002$, $MSE = 0.02$, with no main effect for memory test condition or interaction between memory test condition and source condition (both $Fs < 1$). The difference score for the heard–imagined as seen condition (.05) was significantly higher than either the imagined as seen–imagined as heard condition (.01) or the imagined as seen twice condition (−.01). Thus, for the latter two conditions, the two independent sources were merely additive, whereas for the heard + imagined as seen condition, the joint effect of having experienced the same event twice was above and beyond the individual contributions of each separate source.

Although there were too few trials in the imagined as heard + seen condition to allow firm conclusions, a similar two-versus-one comparison was conducted. Of course, in this case a response of "seen" was a correct answer; thus, the question is, when an event is experienced from two different sources, does imagination in a different modality add to the belief that the event was seen above and beyond the separate contributions of the individual experiences of imagining the event and perceiving it? The data show that having both seen and imagined hearing the same event led to higher correct "seen" responses (.90) than the sum of the separate contributions of each experience (.86), $t(120) = 2.29$, $p = .02$. Thus, imagining hearing an event can increase (correct) "seen" responses when the event was also perceived (here seen) in much the same way as imagining seeing an event can increase (incorrect) "seen" responses when the event was perceived (here heard). This finding lends credence to the source monitoring framework's claim that there are not separate mechanisms or processes for true and false memories but rather that the same mechanisms that result in false memories also produce veridical ones (Johnson et al., 1993).

In the main two-way ANOVA examining source condition and test format on the proportion of events falsely claimed as seen, a marginally significant main effect of test format was found, $F(2, 118) = 2.77$, $p < .07$, $MSE = 0.10$, with the highest rate of false claims of seeing events for the yes or no group (.15), followed by the checklist group (.11), followed by the MCQ group (.08). Differences across the three memory tests cannot be attributed to participants simply being more lazy on the memory test that requires additional responses when they claim an event had been seen (e.g., the MCQ test) because the proportion of events claimed as seen that were actually seen does not differ across the three memory tests, $F(2, 118) < 1$ (see Table 3).

As shown in Figure 2, there was a significant interaction between test format and source condition, $F(10, 590) = 1.86$, $p = .047$, $MSE = 0.01$. This interaction became marginally significant when the Huynh–Feldt correction was applied ($\epsilon = .77$, $p = .06$). Furthermore, when the new items were not included as one of the levels of source condition, this interaction remained marginally significant, $F(8, 472) = 1.77$, $p = .08$ (Huynh–Feldt correction $\epsilon = .92$, $p = .09$). For both the checklist and the yes or no groups, post hoc comparisons revealed that false claims of having seen events were significantly higher for events that had been imagined visually and heard relative to all four other old conditions (heard only, imagined as seen only, imagined as seen twice, and imagined as seen and imagined as heard), which in turn were all significantly higher than error rates for new items. For the MCQ group, error rates for events imagined as seen and actually heard were significantly higher than were events that were only heard, but they were not significantly higher than events that were visually imagined once, visually imagined twice, or visually imagined and auditorily imagined.

In sum, the cross-modal confusion effect was obtained in both the yes or no and the checklist memory tasks and was less marked in the MCQ condition. A reduction in error rates was obtained when people considered the different potential sources of their memories or more carefully evaluated the features of those memories. This supports the source monitoring framework's claim that judgment processes flexibly vary with the situation and task (Johnson et al., 1993) and is consistent with work showing that different memory tasks may shift the features or processes participants use in judging a memory's source (e.g., Dodson & Johnson, 1993;

[3] As in Experiment 1, no difference was found in error rates in claiming to have seen events when the visually imagined version preceded (.20) or followed (.23) the heard version, $t(120) = 1.38$. For events both visually and auditorily imagined, error rates did not differ when the visual event preceded (.12) or followed (.13) the auditory event, $t(120) < 1$. No significant difference was found when a visually imagined version preceded (.08) or followed (.06) the corresponding seen event, $t(120) = 1.64$.

Marsh & Hicks, 1998; Mather et al., 1998; Zaragoza & Lane, 1994).

