Memory & Cognition
2009, 37 (2), 130-142
doi:10.3758/MC.37.2.130

The role of extralist associations in false remembering: A source misattribution account

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The finding that new items are judged as remembered in the remember–know paradigm presents a challenge to traditional process and systems accounts of memory. In three experiments, we demonstrated that false remember responses can be caused by misattributing recollection to a context other than the study list. In Experiments 1 and 2, false remember responses to distractors that were unrelated to studied words increased if they were encountered in a "preexposure" phase a few minutes or even a few days prior to the studied list. A third experiment demonstrated that remember responses to preexposed distractors increased when they were encoded in a manner similar to studied items, despite the more similar items being of weaker overall memory strength. We propose a source misattribution account of false remembering to explain these data, suggesting that all remember judgments reflect conscious recollection of contextual details, but false remember judgments are partly the result of recollection of details from an extralist context (i.e., from a source other than the study list).

The remember–know procedure was originally developed to examine whether people could reliably differentiate between memory retrieval that allowed one to mentally reexperience a previous event (i.e., a *remember* response) and retrieval that did not involve this sort of mental time travel (i.e., a *know* response). Remember judgments were intended to demonstrate memory retrieval that involved autonoetic consciousness, or awareness of oneself in a past context, whereas know judgments were intended to demonstrate memory retrieval that involved noetic consciousness, or awareness of the past that was not associated with a particular context. Since the inception of this procedure (Tulving, 1985), many dissociations between remembering and knowing have been reported, with some experimental manipulations leading to increases in remembering, others leading to increases in knowing, and still others leading to increases in both responses or various interactions (for a review, see Roediger, Rajaram, & Geraci, 2007). These dissociations have often been used as evidence for the idea that remembering and knowing reflect discrete states of awareness associated with memory retrieval (Gardiner, 2001; Roediger et al., 2007; Tulving, 1985), or that they reflect discrete memory systems or processes (Gardiner, 1988; Joordens & Hockley, 2000; Reder et al., 2000; Tulving, 1985; Yonelinas, 2002).

Presenting a theoretical challenge to explanations of remember–know judgments is the finding that participants regularly assign remember responses to new items, or distractors, on a recognition test, a phenomenon referred to as *false remembering*. For example, according to a traditional memory systems account (Tulving, 2002), items that involve reexperiencing a specific episode in one's personal past will be judged as remembered, whereas items not associated with a temporal–spatial context will be judged as known. It is not immediately clear from this perspective why a new item on a recognition test would produce the sort of autonoetic retrieval experience that supports a remember judgment. Similarly, because traditional dual-process accounts of remembering and knowing assume that remember judgments accurately measure recollection arising from a study episode (Joordens & Hockley, 2000; Reder et al., 2000; Yonelinas, 2002), it is a challenge to understand why false remembering would occur. For example, Yonelinas has suggested that remember responses provide an estimate of recollection of studied items, whereas an estimate based on know responses (independence remember–know, or IRK; Yonelinas, 2002; Yonelinas & Jacoby, 1995) provides an estimate of familiarity. According to this so-called *process-pure perspective* (Rotello, Macmillan, Reeder, & Wong, 2005), remember false alarms should not occur because "participants cannot truly recollect new items" (Yonelinas, Kroll, Dobbins, Lazzara, & Knight, 1998, p. 339). Wixted and Stretch (2004) also raised this issue, noting that it is "awkward to assert that randomly chosen lures (which often are selected from a large pool of possible lures) occasion the recollection of an encoding event that never happened" (p. 618).

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A Source Misattribution Account of Remember False Alarms

The purpose of the present article is to provide an account of false remembering consistent in principle with traditional systems and process accounts, and to demonstrate that false remembering often reflects conscious recollection from a source other than the study episode. According to this *source misattribution account*, false remembering reflects the subjective experience of conscious recollection. The source misattribution account borrows from attributional approaches; as such, it operates under the assumption that several factors can influence the accuracy with which current processing is attributed to past events (Jacoby, Kelley, & Dywan, 1989; Johnson, Hashtroudi, & Lindsay, 1993; Kelley & Rhodes, 2002; Whittlesea & Williams, 1998). Specifically, we suggest that remember responses can be based either on retrieval of contextual details from a study session or on retrieval of contextual details from an episode other than the study session (i.e., extralist sources). Thus, we adopt the traditional systems or process view that recollection of contextual details underlies the experience of remembering (Jacoby, Debner, & Hay, 2001; Yonelinas, 2002), but we relax the assumption that this recollection must be associated with the study context. As such, our approach is also consistent with the global matching model principle that test probes activate all items in memory (Hintzman, 1988), particularly versions that include a list or context parameter (Hicks & Starns, 2006). According to the source misattribution account, the attribution of remembering to the study context can be independent from the retrieval of contextual information that supports the remember response itself. Note that, in this case, we are treating remember–know judgments as metacognitive judgments in need of an explanation (Koriat, 1997; Nelson & Narens, 1990); our primary interest, therefore, is in explaining why research participants claim to recollect details associated with new items unrelated to items from the study episode.

According to a source misattribution explanation, remember false alarms are source memory errors, and may reflect recollection of events or event features experienced in a context other than the study list. Thus, "new" items on a recognition test can cause participants to experience remembering, if such items act as effective retrieval cues for past events that occurred outside of the experimental context (Madigan, McDowd, & Murphy, 1991; Tulving & Kroll, 1995). The former situation, in which objectively "new" items cue recollection of events related to those presented in the study episode, has been studied extensively under the rubric of illusory recollection, phantom recollection, or false recollection (Gallo & Roediger, 2003; Geraci & McCabe, 2006; Lampinen, Meier, Arnal, & Leding, 2005; Lyle & Johnson, 2007; Roediger & McDermott, 1995; S. M. Smith, Tindell, Pierce, Gilliland, & Gerkens, 2001), and will be discussed in more detail in the General Discussion. The latter situation, in which new items cue recollection of events from outside the study context (i.e., extralist events) is the focus of the present study, and thus differs from previous studies of associative false memories in that regard. To our knowledge, the influence of extralist associations on false remembering, using standard unrelated lists of items, has not been addressed.

