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Evidence that nonconscious processes are sufficient to produce false memories

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Abstract

Are nonconscious processes sufficient to cause false memories of a nonstudied event? To investigate this issue, we controlled and measured conscious processing in the DRM task, in which studying associates (e.g., *bed*, *rest*, *awake*...) causes false memories of nonstudied associates (e.g., *sleep*). During the study phase, subjects studied visually masked associates at extremely rapid rates, followed by immediate recall. After this initial phase, nonstudied test words were rapidly presented for perceptual identification, followed by recognition memory judgments. On the perceptual identification task, we found significant priming of nonstudied associates, relative to control words. We also found significant false recognition of these nonstudied associates, even when subjects did not recall this word at study or identify it at test, indicating that nonconscious processes can cause false recognition. These recognition effects were found immediately after studying each list of associates, but not on a delayed test that occurred after the presentation of several intervening lists. Nonconscious processes are sufficient to cause this memory illusion on immediate tests, but may be insufficient for more vivid and lasting false memories.

Keywords: Nonconscious activation; False recognition without identification

1. Introduction

Memory can influence our thoughts and behaviors even when we are not consciously aware of this influence. For instance, the ability to perceive a perceptually degraded picture can be facilitated by an earlier encounter with this picture, even if one cannot explicitly remember this prior occurrence (Mitchell, 2006). Numerous other studies have demonstrated that memory can nonconsciously prime performance, using a variety of implicit memory tasks that are relatively insensitive to more conscious forms of memory (e.g., Roediger & McDermott, 1993; Schacter, 1987). There is no unquestionable evidence, though, that nonconscious processes are sufficient to cause false memories for nonstudied events. In perhaps the strongest evidence for such nonconscious effects,

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Jacoby and Whitehouse (1989) found that the false recognition of nonstudied words could be increased by briefly flashing a prime word just prior to the recognition decision. However, although the prime was initially thought to exert a nonconscious influence on the memory decision, subsequent research indicates that some minimal conscious processing of the primes may be necessary (see Bernstein & Welch, 1991; Higham & Vokey, 2000). These and other findings raise questions about whether nonconscious processes can cause false recognition. More generally, it is often difficult to distinguish between memory processes that occur completely nonconsciously and those that occur with minimal conscious awareness, making the role of nonconscious processes on false memories difficult to determine.

More recent research has tried to isolate the influence of nonconscious processes on false memory creation using the Deese, Roediger, and McDermott (DRM) procedure (Deese, 1959; Roediger & McDermott, 1995). In this task, subjects study lists of words (e.g., *bed*, *rest*, *awake*, etc.) that are semantically associated to critical nonpresented word (e.g., *sleep*). On subsequent tests, subjects are more likely to falsely remember the nonstudied critical words, relative to unrelated control words (see Gallo (2006), for a review of the research on this illusion). In the first study to explore nonconscious processes using this illusion, Seamon, Luo, and Gallo (1998) presented DRM lists at extremely rapid presentation rates (approximately 20 ms per word). Even though recognition of studied items was at chance levels, they found significant false recognition of critical words (relative to unrelated words). Seamon et al. (1998) argued that the lists were presented too rapidly for conscious generation of the critical words at study, and because memory for studied items was at chance, nonconscious processes created this memory illusion. As one explanation, they argued that studied associates nonconsciously activated the critical word, via spreading activation in semantic memory, and this activation was later confused with actual presentation in the study list.

The conclusions of Seamon et al. (1998) have been questioned for at least two reasons. First, from the semantic priming literature, it is clear that activation of one word from the brief presentation of another word tends to be short-lived, lasting only several hundred milliseconds (for relevant discussion, see Roediger, Balota, & Watson, 2001). Thus, unless the critical word is consciously generated, rehearsed, and encoded into episodic memory during the study phase, nonconscious activation at study is unlikely to cause DRM false recollections over longer retention intervals lasting up to several weeks (e.g., Seamon et al., 2002; Toglia, Neuschatz, & Goodwin, 1999). Second, as pointed out by Zeelenberg, Plomp, and Raaijmakers (2003), chance recognition of some of the studied words is relatively weak evidence for nonconscious processess. It may have been that subjects consciously processed some of the list items, but these items were not tested in the subsequent recognition phase. If so, then conscious processes occurring at test may have caused false recognition. Gallo and Seamon (2004) proposed one such mechanism, in the form of test-based associative activation. The presentation of the critical word at test might have cued the recollection of those studied associates that were actually perceived, and these recollections might, in turn, have activated the critical word.[1] Such resonant activation could occur automatically and nonconsciously, as predicted by spreading activation models, leaving the subject with a feeling of familiarity toward the critical word. Alternatively, the recollection of related words may have simply caused subjects to guess that the critical word was studied, in the absence of any nonconscious activation of the critical word. Although such associatively-based guessing strategies cannot explain the typical DRM false memory illusion (see Gallo, 2006), these strategies may play a larger role in situations where encoding is extremely impoverished, as in the rapid presentation procedures used by Seamon et al. (1998).

