Recollection-based recognition eliminates the revelation effect in memory

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The *revelation effect* refers to the tendency to call an item on a recognition test *old* if it is preceded by a cognitive task that involves the processing of a similar stimulus (Watkins & Peynircioğlu, 1990). It has been proposed that the revelation effect occurs because of an increase in the familiarity of the test items in the revelation condition (Luo, 1993; Westerman & Greene, 1998). In the present experiments, the revelation effect was investigated in recognition tasks that were not based solely on the familiarity of the test items but, also, on a recall-like retrieval process. A revelation effect was not found on an associative-recognition task or on a plurality recognition task. The results of this study show that the revelation effect does not occur when the contribution of familiarity to recognition decisions is reduced by factors that encourage the recollection of the study episode.

Lately, a great deal of attention has been devoted to trying to understand the factors that lead a person to claim to remember something that did not actually occur (e.g., Hyman & Pentland, 1996; Pezdek, Finger, & Hodge, 1997; Read, 1996; Roediger, 1996; Zaragoza & Mitchell, 1996). Numerous studies have demonstrated that so-called *memory illusions* can be brought about by specific *encoding* conditions. For instance, it is well known that studying a list of conceptually related words, such as, *bed*, *dream*, and *pillow*, will make a person likely later to (incorrectly) recall or recognize the word *sleep* (e.g., Deese, 1959; Payne, Elie, Blackwell, & Neuschatz, 1996; Roediger & McDermott, 1995; Tussing & Greene, 1997).

Memory illusions can also occur because of factors that influence the memory *test* (see, e.g., Jacoby & Whitehouse, 1989; Lindsay & Kelly, 1996; Reinitz, Lammers, & Cochran, 1992; Whittlesea, 1993; Whittlesea, Jacoby, & Girard, 1990). One robust finding that has been demonstrated primarily on tests of recognition memory is the *revelation effect* (Watkins & Peynircioğlu, 1990). As it was originally reported, the revelation effect referred to the finding that a word on a recognition test will tend to be called *old* (i.e., previously studied) if it first appears in a distorted fashion—for instance, as a word fragment or as an anagram (e.g., *rcukt*)—and the research participant has to solve the word by putting it into its correct form (*truck*) prior to the recognition judgment. The tendency to claim that items that are revealed had been presented previously occurs both for items that actually had

been presented (targets) and for items that had not been presented (lures); however, the magnitude of the revelation effect is typically larger for lures than for targets (see Hicks & Marsh, 1998, for a meta-analysis). As a result, revealing an item on a recognition test leads to a greater increase in false alarms than in hits; therefore, recognition performance tends to be less accurate in the revelation condition. Recent research has shown that the term *revelation effect* appears to be a misnomer, since the effect does not depend on the revelation of the test word and has been found with a variety of tasks interleaved among test trials. A revelation effect has been found when the word that was revealed was not the word that was subsequently recognized but, rather, a different word that had not been presented on the study list and that bore no apparent relationship to the test word. For instance, unscrambling an anagram of the word *vineyard* made participants more likely to claim that a different test word that followed it, such as *raindrop*, had been previously studied, as compared with test words that did not follow an anagram task (Westerman & Greene, 1996). Other cognitive tasks, such as counting letters, generating synonyms, and recalling a short list of letters, have also been found to produce a revelation effect. That is, test items that immediately followed these tasks were more likely to be called *old* than were test items that did not follow these tasks (Westerman & Greene, 1998).

A theoretical explanation of the revelation effect has been elusive. One possible explanation is that the cognitive task that is performed during the revelation phase somehow increases the familiarity of the test item that follows it (LeCompte, 1995; Luo, 1993; Peynircioğlu & Tekcan, 1993; Westerman & Greene, 1998). Evidence in support of this notion was reported by LeCompte, who conducted experiments that used the remember/know procedure (Tulving, 1985) and the process dissociation technique (Jacoby, 1991) to study the contribution of familiarity to recognition decisions in revelation effect experiments.