It is important to examine the influence of extralist associations on false remembering, because most accounts of false memories have not addressed this issue, instead focusing on explaining illusory recollections related to studied events (e.g., Gallo & Roediger, 2003; Roediger & McDermott, 1995). However, examining false remembering for unrelated distractors can be quite useful in constraining theories of remember–know judgments (Rotello et al., 2005; Wixted & Stretch, 2004), and we hope to convince the reader that these responses are at least partly based on recollection of extralist associations. A schematic illustration of the source misattribution account, and the potential influence of extralist events, is presented in Figure 1. According to this account, remember false alarms can be based on recollection of details from extralist sources (the focus of the present study), recollection of thoughts imagined during study (Gallo & Roediger, 2003; Henkel, Johnson, & De Leonardis, 1998; Hicks & Hancock, 2002), and partial recollection of features of studied items (Lampinen et al., 2005; A. D. Smith, 1975). Recollection of studied items can be based on the same sources as remember false alarms, as well as recollection of the studied item's presentation during the study episode (see Lyle & Johnson, 2007, for evidence that feature misattributions contribute to accurate source recollection).

Overview of the Present Experiments

Because the stimuli used in recognition experiments are familiar stimuli (or at least include familiar features),

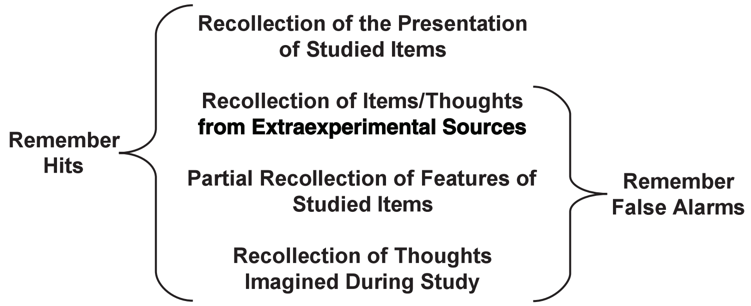

Figure 1. Possible sources of recollection for remember hits and false alarms according to the *source misattribution account*.

they are not "new" in a general sense. Instead, participants must distinguish which preexperimentally familiar items were presented in a study list, and which are new in terms of that experimental context. In three experiments, we investigated whether items experienced prior to the study phase of an experiment can be cued by items on a recognition test. This kind of paradigm has been used by others to examine priming (Madigan et al., 1991), novelty effects (Tulving & Kroll, 1995), and process dissociation (Dobbins, Kroll, Yonelinas, & Liu, 1998; Gruppuso, Lindsay, & Kelley, 1997). The present study is the first to examine remembering and knowing by means of this approach. In remember–know experiments, the participant's task is to discriminate between items remembered or known, and to discriminate the source of that remembering and knowing. From this perspective, it should not be surprising that so-called new items—that is, distractors—could cue subjective recollection associated with events outside the experimental context. Indeed, it is possible that most false remembering in typical remember–know experiments, using purportedly unrelated items, reflects a combination of recollection associated with a context other than the study list presented in the experiment and within-list source confusions (e.g., *cash* was studied, but *money* was on the test).

In the present article, we test two of the basic principles of the source misattribution account. The first principle is that exposure to items prior to the presentation of a study list can lead to increased levels of remember responses for those "preexposed" items. This is the most obvious prediction of the source misattribution account—that is, that new items can cue recollection of events from a source other than the study list. This principle is demonstrated in all three experiments. The second principle of the source misattribution account is that participants should be more likely to assign remember responses when preexperimental events are similar to events processed during a study session than when preexperimental and studied events are less similar. Because the event details that support a remember response (e.g., creating a personal association for a word) are dissociable from the details that allow discrimination between whether an item was processed as part of the study list or some preexperimental source (e.g., temporal cues), it should be possible to have weaker items elicit more false remember responses than stronger items. This principle is demonstrated in Experiment 3.

Given the recent debate regarding the adequacy of different signal detection based models of remembering and knowing (Dunn, 2004; Parks & Yonelinas, 2007; Rotello, Macmillan, & Reeder, 2004; Wixted & Stretch, 2004), it may be helpful to briefly explain the issues not addressed in the present article. We do not attempt to adjudicate between single-process and dual-process explanations of remembering and knowing, nor do we compare the fits of quantitative models. Our goals for the present article are in line with the original purpose of remember–know judgments: to understand the subjective experience associated with memory retrieval. This article outlines a framework for understanding remember–know judgments that can plausibly account for the subjective experience of conscious recollection of old and new items on a recognition test. The implications of these data for extant accounts of remember–know judgments will be discussed in more detail in the General Discussion.

EXPERIMENT 1

In the first experiment, participants were preexposed to items in a session 2 days prior to the study episode, and some of these preexposure items were used as distractors on the recognition test administered 2 days later (along with experimentally novel distractors[1]). Figure 2 presents a schematic illustration of the general procedure used in the experiment. This procedure was intended to mimic the phenomenon that occurs when participants have recently encountered a "new" item in a context outside the experi-

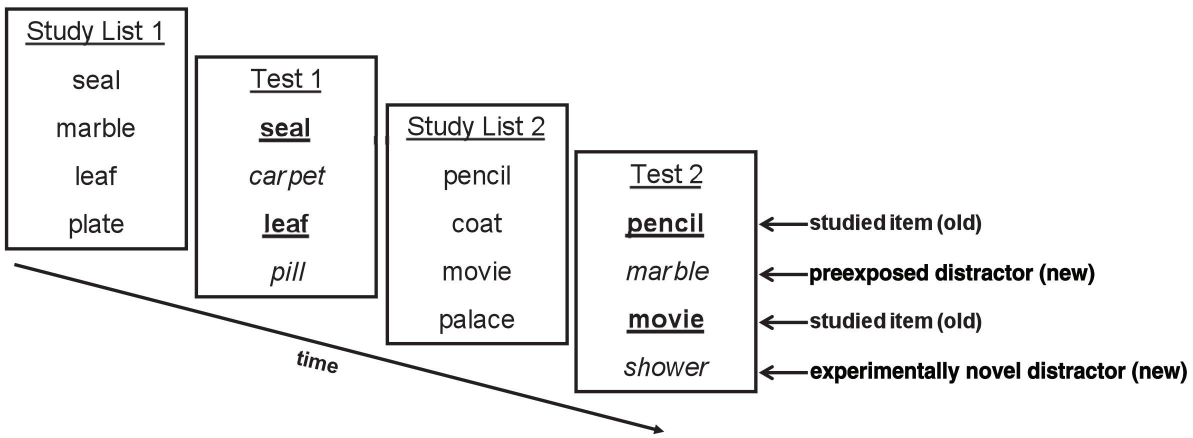

Figure 2. A schematic diagram outlining the general preexposure procedure used in the present experiments. Some of the studied items from Study List 1 are used as distractors, or new items, on Test 2. The effect of preexposure can be examined by comparing remembering and knowing for experimentally novel and preexposed distractors. For purposes of illustration, studied words are underlined and new words are italicized in the figure but all words were presented in the same font in the experiments.

ment: while writing a to-do list the day before the experiment, for example, or completing a crossword puzzle the morning of the experiment. According to the source misattribution account, the preexposure items should show fairly low levels of false remembering, similar to what one would typically find in a remember–know experiment, but the levels of false remembering should still be greater than for experimentally novel distractors.