Motivated by these concerns, Gallo and Seamon (2004) developed a stronger test of the nonconscious activation hypothesis. As in Seamon et al. (1998), they rapidly presented DRM lists to subjects, using masked visual presentation. Rather than assuming that these procedures eliminated the conscious generation of critical words at study, Gallo and Seamon (2004) attempted to measure such activation. Immediately after the rapid presentation of each list (presenting all 15 associates in less than 2 s), subjects were asked to write down every word that they perceived in the list. (This test can be considered a perceptual identification test, but because it occurred after the presentation of all 15 associates, we will refer to it as a recall test.) Consistent with the assumptions of Seamon et al. (1998), subjects rarely falsely recalled the critical word, suggesting that the rapid

[1] This test-based activation hypothesis differs from the idea that the related lure can be activated at test by other associates presented on the test. There is mixed evidence for this latter process (e.g., Marsh, McDermott, & Roediger, 2004), and some have argued that processing studied associates at test can actually suppress false recognition (see Brainerd, Reyna, & Kneer, 1995).

presentation technique made it unlikely that subjects would consciously generate nonstudied words. However, consistent with the concerns of Zeelenberg et al. (2003), subjects did report seeing several of the list words (on average, about 8% of the list words were generated on the immediate recall test). Further, perceiving these list words was related to subsequent false recognition of the critical word on a two-alternative forced-choice test: When no list items were initially perceived, false recognition was at chance (49%), but false recognition increased as more list items were initially perceived (57% with 1 item, 64% with 2 items, and 78% with 3 or more items). Gallo and Seamon (2004) argued that subjects could have consciously recollected these list words at test, using the critical word as a retrieval cue. These recollections, in turn, could have caused false recognition either by (1) nonconsciously activating the critical word or (2) causing subjects to guess that the critical word was studied (in the absence of nonconscious activation). Given these possibilities, Gallo and Seamon (2004) concluded that there was yet no direct evidence for nonconscious activation producing DRM false memories.

Although associatively based guessing strategies could explain prior results, they cannot explain results reported by Cleary and Greene (2004). Subjects studied DRM lists and were tested using a recognition-without-identification procedure, in which critical words were rapidly presented for perceptual identification, followed by a recognition judgment. Cleary and Greene (2004) found that critical words that were not consciously identified at test were more likely to be judged as presented in the study lists than were unrelated words. Because critical words were not consciously identified at test, subjects could not be sure that the critical word was associated to some of the studied words, and so the test-based associative guessing process described by Gallo and Seamon (2004) does not apply. This finding provides evidence that the conscious recollection of studied associates at test is unnecessary for DRM false recognition. Importantly, though, no steps were taken to minimize conscious activation of critical words during the study phase in this study. In fact, Cleary and Greene (2004) argued that such study-based activation might have caused their recognition-without-identification results.

In sum, prior research has attempted to minimize conscious processes occurring at study (e.g., Gallo & Seamon, 2004) or at test (e.g., Cleary & Greene, 2004), but no study has attempted to minimize conscious processes occurring at both study *and* test. As such, there is no unequivocal evidence for the nonconscious activation of false memories. The current study was a logical extension of these prior studies, combining the methodologies of Gallo and Seamon (2004) and Cleary and Greene (2004) in order to control conscious processes occurring at both study and test. As in Gallo and Seamon (2004), subjects studied DRM lists at a rapid presentation rate (40 ms per word, masked) and then immediately tried to recall all of the items that they perceived. In the recognition-without-identification trials, critical words were briefly presented (20 ms, masked) for perceptual identification and recognition judgments. This procedure allowed us to minimize conscious generation of critical words at study and exclude those few instances where critical words were falsely recalled. It also allowed us to minimize (and exclude) conscious identification of critical words during the recognition test. To investigate the longevity of these effects (i.e., their ability to persist over a delay filled with potentially interfering lists), identification-and-recognition trials were presented either immediately after each list or in a delayed testing block after all lists were studied and recalled. We also included a slow study rate (2 s per word), along with our rapid rate, to approximate more typical DRM experiments. By accounting for conscious processes at study and test, this experiment provided the strongest possible test of the nonconscious activation hypothesis.