Forgetting events: Claiming old items were new for the checklist condition. For the checklist group, the percentage of old items erroneously called "new" (i.e., misses) was examined in a one-way ANOVA, yielding a significant main effect of source, $F(4, 160) = 38.02$, $p < .0001$, $MSE = 0.02$. Overall, events experienced twice were more likely to be recognized as old than were events experienced once. Post hoc comparisons showed that the rate of misses was significantly higher when events were visually imagined once (.33) than when heard once (.17), which in turn were significantly higher than when items had been imagined visually twice (.08), imagined visually and imagined auditorily (.06), or imagined visually and heard (.03). As in Experiment 1, the pattern of misses differs from that found for source errors. For example, although misses were lowest (and thus recognition was highest) for items that had been heard and visually imagined, source errors were highest for those items.

Features of falsely attributed memories for the MCQ group. Participants in the MCQ group not only indicated whether they had seen a named event but they also rated their confidence in the accuracy of their source judgment and the vividness of several features for events they claimed to have seen. Confidence was rated on a 3-point scale, with 1 = *guessing,* 2 = *fairly sure,* and 3 = *very sure.* Confidence ratings were significantly higher for items correctly judged as perceived ($M = 2.89$) than for those incorrectly judged as perceived ($M = 2.09$), $t(34) = 10.18$, $p < .001$.

Ratings for other memory features were made using a 5-point scale, with higher values associated with greater clarity of the probed feature. A two-way ANOVA examining clarity ratings for correctly and incorrectly attributed memories across these memory features showed a significant interaction between feature and attribution accuracy, $F(4, 136) = 15.04$, $p < .0001$, $MSE = 0.17$ (see Figure 3). Follow-up comparisons showed that clarity ratings were significantly higher for correctly attributed events than for incorrectly attributed events for all features except frequency of thoughts. Thus, events that were actually seen had greater overall vividness, more visual detail, and more information about the person's thoughts and feelings than did events that were falsely claimed as seen. This is consistent with previous work showing differences in veridical and false memories (Henkel et al., 1998; Johnson, Nolde, & De Leonardis, 1996; Johnson, Raye, Foley, & Foley, 1981; Mather et al., 1998; Norman & Schacter, 1998) and suggests that although people often fail to use information effectively in making source judgments, the features of a memory nevertheless may include cues as to its source.