Method

Participants. Thirty-two Colorado State University undergraduates between the ages of 18 and 23 received course credit for their participation.

Materials. Stimulus materials consisted of 180 medium frequency nouns selected from the English lexicon project database (Balota et al., 2007). The mean log HAL frequency of the words was 8.8 ($SD = 0.9$), with a range of 6.7–11.3. All words ranged in length from four to seven letters, with a maximum of two syllables. Concreteness ratings were over 550, according to the MRC psycholinguistic database (Wilson, 1988). Stimuli were assigned to one of three 60-item sets for counterbalancing. For a given participant, one set served as the preexposure items, one set served as the studied items, and one set was used to select experimentally novel distractors for the recognition test. The use of each set for each item type was counterbalanced across participants. The subset of items from each set that served as the studied targets, the preexposure distractors, and the experimentally novel distractors were randomly selected from each set.

Procedure. Participants were tested in small groups. On Day 1, after providing informed consent, participants were asked to state, for the study phase, whether each word they saw on a screen was feminine or masculine, using a binary scale (i.e., masculine or feminine). Participants responded using "clicker" devices (remote control keypads often used for classroom participation). One word was presented every 4 sec. After participants had rated all 60 words, they were given instructions for a remember–know recognition test. Thirty-six studied items were tested during the test on the first day, along with 36 experimentally novel distractors. Eighteen items studied on Day 1, but *not* tested, were used as preexposure distractors for the recognition test on Day 2.

The recognition test on Day 1 was given immediately after study. Participants were told that some of the items on the test had been studied and that some were new. To the right of each test word, the words YES and NO were printed in capital letters. Participants were asked to circle YES if they had rated the word in the study list, and NO if they had not. Participants were told that if they circled YES to indicate that they encountered a word in the study list, they should also circle *R* or *K* (in a box to the right of YES or NO) to indicate whether they remembered the studied item or just knew it had been presented. The difference between remember and know judgments was closely modeled on Rajaram (1993).

After a 2-day delay, participants returned for a second session. On Day 2, the experimental session began with a study phase, which involved making a binary pleasantness–unpleasantness rating using remote clickers, with 1 word presented every 4 sec. After rating the 60 studied words, participants completed a 10-min visuospatial reasoning test as a distractor task, then received instructions for the recognition test; they were the same as those used on Day 1. It was clearly stated that participants should circle YES for items they rated for pleasantness on Day 2 and NO for any other items not rated during the study session on the second day (recall that items had been rated for gender on Day 1). The idea that they should focus their responses only on items from Day 2 was explained twice, at the beginning and end of the instructions. The recognition test included 54 studied words (excluding the first and last 3 from the study list as buffers), 36 experimentally novel words, and 18 preexposure words, randomly intermixed.

Results

Results of statistical tests were significant at $p < .05$. F values, mean square error (MS_e), and effect sizes (partial eta squared; η_p^2) were included for each analysis.

The recognition data for Test 1 and Test 2 are presented in Table 1. Twenty-nine of the 32 participants returned for the second session and were included in the analysis. We began the analysis by comparing performance on Tests 1 and 2, which were similar except for the 10-min distractor task between the study and test for Test 2. Levels of performance were similar for the two tests. Remember hits did not differ between Test 1 and Test 2 [$F(1,28) = 1.65$, $MS_e = 0.04$, $\eta_p^2 = .06$], nor did know hits ($F < 1$). Similarly, remember false alarms did not differ between Test 1 and Test 2 [$F(1,28) = 1.35$, $MS_e = 0.002$, $\eta_p^2 = .05$], nor did know false alarms [$F(1,28) = 2.60$, $MS_e = 0.02$, $\eta_p^2 = .09$]. Next, we turned to the main question of interest: whether remember responses for preexposure distractors were greater than were remember responses for experimentally novel distractors in Test 2. Remember responses to preexposed distractors (.05) were significantly greater than were remember responses to experimentally novel distractors (.02) [$F(1,28) = 5.59$, $MS_e = 0.01$, $\eta_p^2 = .17$]. This finding supports the idea that some distractors on a recognition test can cue recollection of details from a context other than the study list, even when those distractors are purportedly unrelated to studied words, were encountered days before the study episode, and were processed in a different manner (i.e., using a different orienting task). It should also be noted that, although the mean difference between remember false alarms for new and preexposure items was small (i.e., 3%), the effect size was not trivial (Cohen's $d = .44$, a medium-sized effect). And although remembering is close to floor, we replicate this pattern in Experiment 2, with responses well above floor levels. This experiment demonstrates the source misattribution effect in a situation similar to a typical remember–know recognition experiment, and suggests that the typical low levels of remember false alarms may be caused by a similar mechanism. Not surprisingly, preexposure also affected know responses, with know responses for preexposed distractors (.09) being considerably greater than for experimentally novel distractors (.05) [$F(1,28) = 6.38$, $MS_e = 0.02$, $\eta_p^2 =$

Table 1
Probability of Remember and Know Responses for Studied Targets, Preexposed Distractors, and New (Experimentally Novel) Distractors for Recognition Tests on Day 1 and Day 2 in Experiment 1

	Remember		Know		Overall (R + K)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Day 1 test						
Studied items	.65	.03	.30	.03	.95	.01
New distractors	.03	.01	.02	.01	.06	.01
Day 2 test						
Studied items	.60	.05	.30	.05	.90	.02
Preexposed distractors	.05	.02	.10	.02	.14	.03
New distractors	.02	.01	.06	.01	.07	.01

.19]. Note, too, that the preexposure effect size for know responses was similar to that for remember responses (Cohen's $d = .39$).

As mentioned previously, Yonelinas and colleagues (Yonelinas, 2002; Yonelinas & Jacoby, 1995) have argued that an IRK estimate provides a more proper estimate of familiarity than do know responses. They recommend this procedure because the opportunity to make know responses decreases as the level of remember responses increases. The procedure involves dividing know responses by one minus the rate of remember responses [familiarity = know/(1 − remember)], which essentially conditionalizes know responses on the number of opportunities to make know responses. Comparisons of the IRK estimates of familiarity indicated dramatic differences for studied ($M = .67$, $SD = .31$) and preexposed distractors ($M = .11$, $SD = .10$) [$F(1,28) = 99.64$, $MS_e = 4.60$, $\eta_p^2 = .84$], as well as for studied and novel distractors ($M = .06$, $SD = .12$) [$F(1,28) = 88.96$, $MS_e = 5.37$, $\eta_p^2 = .85$]. There was also a difference between preexposed and experimentally novel distractors [$F(1,28) = 6.67$, $MS_e = 0.03$, $\eta_p^2 = .19$]. Thus, the IRK estimates led to results very similar to the analysis of raw know responses.