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The results of LeCompte's experiments were consistent with the idea that the revelation task increases the familiarity of the test item that follows it; both procedures yielded higher familiarity estimates for test items in the revelation condition. Several investigators (Luo, 1993; Peynircioglu & Tekcan, 1993) have suggested that an enhanced sense of familiarity for revealed test items might be due to a misattribution of familiarity (see Jacoby & Whitehouse, 1989). According to this account, the processing of a stimulus during the revelation phase increases its familiarity, and the enhanced familiarity is misattributed to the test item's presence on the study list. Although a misattribution account can explain the revelation effect when the items that are processed during the revelation phase match those items that are recognized, it cannot account for a revelation effect when the stimulus that is processed during the revelation phase is completely different than the word that is recognized. For instance a familiarity misattribution account cannot explain why, after solving an anagram of the word *vineyard*, participants are more likely to claim that a different word (e.g., *raindrop*) had appeared on the study list (Westerman & Greene, 1996, 1998), nor can it explain why participants are more likely to call a test word *old* after having completed a letter-span task (Westerman & Greene, 1998).

Westerman and Greene (1998) have offered an alternative account of the revelation effect that is similar to the familiarity misattribution account, insofar as it attributes the revelation effect to the enhanced familiarity of the test items in the revelation condition. This account has been described in terms of the global matching approach to recognition memory (e.g., Gillund & Shiffrin, 1984; Hintzman, 1988; Murdock, 1993; for a review, see Clark & Gronlund, 1996). According to global matching models, the presentation of an item on a recognition test causes a number of representations in memory to become activated, with the level of activation of each representation a function of its similarity to the test item. Recognition responses are determined by the sum of the activation of all memory representations for the study episode, with higher levels of activation increasing the probability of an *old* response. To explain the revelation effect, Westerman and Greene (1998) proposed that the processing of a stimulus in the revelation task leads to the activation of some memory representations and that this activation persists for some time after the task is completed. When the recognition test item appears, the activation produced by the revelation task contributes to the activation level on which the recognition decision for the next item is made. Because the total level of activation is higher on test trials that follow the revelation task, participants tend to respond *old* more often to these items than to items that do not follow the revelation task.

If the revelation effect is caused by an increase in the familiarity of the test items that follow the revelation task, the magnitude of the revelation effect should depend on the extent to which participants use familiarity as the basis

of their memory judgments. The extent to which performance on a recognition memory task relies on familiarity has been found to vary, depending on the nature of the task. Global matching models of recognition memory, which describe recognition memory performance as reflecting a single familiarity assessment process, have been successful in accounting for performance on most tasks that require participants to discriminate previously presented items (*old* items) from items that were not presented (*new* items). However, there is evidence that a second, recall-like retrieval process contributes to recognition judgments in certain cases (Clark, 1992; Hintzman & Curran, 1994; Jacoby, 1991; Yonelinas, 1997). These are cases in which the familiarity level of the test item is not a reliable basis on which to judge its target/lure status. One case is when a person has to discriminate targets from highly similar lures—for instance, when trying to discriminate a picture from its mirror image or a noun from its alternate singular/plural form (e.g., *raindrop* vs. *raindrops*; Hintzman & Curran, 1994). In these cases, the similarity between the targets and the lures should result in a high level of familiarity for both; therefore, judgments based on familiarity alone would be inadequate. Another situation that seems greatly to involve a recall-like process is associative recognition. In associative-recognition tasks, participants are first shown pairs of words to study. On the test, pairs of words are shown, and participants are asked to judge whether each pair consists of words that were presented *together* on the study list or whether each word had been presented with a different word. One way that recall processes may operate in these cases is that distractor items may be used as a cue to recall a target item and the recollection of the target item could be used as a basis on which to reject the lure (Clark, 1992; Clark & Hori, 1995; Hintzman, Curran, & Oppy, 1992). For example, if the lure *raindrop-vineyard* appears on an associative recognition test, an individual could use *raindrop* to recall that it had been paired with *computer* on the study list and, on that basis, reject *raindrop-vineyard*. A similar process may occur when discriminating between a target and its plural/singular alternate. The test word may cue the recall of the word that was studied, and judgments may be based on the information that is recollected (Hintzman & Curran, 1994).