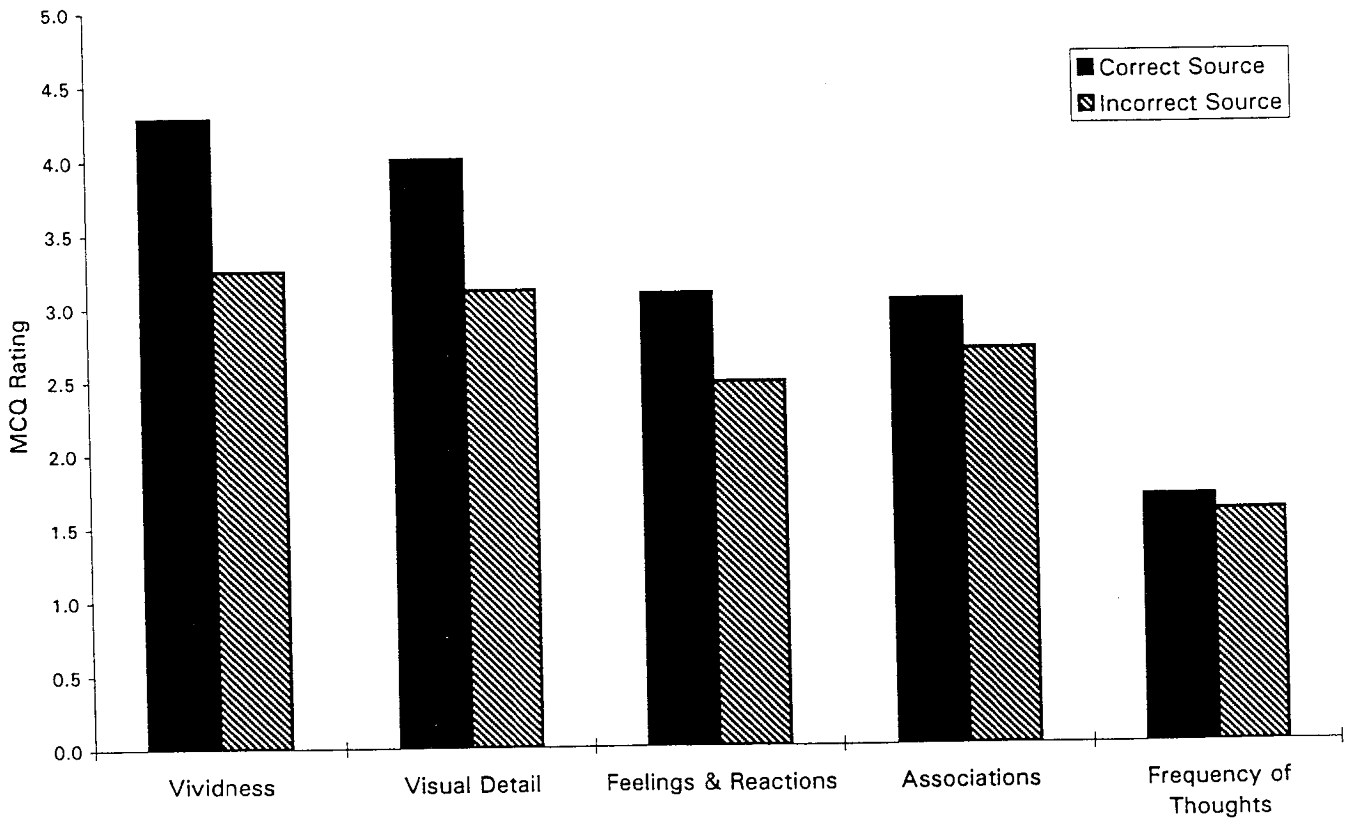

Figure 3. Memory characteristics for correctly and incorrectly attributed memories in the MCQ group of Experiment 2. MCQ = memory characteristics questionnaire.

General Discussion

On the basis of the source monitoring framework, we expected that compared with imagination alone, imagination about events for which there is also related perceptual support would increase the likelihood of false memories. Consistent with this prediction, errors in mistakenly claiming to have seen events were most likely when an event had been both visually imagined and actually heard. Two mechanisms would be expected to contribute to this cross-modal confusion effect. First, spontaneous visual imagery may occur when hearing an event, which may then in turn be mistaken as evidence for visual perception. In line with this possibility, participants in both experiments reported a greater tendency to visually imagine events when hearing them than to auditorally imagine events when seeing them. Furthermore, according to the source monitoring framework, insofar as this imagery was spontaneous rather than deliberate, people should be relatively less likely to attribute it to imagination rather than to perception. Consistent with this, more false memories were observed in the imagined seen and heard condition than in the condition in which participants imagined the event twice because in the latter case, the memory presumably would include more cognitive operations. Thus, this first mechanism is related to similarity between perceived and imagined events in a particular type of feature—in this case visual detail.

The second mechanism is related to the idea that not only the most relevant or diagnostic features enter into source attributions, but also source attribution processes may be influenced by a wide range of features, as well as by general knowledge, beliefs, and wishes. Relevant to the present instance, in determining whether an event was seen, people sometimes may rely on a global evaluation of evidence suggesting an event was perceived rather than only on evidence suggesting the event was seen per se. This possibility is supported by the finding that false memories were higher in the imagined seen and heard condition than in the imagined seen and imagined heard condition, under the assumption that there is more perceptual information for heard than for imagined as heard events (and fewer cognitive operations in the former case). Also consistent with the idea that source attributions sometimes involve a more global and sometimes a more specific assessment of features is the finding in Experiment 2 that source accuracy was affected by the test format used to assess memory: Participants had fewer false memories of having seen events in conditions in which they were encouraged to evaluate qualitative characteristics of their memories or to consider the various possible sources of their memories (see also Dodson & Johnson, 1993; Lindsay & Johnson, 1989; Marsh & Hicks, 1998; Marsh, Landau, & Hicks, 1997; Mather et al., 1998; Zaragoza & Koshmider, 1989; Zaragoza & Lane, 1994). This pattern of results is what would be expected if people are to some extent capable of gating out inappropriate feature information—in this case, reducing the weights assigned to auditory information. This pattern in which inappropriate evidence is selectively gated out is also inconsistent with any model in which information is represented in memory in a way that does not reflect its origins and in which source attributions are made simply on the basis of trace strength (e.g., Hoffman, 1997).