EXPERIMENT 2

Experiment 1 demonstrated that remember false alarms occurred for "new" items encountered days before the study phase. This finding demonstrates that participants can inadvertently recollect details that support a remember response from a context other than the study list, suggesting that the remember false alarms that occur under normal conditions may operate according to a similar mechanism.

In Experiment 2 we sought to demonstrate source misattribution in a more striking fashion than in Experiment 1, by making the preexposed distractors difficult to discriminate from the studied items. In Experiment 2, the preexposure items were encountered immediately prior to study in the same experimental session, and were processed in a fashion similar to the old items (cf. Dobbins et al., 1998; Gruppuso et al., 1997).

Method

Participants. Thirty-two Colorado State University undergraduates between the ages of 18 and 23 participated and received course credit.

Materials. Stimulus materials consisted of 216 medium- to high-frequency nouns, selected from the English lexicon project database (Balota et al., 2007). The mean log HAL frequency of the words was 10.1 ($SD = 1.0$), with a range of 6.5–13.7. All words ranged in length from four to eight letters, with a maximum of three syllables. Concreteness ratings were between 400 and 550, according to the MRC psycholinguistic database (Wilson, 1988). Stimuli were assigned to one of three 72-item sets for counterbalancing. The preexposure items and studied items were each presented on a sheet of paper including 36 items on each side (two rows of 18 on each side). Each word had a blank box to the right of it for participants to fill in their pleasantness ratings. The rest of the procedures were identical to those used for the test on the second day of Experiment 1, except where noted.

Procedure. After providing informed consent, participants were given instructions for the study phase. Participants were asked to make pleasantness ratings on a sheet of paper, using a 5-point scale, with 5 indicating that the word was *very pleasant*, and 1 that it was *very unpleasant*. Participants were asked to rate 1 word every 4 sec. This pace was ensured by a camera click sound played over a speaker every 4 sec, which signaled that participants should rate the next word. After all 72 words had been rated, the preexposure sheets were collected and participants were told that this phase of the experiment had been practice, and that they would now be asked to rate another list of words for pleasantness. They were informed that only their memory for the second list would be tested and that they should forget the practice words. They were also informed that the purpose of the pleasantness ratings was to make the words memorable, and that the ratings were usually effective in achieving this purpose. Readers may note that this paradigm is quite similar to the list method directed-forgetting paradigm (MacLeod, 1998).

Instructions for the remember–know recognition test were the same as those given in Experiment 1. Participants were also told that if an item on the test was from the practice list, they should circle No to indicate that it was not from the study list. To ensure that participants understood this aspect of the instructions, the instructions were given twice in detail, at the beginning and end of the recognition instructions.

Results

As in Experiment 1, we investigated whether remember responses for preexposed distractors were greater than were remember responses for experimentally novel distractors. These data are presented in Table 2. As expected, remember responses to preexposed distractors (.53) were considerably greater than were remember responses to experimentally novel distractors (.07) [$F(1,31) = 193.75$, $MS_e = 3.39$, $\eta_p^2 = .86$]. This finding supports the idea that items that were recently encountered and processed in a manner similar to studied items would receive a substantial amount of remember responses. Indeed, the level of remember false alarms for preexposed distractors was similar to the level of remember hits for studied targets (.61), but the difference between these values was significant [$F(1,31) = 6.45$, $MS_e = 0.10$, $\eta_p^2 = .17$]. Preexposure also affected know responses, albeit to a lesser

Table 2
Probability of Remember and Know Responses for Studied Targets, Preexposed Distractors, and Experimentally Novel Distractors in Experiment 2

	Remember		Know		Overall (R + K)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Studied items	.61	.03	.24	.02	.85	.01
Preexposed distractors	.53	.03	.28	.03	.81	.02
Experimentally novel distractors	.07	.02	.08	.01	.16	.03

extent than it did remember responses. Know responses for preexposed distractors (.28) were considerably greater than were know responses for experimentally novel distractors (.08) [$F(1,31) = 50.13$, $MS_e = 0.63$, $\eta_p^2 = .62$]. Know responses for preexposure items and studied items did not differ [$F(1,31) = 2.34$, $MS_e = 0.03$, $\eta_p^2 = .07$]. As with Experiment 1, the results from the analysis of the IRK estimates of familiarity were similar to the results using raw know responses. Specifically, IRK estimates for preexposed distractors ($M = .56$, $SD = .27$) were considerably greater than IRK estimates for experimentally novel distractors ($M = .10$, $SD = .09$) [$F(1,31) = 124.74$, $MS_e = 3.46$, $\eta_p^2 = .80$]. IRK estimates of familiarity were much greater for studied items ($M = .59$, $SD = .22$) than they were for novel distractors [$F(1,31) = 165.40$, $MS_e = 3.80$, $\eta_p^2 = .84$]. However, IRK estimates for preexposed distractors and studied items did not differ ($F < 1$).

EXPERIMENT 3

Experiments 1 and 2 established the plausibility of the mechanism by which source misattributions could cause false remember responses to unrelated items and demonstrated that conscious recollection underlying remember responses, and conscious recollection related to discriminating the study context from other contexts, could be dissociated. Results from both experiments demonstrated that misattribution of extralist information can influence false remembering, consistent with a source misattribution account.

The purpose of Experiment 3 was to directly test a second principle of the source misattribution account: that remember false alarms will be more likely to occur when new items are difficult to discriminate from studied items than when such items are easier to discriminate (cf. Gruppuso et al., 1997; Hashtroudi, Johnson, & Chrosniak, 1990; Hicks & Starns, 2006; Johnson et al., 1993). To examine this source discriminability principle, we manipulated the similarity between preexposed distractors and studied items (cf. Gruppuso et al., 1997).