2. Methods

2.1. Subjects

Eighty Wesleyan University undergraduates, 17–21 years of age, participated for psychology credit ($n = 20$ per condition). None had participated in any related memory research.

2.2. Materials

We used the same 36 DRM lists as Gallo and Seamon (2004). Each list contained 15 associates to a nonstudied critical word. For each subject, only one of two randomly counterbalanced sets of 18 lists was studied. All stimuli were presented on PowerMac G3 computers using PsyScope software and CRT monitors.

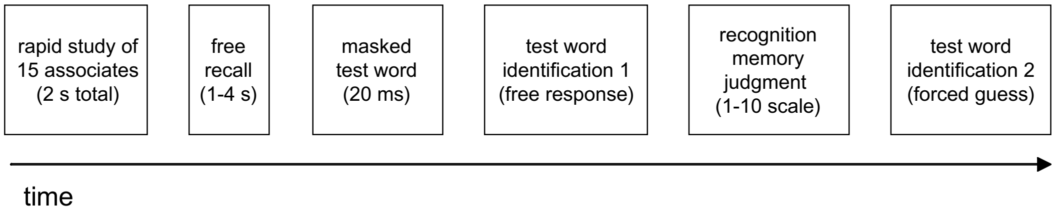

Fig. 1. Temporal sequence of events in the 40 ms condition/immediate test. After studying each list of 15 items (approximately 2 s), subjects attempted to recall the items, and then attempted to identify the test word. Following this first identification attempt, they made a recognition decision, and then made a second identification attempt.

2.3. Procedure

In order to illustrate the procedure, Fig. 1 outlines the sequence of events for subjects in the rapid study/immediate test condition. Half of the subjects saw list words presented sequentially at a 40 ms rate, and half saw the words at a 2 s rate. Each list word was presented in 55-point font in the center of the screen, preceded and followed by a 65-point font pattern mask (&#&#&#&#&#&) for 80 ms that covered the letters of each word. The mask made it difficult to see the list words in the 40 ms condition. Immediately after each list, the subjects provided self-paced written free recall of that list. If no words were perceived, the subjects were instructed to write the word "none."

In each presentation rate condition, half of the subjects were presented with two identification-and-recognition trials immediately after recalling each list (the immediate test condition), whereas the other subjects were given surprise identification-and-recognition trials only after all lists had been studied and recalled (the delayed test condition). For each list, there were two identification-and-recognition trials, one for a related critical word and one for an unrelated critical word. In the immediate test condition, the order of the trials was randomized so that each item (related or unrelated word) occurred first or second equally often. For the delayed test condition, similar procedures were used, except that all 36 trials were randomly presented after all of the lists had been studied and recalled. Because the subjects did not know of the delayed test, they had no incentive to rehearse the list words (and potentially generate a critical word) after list recall. Following Gallo and Seamon (2004), test trials did not include studied words to avoid the possibility that these words could activate critical words.[2]

Each identification-and-recognition trial consisted of the following four parts, following Cleary and Greene (2004). First, a nonstudied critical word was presented for 20 ms, preceded and followed by the same 80 ms pattern mask used during study. Second, the subjects were asked to identify and write the briefly presented critical word. If they could not identify the word, they were told to write "none." Third, regardless of their initial identification response, the subjects were asked to rate their belief that the briefly presented word was a member of a preceding study list on a scale of 1 (definitely not studied) to 10 (definitely studied). Finally, without seeing the word again, the subjects were once more asked to identify and write the previously exposed critical word. If they had previously written the word "none," they were asked to provide their best guess, even if it was just the first word that came to mind. This second identification attempt helped to ensure that subjects were not withholding possible correct responses due to insufficient confidence or a high response criterion. We considered a word to be correctly identified if it was reported on either attempt. If an incorrect guess was rendered on the second attempt, we assumed that the test word was not consciously perceived.

[2] On Cleary and Greene's (2004) identification-and-recognition test, associates were always tested immediately prior to critical words, permitting the possibility that such activation could have contributed to their false recognition-without-identification result. Although this effect would have been present for both related and unrelated critical words in their experiment, and thus should not have affected the comparison between these two items, the possibility of such activation was eliminated altogether in our experiment.