People sometimes report with high confidence and a strong sense of recollective experience that they have seen things that were not in fact seen (e.g., Zaragoza & Mitchell, 1996). Nevertheless, as in several other studies (e.g., Henkel et al., 1998; Mather et al., 1998; Norman & Schacter, 1998), the present findings show differences in the qualitative features of correctly and incorrectly attributed memories. On average, accurate source memories had more visual detail and more information about thoughts and feelings than did inaccurate source memories. The facts that some false memories can yield highly confident recollective experiences and that, on average, false memories tend to have less information than true memories are both consistent with the source monitoring framework. According to the source monitoring framework, mental experiences may vary along many qualitative dimensions (e.g., visual detail, spatial information, emotion, etc.), and the experience of remembering is an interaction between these qualitative experiences and judgment or attribution processes (including the flexible criteria and feature weights that are adopted at any moment in time). Just as "recollected" true memories would be expected to vary among themselves in qualitative characteristics, so would the false memories, and these two distributions overlap (or else there would be no false memories). False (and true) memories that people are willing to categorize as recollected in any particular experiment are presumably experiences that are on the high end of the distribution of the qualities being evaluated, or they pass a subjective threshold for possessing the characteristic(s) being used diagnostically on the basis of the instructions participants received about the meaning of recollection. Outside of experimental contexts, the meaning of recollection would be expected to vary with the circumstances (e.g., social context, cost of mistakes). Real-world contexts are more complex than those modeled in the laboratory but presumably rely on the same basic principles.

There are a number of practical implications of the fact that false memories are especially likely when people embellish, through imagination, events that have happened—that is, events for which related memories include perceptual support. False memories augmented by the kind of perceptual detail provided by viewing photographs (Schacter, Koutstaal, Johnson, Gross, & Angell, 1997), hearing other eyewitnesses' accounts (Loftus, 1979), or, in the case here, having multiple experiences with events through different sources and modalities, may occur quite frequently and can be especially problematic in situations where correct attribution of the source of information matters. In fact, many of the most compelling false memories may be of this type, that is, in which some fragments of related perceptions increase the sense that memory for an imagined event is a memory for an actual event. These findings thus are relevant to any situation in which the phenomenal features of mental experiences are used to make judgments about what really happened, as in the case of eyewitness testimony (e.g., Lindsay & Johnson, 1989; Zaragoza & Lane, 1994) or in remembering childhood events (e.g., Hyman & Pentland, 1996).

References

Belli, R. F. (1988). Color blend retrievals: Compromise memories or deliberate compromise responses. *Memory & Cognition, 16,* 314–326.

Ceci, S. J., & Bruck, M. (1993). Suggestibility of the child witness: A historical review and synthesis. *Psychological Bulletin, 113,* 403–439.

Dodson, C. S., & Johnson, M. K. (1993). The rate of false source attributions depends on how questions are asked. *American Journal of Psychology, 106,* 541–557.

Durso, F. T., & Johnson, M. K. (1980). The effects of orienting tasks on recognition, recall, and modality confusion of pictures and words. *Journal of Verbal Learning and Verbal Behavior, 5,* 325–377.

Finke, R. A., Johnson, M. K., & Shyi, G. C. (1988). Memory confusions for real and imagined completions of symmetrical visual patterns. *Memory & Cognition, 16,* 133–137.

Henkel, L. A., & Franklin, N. (1998). Reality monitoring of physically similar and conceptually related objects. *Memory & Cognition, 26,* 659–673.

Henkel, L. A., Johnson, M. K., & De Leonardis, D. M. (1998). Aging and source monitoring: Cognitive processes and neuropsychological correlates. *Journal of Experimental Psychology: General, 127,* 251–268.

Hoffman, H. G. (1997). Role of memory strength in reality monitoring decisions: Evidence from source attribution biases. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23,* 371–383.

Hyman, I. E., Jr., & Pentland, J. (1996). The role of mental imagery in the creation of false childhood memories. *Journal of Memory and Language, 35,* 101–117.

Jacoby, L. L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Journal of Memory and Language, 30,* 513–541.

Johnson, M. K. (1988). Discriminating the origin of information. In T. F. Ohmanns & B. A. Maher (Eds.), *Delusional beliefs* (pp. 34–65). New York: Wiley.

Johnson, M. K., Foley, M. A., Suengas, A. G., & Raye, C. L. (1988). Phenomenal characteristics of memories for perceived and imagined autobiographical events. *Journal of Experimental Psychology: General, 117,* 371–376.

Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin, 114,* 3–28.

Johnson, M. K., Nolde, S. F., & De Leonardis, D. M. (1996). Emotional focus and source monitoring. *Journal of Memory and Language, 35,* 135–156.