Experiment 3 replicated the basic design of Experiment 1 (see Figure 2), but the similarity of the preexposure items and studied items was also manipulated. For the first study list, participants made either pleasantness ratings (i.e., pleasant–unpleasant) or gender ratings (i.e., masculine–feminine). They then completed an old–new recognition test for some of those studied items. Consistent with Experiment 1, some of the studied items were not tested on this first test. Immediately following the first old–new recognition test, a second study phase occurred in which all of the participants made gender ratings. This was followed by a remember–know recognition test that included preexposure items from the first study list as distractors. For the group that had completed gender ratings during the first and second study phases (hereafter referred to as the similar source group), the preexposed distractors could be easily confused with studied items, because words in both study phases were given the same type of ratings (i.e., gender ratings). Thus, for the similar source group, only temporal cues would allow participants to distinguish between studied and preexposure items. In the group that had completed pleasantness ratings during the first study phase but gender ratings during the second study phase (hereafter referred to as the dissimilar source group), the preexposed distractors were less confusable with studied items, because words in each study phase were given different types of ratings (i.e., pleasantness and gender ratings). Thus, for the dissimilar source group, both the type of processing and the temporal cues would allow participants to distinguish between studied items and preexposure items, which should lead to fewer false remember responses relative to the similar source group.

Method

Participants. Eighty-four Colorado State University undergraduates between the ages of 18 and 23 received course credit for their participation.

Materials. Stimuli were the 216 words used in Experiment 2. Words were divided into three sets of 72 items. The first set of 72 items served as studied items for the first study episode, with 36 of these items being tested on Test 1, and 18 being used as preexposure distractors for Test 2. Another set of 72 items served as the studied items for the second study episode, with half of those being tested on Test 2. The third set of 72 items provided the 36 novel new items for Test 1, and the 18 novel new items for Test 2. The study words were presented on a sheet of paper, with 18 words presented in each of four columns. Words were numbered between 1 and 72. The study sheet also had a summary of the rating instructions for the pleasantness or gender ratings. The test sheet was very similar to the study sheet, except there were no numbers next to the test words. For Test 1, the words YES and NO were printed to the right of each test word for par-

Table 3
Probability of Remember and Know Responses for Studied Targets, Preexposed Distractors, and Experimentally Novel Distractors for the Second Test in Experiment 3

	Remember		Know		Overall (R + K)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Similar source condition						
Studied items	.59	.03	.24	.03	.83	.02
Preexposed distractors	.43	.03	.28	.03	.72	.03
Experimentally novel distractors	.03	.01	.07	.03	.10	.03
Dissimilar source condition						
Studied items	.62	.03	.24	.03	.86	.02
Preexposed distractors	.24	.04	.25	.03	.49	.04
Experimentally novel distractors	.02	.01	.03	.01	.05	.01

ticipants to use to indicate whether they studied the word or not. For Test 2 there was an additional R and K to the right of the Yes and No for participants to indicate a remember or know response.

Procedure. Forty-two of the participants were assigned to the similar source group and the other 42 were assigned to the dissimilar source group. The procedures were similar to those used in Experiments 1 and 2. The pleasantness ratings and gender ratings were explained to participants. Participants in the pleasantness rating condition were told to write a P or U next to each word to indicate whether it was pleasant or unpleasant. Participants in the gender rating condition were told to write an M or F next to each word to indicate whether it was masculine or feminine. Participants were asked to rate one word every 3 sec, and the experimenter called out the number of the word they should be rating to keep proper time. After all 72 words had been rated, the study sheets were collected and participants were told that they were going to complete a memory test for the words they had just studied. For Test 1, they were simply told to circle Yes if they had studied a word and No if they had not. After they completed Test 1, the test sheets were collected and they listened to a 10-min lecture explaining the "savings method" Hermann Ebbinghaus used to study memory. After the short lecture, participants were given the study sheets for the second study list and were asked to make gender ratings for each word, according to the procedure described above. Immediately following the study episode, detailed remember–know instructions were given to the participants, followed by their completion of the remember–know recognition test. As with the first two experiments, participants were clearly instructed to call an item studied only if it had been studied on the second study list.

Results

We began the analysis of Experiment 3 by comparing old–new recognition for Test 1 for the similar source and dissimilar source groups. Note that for this first study list, the two groups used different orienting tasks, with the similar source group completing gender ratings and the dissimilar source group completing pleasantness ratings. There was no significant difference in the false alarm rates for the dissimilar (M = .05, SD = .07) and similar (M = .07, SD = .12) groups [$F(1,82) = 1.31$, $MS_e = .01$, $\eta_p^2 = .02$], but hits were greater in the dissimilar source group (M = .94, SD = .07) than in the similar group (M = .90, SD = .09) [$F(1,82) = 5.34$, $MS_e = .04$, $\eta_p^2 = .06$]. Overall, d' was also greater in the dissimilar (M = 3.58, SD = .83) than in the similar (M = 3.12, SD = .86) group [$F(1,82) = 6.03$, $MS_e = 4.32$, $\eta_p^2 = .07$]. Thus, words initially rated for pleasantness in the dissimilar source condition had greater overall memory strength than did words rated for gender in the similar source condition.

To determine whether the similarity of the preexposure items and studied items influenced the level of remember false alarms for preexposed distractors, a 2 (source condition: similar source, dissimilar source) × 2 (item type: experimentally novel distractors, preexposed distractors) mixed-model ANOVA was conducted. Replicating the findings from the previous experiments, there was a main effect of item type [$F(1,82) = 172.21$, $MS_e = 4.15$, $\eta_p^2 = .68$], showing more remember responses to preexposed distractors than to experimentally novel distractors. Moreover, there was a main effect of source condition [$F(1,82) = 15.63$, $MS_e = 0.41$, $\eta_p^2 = .16$] and a significant interaction [$F(1,82) = 14.75$, $MS_e = 0.36$, $\eta_p^2 = .15$]. This interaction was driven entirely by higher levels of remember false alarms to preexposed distractors in the similar source group (.43) than in the dissimilar source group (.24) [$F(1,82) = 15.71$, $MS_e = 0.76$, $\eta_p^2 = .16$], with no significant difference between groups for remember false alarms to experimentally novel distractors ($F < 1$). There were also no significant differences between the similar and dissimilar source conditions on remember or know responses for studied items (Fs < 1), or for know responses for experimentally novel distractors [$F(1,82) = 2.23$, $MS_e = 0.04$, $\eta_p^2 = .03$], or know responses for preexposed distractors ($F < 1$). Thus, source similarity selectively increased remember responses for preexposed items but had no significant effect on any other remember or know responses. Consistent with the source misattribution account, distractors were more likely to give rise to remembering when they were easily misattributed to the study context than when they were easily discriminated from the study context.