3. Results and discussion

3.1. Immediate recall

Table 1 shows the proportions of list words and related critical words recalled immediately after list presentation in each exposure condition (40 ms or 2 s per word). Note that, in the 40 ms condition, each list of 15 items was presented in less than 2 s, so that this immediate recall test was more like a perceptual identification test. Because list word recall always preceded the identification-and-recognition trials for each list, we collapsed the recall results over the delay manipulation (this variable did not influence the recall results). A 2 (item type) × 2 (study rate) ANOVA revealed a main effect of item type, $F(1,78) = 146.11$, $MSE = 2.15$, $p < .001$, indicating that true recall of list words was greater than false recall of critical words. There also was a main effect of exposure duration, $F(1,78) = 98.87$, $MSE = 1.64$, $p < .001$, and a significant interaction $F(1,78) = 80.68$, $MSE = 1.19$, $p < .001$. True recall of list words increased from 40 ms to 2 s, $F(1,155) = 179.48$, $MSE = .02$, $p < .001$, but false recall of critical words did not, $p > .25$.

This differential effect of presentation rate on true and false recall is consistent with McDermott and Watson (2001), and our means are almost identical to theirs for comparable conditions. McDermott and Watson (2001) argued that subjects are less likely to consciously generate critical words at extremely fast presentation rates (as in our 40 ms condition) relative to slower rates (as in our 2 s condition). However, with slower presentation rates, subjects also are more likely to realize that the critical word was not presented, thereby counteracting activation processes with enhanced source monitoring (see also Gallo & Roediger, 2002). To investigate this issue, we correlated the true and false recall rates across subjects. For the 40 ms condition, we found a positive correlation, $r(40) = +.76$, $p < .01$, suggesting that as more list words were perceived, the critical word was more likely to be activated. This finding replicates the relationship observed by Gallo and Seamon (2004) that was discussed in the Introduction. In contrast, we found a negative correlation in the 2 s condition, $r(40) = -.43$, $p < .01$. This reversal suggests that additional processing of the list words in this condition helped subjects to monitor critical words (see Gallo (2006), for other evidence that such monitoring processes contribute to the DRM task). Given this possibility, the probability of recalling critical items in the 2 s condition potentially underestimates the frequency that subjects actually thought of these items during study, and so this condition does not provide a strong test of the nonconscious activation hypothesis. Of course, this interpretative limitation does not apply to the more critical rapid presentation condition. As in Gallo and Seamon (2004), we assume that subjects in this condition would have written down any word that they believe might have been in the list (including critical words), because the words were so difficult to perceive.

3.2. Critical word identification

Table 2 presents the proportions of related and unrelated critical words that were correctly identified on the identification-and-recognition trials. As discussed, we considered a word to be correctly identified if it was reported on either the first (free response) or the second (forced response) attempt (see Fig. 1). Because we were interested in nonconscious activation processes, this table (and all subsequent analyses) includes data only for critical words that were not falsely recalled immediately following list presentation (approximately 85% of the data). A 2 (item type) × 2 (rate) × 2 (test delay) ANOVA showed that the proportion of correctly identified related critical words was higher than unrelated critical words, $F(1,76) = 67.14$, $MSE = .68$,

Table 1
Recall proportions of list words and related critical words

	List words	Related critical words
Study exposure duration (40 ms)	.20	.13
Study exposure duration (2 s)	.57	.17
Mean	.38	.15

Note. Noncritical recall intrusions were rare and tended to be misperceptions.

Table 2
Correct identification proportions for critical words that were not consciously generated at study

	Related critical words	Unrelated critical words
Study exposure duration (40 ms)		
Immediate identification test	.58	.49
Delayed identification test	.54	.47
Study exposure duration (2 s)		
Immediate identification test	.61	.30
Delayed identification test	.48	.43
Mean	.55	.42

$p < .001$. This effect interacted with presentation rate, $F(1, 76) = 9.05$, $MSE = .09$, $p < .005$, and the delay manipulation, $F(1, 76) = 20.64$, $MSE = .21$, $p < .001$. These interactions indicate that the priming of critical word identification was largest in the 2 s study exposure duration and on the immediate test, potentially because these conditions provided the strongest levels of activation of the critical words, although this condition also had a lower base rate than the other conditions. No other main effects or interactions were significant.