Johnson, M. K., & Raye, C. L. (1981). Reality monitoring. *Psychological Review, 88,* 67–85.

Johnson, M. K., & Raye, C. L. (1999). Cognitive and brain mechanisms of false memories and beliefs. In D. L. Schacter & E. Scarry (Eds.), *Memory and belief* (pp. 35–86). Cambridge, MA: Harvard University Press.

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

Johnson, M. K., Raye, C. L., Wang, A. Y., & Taylor, T. H. (1979). Fact and fantasy: The roles of accuracy and variability in confusing imaginations with perceptual experiences. *Journal of Experimental Psychology: Human Learning and Memory, 5,* 229–240.

Lindsay, D. S., & Johnson, M. K. (1989). Recognition memory and source monitoring. *Bulletin of the Psychonomic Society, 29,* 203–205.

Lindsay, D. S., Johnson, M. K., & Kwon, P. (1991). Developmental changes in memory source monitoring. *Journal of Experimental Child Psychology, 52,* 297–318.

Lindsay, D. S., & Read, J. D. (1994). Psychotherapy and memories of childhood sexual abuse: A cognitive perspective. *Applied Cognitive Psychology, 8,* 281–338.

Loftus, E. F. (1979). *Eyewitness testimony.* Cambridge, MA: Harvard University Press.

Loftus, E. F., Miller, D. G., & Burns, H. J. (1978). Semantic integration of verbal information into a visual memory. *Journal of Experimental Psychology: Human Learning and Memory, 4,* 19–31.

Marsh, R. L., & Hicks, J. L. (1998). Test formats change source-monitoring decision processes. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 24,* 1137–1151.

Marsh, R. L., Landau, J. D., & Hicks, J. L. (1997). The contribution of inadequate source monitoring during idea generation to unconscious plagiarism. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23,* 886–897.

Mather, M., Henkel, L. A., & Johnson, M. K. (1998). Evaluating characteristics of false memories: Remember/know judgments and memory characteristics questionnaire compared. *Memory & Cognition, 25,* 826–837.

McCloskey, M., & Zaragoza, M. (1985). Misleading postevent information and memory for events: Arguments and evidence against memory impairment hypothesis. *Journal of Experimental Psychology: General, 114,* 3–18.

Metcalfe, J. (1990). A composite holographic associative recall model (CHARM) and blended memories in eyewitness testimony. *Journal of Experimental Psychology: General, 119,* 145–160.

Mitchell, K. J., & Johnson, M. K. (2000). Source monitoring: Attributing (and misattributing) mental experiences. In E. Tulving & F. I. M. Craik (Eds.), *Oxford handbook of memory* (pp. 179–195). New York: Oxford University Press.

Multhaup, K. (1995). Aging, source, and decision criteria: When false fame errors do and do not occur. *Psychology and Aging, 10,* 492–497.

Norman, K., & Schacter, D. L. (1998). False recognition in younger and older adults: Exploring the characteristics of illusory memories. *Memory & Cognition, 25,* 838–848.

Rabinowitz, J. C. (1990). Effects of repetition of mental operations on memory for occurrence and origin. *Memory & Cognition, 18,* 72–82.

Raye, C. L. (1976). Recognition: Frequency or organization? *American Journal of Psychology, 89,* 645–658.

Raye, C. L., Johnson, M. K., & Taylor, T. H. (1980). Is there something special about memory for internally generated information? *Memory & Cognition, 8,* 141–148.

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

Ross, M. (1997). Validating memories. In N. L. Stein, P. A. Ornstein, B. Tversky, & C. Brainerd (Eds.), *Memory for everyday and emotional events* (pp. 49–81). Hillsdale, NJ: Erlbaum.

Schacter, D. L., Koutstaal, W., Johnson, M. K., Gross, M. S., & Angell, K. E. (1997). False recollection induced by photographs: A comparison of older and younger adults. *Psychology and Aging, 12,* 203–215.

Schooler, J. W., & Tanaka, J. W. (1991). Composites, compromises, and CHARM: What is the evidence for blend memory representations? *Journal of Experimental Psychology: General, 120,* 96–100.

Tversky, B., & Tuchin, M. (1989). A reconciliation of the evidence on eyewitness testimony: Comments on McCloskey and Zaragoza (1985). *Journal of Experimental Psychology: General, 118,* 86–91.