As in the previous studies, we examined IRK estimates of familiarity as well, in this case as a function of source condition for studied items and preexposed distractors. This analysis revealed an effect of item type [$F(1,80) = 27.73$, $MS_e = 0.99$, $\eta_p^2 = .26$], no main effect of source condition, and an interaction between the two variables [$F(1,80) = 9.88$, $MS_e = 0.35$, $\eta_p^2 = .11$]. In the dissimilar source condition, there was a significant difference between the studied items (M = .61, SD = .27) and preexposed distractors (M = .36, SD = .26) [$F(1,38) = 23.93$, $MS_e = 1.23$, $\eta_p^2 = .38$], but in the similar source condition studied items (M = .55, SD = .26) and preexposed distractors did not differ (M = .49, SD = .26) [$F(1,38) = 3.98$, $MS_e = 0.08$, $\eta_p^2 = .09$], although the effect was marginally nonsignificant ($p = .053$). Thus, in contrast to the raw know responses, IRK estimates of familiarity were affected by source similarity. Although our interests in the present study center on false remembering, this inconsistency between the results from the raw know responses and IRK estimates presents an interesting dilemma with respect to assessing familiarity. In this particular case, the raw know responses seem to provide a better assessment of familiarity because the IRK estimates are dependent on the level of remembering, which was intentionally influenced by the between-subjects experimental manipulation; that is, in this study we created a situation in which the effect of source similarity on remembering for preexposed distractors was so great that it had a dramatic effect on IRK estimates. Of course, the IRK procedure was intended to assess familiarity for studied items (Yonelinas, 2002; Yonelinas & Jacoby, 1995), so false alarms may represent a boundary condition with respect to applying the IRK procedure. Moreover, as discussed in the General Discussion, there are data indicating that know responses may be "contaminated" by contextual retrieval, suggesting that the measurement of familiarity is a difficult issue to address using the remember–know procedure.

GENERAL DISCUSSION

In three experiments, participants gave more false remember responses to distractors that had been experienced during a preexposure phase than to experimentally novel distractors. In Experiment 1, this result occurred under conditions in which the preexposed items were processed 2 days prior to the study list, and in a manner dissimilar to studied items. In Experiment 2, this result occurred under conditions in which the preexposed distractors were processed immediately before the study list, and in a manner similar to studied items. Experiment 3 showed that studying items from an episode that was more similar to the study context led to more reports of false remembering than did studying items from an episode that was dissimilar to the study context. These data show that source misattributions can lead to false remembering, providing a plausible explanation for the standard reports of false remembering. Of course, the adequacy of the source misattribution account must be considered not only in light of the present data, but in light of previously reported data as well. We turn to an examination of these issues forthwith.

Response Bias Effects

According to the source misattribution account, response bias effects occur for remember responses because there is a common basis for responding to both studied and new items (e.g., misrecollection of items from extralist sources). This is clearly shown in Figure 1, with both remember hits and false alarms being influenced by recollection of details from extralist sources, recollection of thoughts imagined during study, and partial recollection of features (e.g., synonymy) of studied items. An implication of this idea is that when participants can easily discriminate the study context from extralist contexts, remember hits should be based almost exclusively on recollection of the studied context. By contrast, if the studied items are not well bound to their study context, remember responses should be influenced by sources other than the recall of a specific item's presentation in the study list, and response bias effects will be more likely to operate on remember hits and false alarms (e.g., McCabe & Balota, 2007, Experiment 3). For example, when attention is limited at encoding, source discrimination should be poor, and remember false alarms should increase. This is consistent with findings showing that false remembering increases when attention is limited at encoding as a result of sedative–hypnotic drug administration (Huron, Giersch, & Danion, 2002), divided attention (Parkin, Gardiner, & Rosser, 1995), aging (McCabe, Roediger, McDaniel, & Balota, in press), amnesia (Knowlton & Squire, 1995), and Alzheimer's disease (Dalla Barba, 1998).

The finding that false remember responses increase when overall memory is poor does not mean that under these conditions participants consciously decide to accept items from extraexperimental sources when memory is poor. Rather, we suggest that when memory is poor, the criterion for what constitutes remembering may be more lax, so that even partial recollection of details associated with an item (e.g., "I remember thinking about *x* recently") may provide sufficient evidence to produce a remember response. These sorts of changes in the number of recollective details that are required for a remember response across conditions or participants provide a potential explanation of why remember response distributions show a graded quality (see Parks & Yonelinas, 2007, for a more detailed discussion of this issue).

Other recent findings showing response bias for remember responses can also be accounted for within the context of the source misattribution framework. For example, when the global test context (e.g., the background photo on the screen when a word was studied) matches, or is similar to, the context in which an item was presented at study, remember response bias effects are observed (Hockley, 2008). Similarly, when participants expect tested items to be of weaker overall memory strength, they give more remember responses (both old and new) than when they are expecting stronger items (McCabe & Balota, 2007). Finally, participants show a more liberal response bias when a three-option recognition decision is used (i.e., remember–know–new) rather than when successive binary decisions (old–new followed by remember–know; Hicks & Marsh, 1999) are used. According to the source misattribution account, these response bias effects on remembering may result, in part, from participants accepting as indicative of remembering contextual details from a source other than the study context.

Note, however, that changes in the use of remember responses across different contexts need not always reflect source misattribution. Bodner and colleagues (Bodner & Lindsay, 2003; Bodner & Richardson-Champion, 2007) have shown that participants define remembering differently, depending on the nature of the test context. For example, participants give more remember responses to items processed at a medium depth of processing when these items are tested in the context of shallowly processed items than when they are tested with deeply processed items (Bodner & Lindsay, 2003). Bodner and colleagues have proposed a functional account of remembering and knowing, according to which participants define remembering on the basis of whatever contextual details allow them to discriminate old and new items. These context effects are not consistent with the source misattribution framework, in that remembering can still be based on contextual retrieval in these cases, although the type, amount, or even source of those details may differ, depending on context.

One implication of the response bias and context effects considered thus far is that know responses should include recollective details, at least in some cases. Although the source misattribution account is primarily aimed at addressing remember judgments, any explanation of remember–know judgments must account for the nature of both responses. There is certainly mounting evidence that knowing is not "process pure." For example, evidence shows that participants make source memory judgments for know responses at above-chance levels, indicating that know responses are associated with some access to recollection of contextual details arising from the study episode (e.g., Hicks, Marsh, & Ritschel, 2002; Wais, Mickes, & Wixted, 2008). Thus, although we believe that remember responses are only made when participants can recollect contextual details, the converse—that know responses cannot contain recollection of contextual details—is not necessarily true.

Given the possibility that know responses are associated with retrieval of contextual information, one might wonder why participants would give a know response when contextual details are available. One possible explanation, alluded to previously, is that participants give know responses when they either do not have access to recollective details or have little confidence that the recollective details arose from the study episode. By this account then, in most cases "old" responses include some recollective details; but when those recollective details are comparatively less vivid, participants may decide to assign a know rather than a remember response. Considering that most know responses do reflect accurate discrimination of the study context from other contexts (i.e., know responses are above chance in terms of discrimination), it is not unreasonable to propose that there is some episodic context associated with those responses.