To follow-up these interactions, *t*-tests revealed that the difference between related and unrelated critical words was reliable for each exposure duration and test delay condition shown in Table 2, all p's $< .05$. These differences represent implicit priming of the perceptual identification of critical words, following both standard and rapid study list presentation, and they extend other DRM priming demonstrations (McDermott, 1997; Tse & Neely, 2005). Importantly, unlike these previous priming effects, the effects observed in the current study cannot be attributed solely to the conscious generation of critical words during the study phase. Even when we presented list words extremely rapidly, and excluded those trials where critical words were consciously generated on the immediate recall test, we found significant priming of critical words. These effects are relevant to the nonconscious activation hypothesis, and we discuss their implications in the General Discussion, after presenting the recognition results.

3.3. Critical word recognition

The most important data for the nonconscious activation hypothesis are the recognition judgments that were made after subjects attempted to identify the test word. For each judgment, the subjects rated their belief that the test word had been presented in a study list. Table 3 presents the mean recognition ratings for related and unrelated critical words, again including only those critical words that were not falsely recalled immediately following list presentation. Results were analyzed separately for correctly identified and unidentified critical words, with unidentified critical words defined as words that were not identified on the first opportunity

Table 3
Mean list-membership ratings for critical words that were not consciously generated at study, as a function of whether they were consciously identified at test

	Not correctly identified		Correctly identified	
	Related	Unrelated	Related	Unrelated
Study exposure duration (40 ms)				
Immediate recognition test	5.19	3.88	7.56	3.93
Delayed recognition test	4.14	3.96	6.76	4.45
Study exposure duration (2 s)				
Immediate recognition test	5.21	4.86	4.62	2.55
Delayed recognition test	4.73	4.80	6.06	2.86
Mean	4.82	4.37	6.25	3.45

Note. Ratings were based on a scale of 1 (definitely not studied) to 10 (definitely studied).

(subjects wrote ''none'') and guessed incorrectly on the second opportunity. Trials in which subjects incorrectly identified critical words on the first opportunity (17.5% of all trials) were omitted because the subjects would have been rating an incorrect word. Because the second opportunity occurred after the ratings judgments and were forced guesses, these guesses should not have affected the recognition ratings. Of course, in the unlikely event that subjects already had these incorrect guesses in mind while making their recognition decisions, this would have worked against our ability to find a systematic effect of the actual test word on recognition judgments. Said differently, our recognition-without-identification procedures were very conservative, and so they potentially underestimated the effects of nonconscious activation on false recognition.

The crucial results for the nonconscious activation hypothesis are the recognition ratings for critical words that were not correctly identified. On these trials, related critical words were rated as more likely to have been studied than unrelated critical words, $F(1,66) = 6.09$, $MSE = 6.82$, $p < .02$. In addition, there was an interaction of delay manipulation and word type, $F(1,66) = 4.61$, $MSE = 5.16$, $p < .05$. Related critical words (5.20) were rated higher than unrelated critical words (4.37) on the immediate test, $F(1,66) = 10.18$, $MSE = 1.12$, $p < .005$, but there was no difference between related (4.43) and unrelated (4.38) critical words on the delayed test, $F < 1.0$. No other effects or interactions were significant. These results demonstrate a false recognition-without-identification effect when critical words were tested immediately after each list was studied, but not on the delayed test. The effect found on the immediate test conceptually replicates the false recognition-without-identification effect of Cleary and Greene (2004), and extends this effect to conditions where the critical word was not consciously generated at study. The fact that this effect did not persist on the delayed test was potentially due to interference from the intervening lists, a point that we discuss more fully in the General Discussion.

Overall, false recognition ratings were greater when critical words were correctly identified than when they were not, replicating Cleary and Greene (2004). For correctly identified words, related critical words were rated as studied more than unrelated critical words, $F(1,66) = 100.28$, $MSE = 271.10$, $p < .001$. This finding is analogous to the typical DRM relatedness effect on false recognition when test words are clearly presented. We also found that correctly identified critical words were more likely to be falsely recognized in the 40 ms condition (5.67) than the 2 s condition (4.02), $F(1,66) = 26.25$, $MSE = 93.95$, $p < .001$. This effect might seem surprising, given that the 2 s condition should have provided more activation of the critical word than the 40 ms condition. However, as discussed, our recall results suggest that subjects were more likely to consciously monitor the activation of critical words in the slow than the fast condition, and thereby realize that these words were not actually presented (see Gallo & Roediger, 2002; McDermott & Watson, 2001). Similar processes may have contributed to the recognition results in the 2 s condition. No other effects or interactions were significant.