Weldon, M. S., & Roediger, H. L. (1987). Altering retrieval demands reverses the picture superiority effect. *Memory & Cognition, 15,* 269–280.

Zaragoza, M. S., & Koshmider, J. W., III. (1989). Misled subjects may know more than their memory performance implies. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15,* 246–255.

Zaragoza, M. S., & Lane, S. M. (1994). Source misattributions and the suggestibility of eyewitness memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20,* 934–945.

Zaragoza, M. S., & Mitchell, K. J. (1996). Repeated exposure to suggestion and the creation of false memories. *Psychological Science, 7,* 294–300.

Appendix A

Stimuli for Experiment 1

Events seen
binder opening
chain clanking
file drawer closing
sewing machine running
spinning top whirling
subway train running
tin foil ripping
volcano erupting
zipper zipping

Events heard
popcorn popping
rattle shaking
scissors cutting
soap lathering
touchtone phone dialing
trunk slamming
turnstile turning
waterfall flowing
whip cracking

Events imagined as seen
balloon popping
broom sweeping
church bell ringing
cloth tearing
diving board bouncing
fan spinning
match lighting
pages turning
shopping cart rolling

Events imagined as heard
apple crunching
baby crying
clock ticking
coins jingling
glass breaking
high heels walking
swing swinging
tea kettle whistling
walnut cracking

Events imagined as seen and heard
billiard balls colliding
chalk writing
doorknob turning
motorboat running
saw sawing
stapler stapling
toilet flushing
whistle blowing
windchimes ringing

Events imagined as seen twice
aerosol can spraying
American flag blowing
basketball bouncing
bee hive buzzing
champagne bottle opening
dice rolling
dynamite exploding
guitar playing
roller skates rolling

Events imaged as seen and imagined as heard
blinds opening
blowdryer blowing
dog barking
garbage can clanking
jar opening
light switch clicking
slot machine ringing
toaster popping
typewriter typing

Appendix B
Stimuli for Experiment 2

Sets of events counterbalanced across tapes for critical conditions: events imagined as seen and heard, events imagined as seen, events imagined as seen twice, events heard, and events imagined as seen and imagined as heard.

[*Set A*]
aerosol can spraying
bacon frying
cards shuffling
chalk writing
light switch clicking
paper crumpling
typewriter typing
whistle blowing
windshield wipers wiping

[*Set B*]
basketball bouncing
broom sweeping
fan blowing
mailbox closing
rattle shaking
sewing machine running
soap lathering
tin foil ripping
windchimes ringing

[*Set C*]
champagne bottle opening
ketchup squirting
paintbrush brushing
scissors cutting
shopping cart rolling
swing swinging
tea kettle whistling
toilet flushing
touch tone phone dialing

[*Set D*]
American flag blowing
billiard balls colliding
blinds opening
file drawer closing
paper towel ripping
saw sawing
silverware clattering
walnut cracking
waterfall flowing

[*Set E*]
blow drying blowing
car horn beeping
doorknob turning
foot tapping
match lighting
milk pouring
stapler stapling
toaster popping
zipper zipping

Events imagined as heard
baby crying
cannon firing
church bell ringing
crowd cheering
garbage can clanking
guitar playing
ice skates skating
lion roaring
whip cracking

Events seen
binder opening
chain clanking
ice tray emptying
nail file filing
padlock opening
pencil sharpener sharpening
pepper mill grinding
shovel shoveling snow
soda machine dispensing

Events seen and imagined as seen
computer disk ejecting
dice rolling
elevator opening
gun firing
keys jingling
owl hooting
straw sipping
trampoline bouncing

Events seen twice
apple crunching
balloon popping
cash register ringing
cassette tape rewinding
cloth tearing
envelope opening
gumball machine turning
spinning top whirling
train running

Events seen (fillers)
band-aid peeling
globe spinning
lunch box opening
tape measure measuring
cheese grater grating
umbrella opening
bubble blowing
volcano erupting
pillow fluffing
rolling pin rolling
microscope focusing
smoke detector ringing
hinge squeaking

Appendix B (*continued*)

Stimuli for Experiment 2

Events seen and heard
fingers snapping
helicopter flying
high heels walking

Events heard and imagined as heard
ambulance siren blaring
heart beating
horse galloping

Events seen and imagined as heard
potato chip bag opening
radio being tuned
turnstile turning

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