The Remember Mirror Effect

Another empirical regularity that has been troublesome for traditional process and systems accounts of remember–know judgments is the "remember mirror effect," which refers to the finding of higher remember hit rates and lower remember false alarm rates under conditions that yield higher levels of memory performance (Higham & Vokey, 2004; Wixted & Stretch, 2004). Higham and Vokey reasoned that

> the fact that new high-frequency words receive higher remember ratings than new low-frequency words, whereas the opposite is true of old words (Joordens & Hockley, 2000; Reder et al., 2000), suggests that familiarity is "leaking" into R [remember] judgments of new items (p. 734).

Our alternative explanation, on the basis of the source misattribution account, is that high-frequency words are likely to appear in more contexts than low-frequency words, so the likelihood that source confusions and false remembering will occur for high-frequency words is greater than it is for low-frequency words (although other factors will also affect these responses). Findings showing poorer source discrimination for high-frequency than for low-frequency words are consistent with this idea (Guttentag & Carroll, 1997).

The source misattribution account can also explain the remember mirror effect that occurs for variables other than word frequency. Wixted and Stretch (2004) reported evidence for a remember mirror effect for several variables, including levels of processing, divided attention, study duration, and retention interval. Like Higham and Vokey (2004), Wixted and Stretch suggested that remember responses were based on both recollection and familiarity; and indeed the crux of Wixted and Stretch's explanation was that participants cannot help but use a combination of recollection and familiarity when making a recognition decision. An alternative explanation, based on a source misattribution view, is that participants in the weaker condition shifted the basis of their remember responses, so they were more willing to base remembering on recollection of details from extralist sources. Indeed, as mentioned previously, in conditions in which memory for details from the study context is lacking, what constitutes remembering may differ dramatically from conditions in which rich contextual details are available (see, e.g., Bodner & Lindsay, 2003).

Remember False Alarms Are Made Faster and With Higher Confidence Than Know Hits

The finding that remember false alarms are sometimes made quickly and with high confidence has also been offered as support for the idea that remember hits and false alarms are both driven by familiarity, in addition to recollection (Higham & Vokey, 2004; Wixted & Stretch, 2004). The alternative explanation, according to the source misattribution account, is that the primary difference between remember hits and false alarms is that remember hits arise from the recollection of events from the experimentally defined study list, whereas false alarms arise at least partly from recollection of events from extralist contexts. As such, remember false alarms (although less common) are qualitatively quite similar to remember hits in terms of the level of confidence and response times (RTs) associated with these responses, because both types of responses reflect recollective experiences. Furthermore, because remember false alarms are typically based on recollection of events prior to the study episode, and therefore from the more distant past, these responses should be associated with slightly lower average confidence ratings and slightly slower RTs than studied items, which is the exact pattern reported by Wixted and Stretch.

Relation to Other Explanations of Remember–Know Judgments

Several variants of single-process and dual-process theories of remember–know have recently been proposed to explain the systematic effects of false remembering (e.g., Higham & Vokey, 2004; Parks & Yonelinas, 2007; Rotello et al., 2004; Wixted, 2007; Wixted & Stretch, 2004). Most of these models are based on the principles of signal detection and propose that remember–know judgments are based on a single dimension of memory strength, itself based either on a single memory process (Donaldson, 1996; Dunn, 2004) or two memory processes (e.g., recollection and familiarity; Wixted & Stretch, 2004). Although there appears to be little consensus on which model provides the best fit to the data, there are notable similarities and differences between the source misattribution framework proposed here and these other models. For example, the source misattribution account is consistent with dual-process models that suggest that remembering and knowing are not process-pure measures of recollection and familiarity arising from the study episode (Higham & Vokey, 2004; Rotello et al., 2005; Wixted & Stretch, 2004). However, the account is not consistent with the proposal that false remember responses result from familiarity in the absence of recollection. Instead—to reiterate—we argue that retrieval of contextual details accompanies all remember responses, but that contextual retrieval may arise from many sources, only one of which is the study episode (see Figure 1). In this sense, our framework is similar to so-called hybrid dual-process theories, like that of Yonelinas and colleagues (Parks & Yonelinas, 2007), who maintain that recollection is a high-threshold process (i.e., recollection of context either occurs or not).

Interestingly, although our framework is not consistent with a single-process model of remember–know judgments, occasionally proponents of these models have discussed these judgments in a manner quite similar to the present account. For example, Dunn (2008, p. 442) has recently suggested that remember and know judgments are metacognitive inferences about whether or not contextual details could be retrieved for a given item. When participants are subsequently asked to retrieve contextual details to support their recognition responses, participants may retrieve contextual details for remember but not for know judgments (Gardiner, Ramponi, & Richardson-Klavehn, 1998; Java, Gregg, & Gardiner, 1997); but according to this single-process account, the initial remember–know judgment was an inference based on memory strength about what could have been retrieved. The source misattribution account is similar, insofar as it proposes that remember–know judgments are metacognitive judgments regarding retrieval experiences associated with qualitatively different types of details; but it also suggests that participants complete the process of determining whether they can retrieve contextual details before deciding between a remember and a know response. Thus, it seems that with respect to understanding subjective experience there is more agreement between single-process and traditional dual-process proponents than there is regarding the nature of the memory processes related to remembering and knowing.

Relation to Other Explanations of False Remembering

The source misattribution account is similar, in principle, to source memory explanations of semantic false memories (see, e.g., Gallo, 2006, for a review). The task facing participants in experiments examining semantic false memories is made more difficult when new items intended to cue studied words are included. For example, in the DRM converging associates paradigm (Deese, 1959; Roediger & McDermott, 1995), the word *sleep* acts as a very effective retrieval cue for the items that were studied, such as *bed*, *rest*, *wake*, *tired*, and so on. Indeed, when remember–know instructions are modified to no longer make reference to recollection of "the word that came before or after the test item in the study list," false remember responses to the critical lures are reduced (Geraci & McCabe, 2006). Thus, there are data directly supporting the idea that distractors—albeit related distractors—can cue recollection of studied items. The data presented in Experiment 2 of the present study show that unrelated distractors can also lead to very high levels of false recollection. Thus, the same general principle (i.e., source misattribution) can be used to explain the typically low levels of false remembering of unrelated words in standard recognition experiments, and the high levels of false remembering in associative false memory paradigms. The source misattribution account extends these previous explanations to include source confusions arising from extralist sources, in addition to intraexperimental sources.