4. General discussion

Our results suggest that nonconscious activation can be sufficient to cause false recognition. The most important results were obtained from the condition where study lists were rapidly presented, thereby minimizing the conscious activation of critical words. Considering only those trials where critical items were not generated on the immediate recall test, we found two pieces of evidence for nonconscious activation. First, we found significant priming of critical words on the perceptual identification test. This priming effect likely was caused by conceptual activation of the critical word, analogous to conceptual priming effects sometimes found in perceptual identification tasks (e.g., MacLeod & Masson, 1997) as well as other implicit memory tasks (see Roediger & McDermott, 1993). Of course, perceptual identification is not the same as episodic memory, and so these priming effects are only indirectly relevant to the idea that nonconscious activation can cause false memories. That hypothesis was more directly tested using the recognition-without-identification procedure, and consistent with the hypothesis, we found significant false recognition of critical words even when they could not be identified at test. Because these items were not consciously generated at study or at test, this result provides the strongest evidence to date that nonconscious processes can cause false memories.

It is important to note that our perceptual identification results were obtained on both the immediate and delayed tests, but the recognition-without-identification results were only obtained on the immediate tests. The most likely explanation for this discrepancy is item-selection effects inherent to the recognition-without-identification procedure. Whereas all of the test items were presented for perceptual identification, only those items that were not correctly identified (by definition) contributed to recognition-without-identification. If priming on the perceptual identification test was due to high levels of associative activation, then only items with weaker levels of associative activation would have contributed to the recognition-without-identification analysis. This activation difference could explain why the recognition-without-identification results were weaker than the perceptual identification results (i.e., less likely to last across the delay filled with potentially intervening lists), and it highlights the fact that the recognition-without-identification procedure provides an *underestimate* of the contribution of nonconscious processes to performance. In fact, given this item-selection artifact, and given that our rapid presentation procedures at study further limited the degree of activation of the critical word, our finding of significant recognition-without-identification on the immediate test becomes even more impressive.

The fact that our recognition-without-identification findings were only obtained on the immediate test also might be attributed to the nature of semantic priming. As discussed in the Introduction, semantic priming effects tend to be short-lived, and a recent study by Meade, Watson, Balota, and Roediger, 2007 confirmed that priming of DRM critical words on a lexical decision task was obtained on an immediate test (after each list was presented) but not on delayed tests. In contrast, false recognition results were obtained at all delays. Like Gallo and Seamon (2004), they argued that associative activation at test might be the cause of long lasting false recognition effects. Our recognition-without-identification results are not inconsistent with these ideas, although the priming of critical words on the perceptual identification test did last beyond our immediate tests. The duration of these priming effects has yet to be tested, but they also might be relatively short-lived, compared to more standard false recognition effects. For instance, Hicks and Starns (2005) failed to find priming of DRM critical words on a perceptual identification task similar to ours, with the potentially important difference that they included a 2-min digit distracter task, as well as several practice and filler trials on their identification test. These additional procedures may have interfered with activation of the critical words, thereby limiting the ability of Hicks and Starns (2005) to find significant priming effects. Obviously, any other number of procedural differences between these studies may have contributed to differences in outcomes. The only firm conclusion that we can draw from our results is that our procedures were adequate to detect significant priming of critical words on a perceptual identification task, as well as significant false recognition-without-identification.

In conclusion, we went to extreme measures to ensure that conscious processes could not contaminate our results, and nevertheless we found significant false recognition of nonpresented words in some conditions. We also replicated more typical DRM false recognition effects (i.e., slow presentation rate, consciously identified test items), but obviously the recognition-without-identification procedure is different than the typical DRM task. False-recognition-without-identification is a subjectively weaker form of false recognition, in the sense that false recognition obtained on more explicit memory tests tends to be accompanied with a strong subjective sense of "remembering" and tends to be long lasting. In these latter situations, and likely in many nonlaboratory situations, false recognition is ultimately a conscious phenomenon, because subjects must consciously decide whether a specific event was studied based on some consciously experienced subjective state (e.g., familiarity). The present results do, however, make an important theoretical contribution to our understanding of these more typical false recognition effects, by showing that nonconscious processes can be sufficient to cause a false recognition decision. The current results therefore echo the ideas initially proposed by Jacoby and colleagues, some of which were discussed in the Introduction, in raising the intriguing possibility that processes occurring outside our conscious awareness can be an important determinant of false memory creation.

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