Critics of the present work might argue that there is nothing particularly novel about applying a source misattribution account to understanding false remembering. However, the situation under investigation here, in which participants report that they remember studying a familiar but unrelated and unstudied word, has posed a considerable theoretical challenge to traditional process and systems accounts of remembering and knowing. Indeed, the various findings just reviewed (e.g., response bias effects, speed of confidence judgments) have been considered by some to be inconsistent with traditional process and systems accounts of remember–know judgments. The unique theoretical contribution of the source misattribution account is that it demonstrates that new items that are unrelated to items from the study list can cue recollective experiences (i.e., remembering). This framework allows for the possibility that traditional systems or process approaches can account for the various patterns of data just reported, including false remember responses to unstudied items (e.g., the present experiments), remember mirror effects, and RT and confidence judgments for remember false alarms. As such, the source misattribution account directly addresses the regular, but previously unexplained, reports of false remembering for unrelated false alarms, particularly given that these are the precise data that have been used to argue against traditional systems and process accounts (e.g., Rotello et al., 2005; Wixted & Stretch, 2004).

Another theoretical implication of the source misattribution account presented here concerns the use of remembering and knowing as estimates of recollection from a dual-process memory perspective. Some have argued that response bias effects suggest that the remember–know procedure is not process pure, and therefore cannot be used to measure a recollection process (e.g., Rotello et al., 2005). However, the data presented here, and the source misattribution account, suggest otherwise. If remember false alarms reflect recollection from nonstudied contexts, and remember hits reflect recollection from studied and nonstudied contexts, using a measure that calculates the difference between remember hits and false alarms (e.g., remember d') will provide a valid measure of a recollection process related to the study context. This is made clear by examining Figure 1, which shows that remember hits are based on all of the same factors as remember false alarms, plus retrieval of details from the study context. Removing the influence of remember false alarms from remember hits should provide an accurate estimate of retrieval of recollective details from the study context. Individual differences research appears to support this idea, with age and ability measures (e.g., frontal or executive functioning) being more strongly related to measures of remembering that measure the difference between remember hits and false alarms (e.g., d' or A'; Bugaiska et al., 2007; McCabe et al., in press).

The idea that remember responses can provide an estimate of contextual recollection stands in contrast to signal detection explanations of remember judgments that indicate that these responses can be based on recollection *or* familiarity (Higham & Vokey, 2004; Wixted, 2007; Wixted & Stretch, 2004). According to recent dual-process signal detection models, although remember responses may reflect recollection of details, or a mixture of recollection and familiarity, they can also be based on high levels of familiarity. The idea that remember responses are based on high levels of memory strength provides an adequate account of certain systematic remember–know findings in the literature, but any comprehensive account of false remembering must explain why new items that are unrelated to studied items lead to the subjective experience of conscious recollection.

Because signal detection based models of remember–know judgments allow for the possibility that high levels of familiarity can cue remember judgments, we believe they are limited with respect to fully explaining remember judgments. From the perspective of understanding subjective experience, it seems strange to us to assume that a familiarity process contributes to remember judgments (Cohen, Rotello, & Macmillan, 2008; Higham & Vokey, 2004; Rotello et al., 2004; Wixted & Stretch, 2004), considering that familiarity is defined as a retrieval process that is devoid of contextual details (Cohen et al., 2008; Rotello & Macmillan, 2006; Wixted, 2007; Wixted & Stretch, 2004; Yonelinas, 2002). From our perspective, signal detection models can be quite useful for understanding many aspects of recognition memory, but the way in which memory strength is related to subjective experience remains to be fully explicated by proponents of memory strength based explanations of remember–know judgments (see Wixted, 2007). We believe that there needs to be some distinction between qualitatively different types of retrieval, in order for any account of remembering and knowing to accord with subjective experience.

Our source misattribution account assumes that remember judgments reflect valid reports of contextual retrieval, with the caveat that this retrieval may not arise from the study episode. On the basis of this assumption, our primary goal has been to explain why participants claim to recollect contextual details for items that had not been presented during the study episode. An alternative perspective suggests that this assumption itself is untenable, and that instead participants are unable or unwilling to follow remember–know instructions (Dunn, 2008; Wixted, 2007). However, the only data available to date that have directly asked participants to report the types of information retrieved for remember–know judgments support the idea that remember judgments do reflect subjective experiences of recollection; specifically, when asked to report the bases for their recognition judgments, participants readily report retrieving contextual details for items for which they give remember responses but not for those items for which they give know responses (Gardiner et al., 1998; Java et al., 1997). Thus, to the extent that this issue has been directly addressed, the data support the validity of remember responses as measures of contextual retrieval. On the basis of the assumption that participants use remember–know judgments as instructed, our goal was to provide a plausible explanation for why they would claim that items that were not presented were accompanied by contextual retrieval. To reiterate, this is a metacognitive approach in which we are treating remember judgments as data to be explained (Nelson, 1996). As such, our goal was to provide a plausible explanation for the phenomenon of false remembering.

CONCLUSION

The source misattribution account of false remembering has been presented here as an explanation for the finding that participants experience autonoetic retrieval for new items on a recognition test (cf. Gardiner, 2001; Rajaram, 1998; Rajaram & Geraci, 2000). According to this account, rather than supposing that participants can perfectly report the memory processes that are influencing performance, we take the view that participants are imperfect metacognitive monitors of performance (Nelson, 1996) and that remember–know judgments are subject to systematic distortions and biases just like any other metacognitive judgment (Koriat, 1997; McCabe & Balota, 2007). Despite this fact, the remember–know paradigm should not be dismissed as uninteresting simply because in some cases subjective experience and so-called objective indices are not perfectly correlated. Rather, systematic distortions from the patterns of data that depart from what would be expected need to be explained by any comprehensive account of remembering and knowing, or memory more generally. The source misattribution account has the advantage of being consistent in explaining subjective experiences associated with remembering and knowing, while being compatible, in principle, with traditional process and systems models of remember–know judgments.

AUTHOR NOTE

We thank Nicolas Soderstrom for assistance with data input. We also thank the WRAMP (Writing, Reading, and Manuscript Preparation) workshop at Colorado State University for comments and suggestions on the final revision of this article. Correspondence concerning this article should be addressed to D. P. McCabe, Department of Psychology, Colorado State University, Fort Collins, CO 80523-1876 (e-mail: david.mccabe@colostate.edu) and/or L. Geraci, Department of Psychology, Texas A&M University, College Station, TX 77843-4235 (e-mail: lgeraci@tamu.edu).

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NOTE

1. The term *experimentally novel distractors* refers to the typical distractors that would be used in an experiment. These distractors are novel in that they have not been presented in the experiment, but they are nonetheless familiar words, so are not novel in this "extralist" sense.

(Manuscript received July 24, 2008;
revision accepted for publication October 20, 2008.)