So far, the revelation effect has only been studied by using memory tasks that can be completed on the basis of the familiarity of the test item. If, as several investigators have suggested (LeCompte, 1995; Luo, 1993; Peynircioglu & Tekcan, 1993; Westerman & Greene, 1998), the revelation task affects the familiarity of a test item that follows it, the revelation effect should be reduced if the contribution of familiarity to the recognition decision is reduced. There is some preliminary evidence that recognition tests that encourage the recollection of specific information from the study episode may lead to an elimination of the revelation effect. In their series of experi-

ments, Peynircioğlu and Tekcan found one situation in which a revelation effect did *not* occur; a revelation effect was not found on an experiment in which the lures were conceptually related to targets. In this experiment (Experiment 5), the study list was composed of six category exemplars from each of 10 semantic categories from Battig and Montague (1969). On the recognition test, two thirds of the lures were also from one of the categories presented in the study phase, and the other lures were from categories that were not represented on the study list. Although the authors had predicted that the revelation effect would be larger for the same-category lures, no revelation effect occurred at all in this condition. Nevertheless, a robust revelation effect was found for the different-category lures. Although Peynircioğlu and Tekcan did not speculate on the reason that the revelation effect did not occur with same-category lures, one possibility is that participants adopted a different recognition strategy for the same- and the different-category lures. When a different-category lure was tested, participants may have used familiarity as the basis of their recognition judgment. However, when the lure was from the same category as some of the study items, it may have cued the retrieval of specific information from the study list, thereby reducing the relative contribution of familiarity to the recognition judgment for this item. If it is true that the revelation effect reflects a change in the familiarity of test items, the absence of a revelation effect with same-category lures may have been due to participants not using familiarity as the sole basis for their recognition decisions.

The primary purpose of the present study was to investigate the role of familiarity in the revelation effect by studying the phenomenon in situations in which recognition judgments are not likely to be based only on the familiarity of the test item but, also, on a recall-like retrieval process. Experiment 1 was a demonstration of the revelation effect in single-item and pair recognition. Experiments 2 and 3 were conducted to determine whether the revelation effect would persist in memory tests that were expected to involve a recall-like retrieval process. In these experiments, the effect of revelation was investigated on tests of singular/plural form recognition and associative recognition.

EXPERIMENT 1

A revelation effect has been found consistently on tests of recognition memory (LeCompte, 1995; Luo, 1993; Peynircioğlu & Tekcan, 1993; Watkins & Peynircioğlu, 1990; Westerman & Greene, 1996, 1998). The first experiment was intended to replicate this finding on a standard recognition test, for comparison with later experiments. In Experiment 2, single words serve as the study and test stimuli, and in Experiment 3, pairs of words serve as the study and test stimuli. Therefore, the first experiment was intended to establish the effect of revelation on the recognition of both single items and pairs.

In Experiment 1, the participants studied either a list of single words or a list of pairs of words and then had a recognition test for the stimuli that were studied. On half of the recognition-test trials, the test stimulus was preceded by an anagram task that required participants to unscramble a word that was not among those that were studied and was not one of the words that was tested.

Method

Participants. Thirty-six students from Case Western Reserve University participated to fulfill a course requirement. The participants were tested individually.

Materials. The study and test stimuli were 240 six- to eight-letter words that were chosen from a pool supplied by Gibson and Watkins (1988). Two hundred words were paired randomly to create 100 word pairs (none of the pairings resulted in words with any obvious relationship to each other). Each participant received a unique assignment of pairs to each recognition condition (revelation or control) and to each test status (target or lure), as well as a unique ordering of items on the study and test lists. Each study list consisted of 60 pairs. The first 10 and last 10 pairs on the list were untested buffers and were the same for all the participants. The other 40 pairs were target pairs that would later appear on the recognition test. The recognition test included the 40 target pairs and 40 previously unseen pairs. Forty words from the same pool that were not used as targets or lures were used as anagrams (e.g., *rorwomot*) to be solved during the revelation phase. The anagrams were the same for all the participants and were presented in the same order on the recognition test.

One hundred single words were selected from the list of pairs to be used as stimuli for the group that studied and was tested on single words. The materials for the group that studied words were identical to those used for the group that studied word pairs, except that single words were used as study and test materials.

Procedure. The participants were assigned randomly to either the single-word recognition condition or the pair recognition condition. All the participants were tested on a computer. The participants in the single-word condition were told that they would see a list of 60 words that they should try to remember. The participants were not told of the specific nature of the memory task. Each word on the study list was presented individually on a computer screen for 2.5 sec. Immediately following the study list, the participants were given instructions for the revelation/recognition phase. The recognition test was self-paced and consisted of 80 words presented individually on the computer screen. Half of the test words had been presented during the study phase (targets), and the other half had not (lures). The test words were presented with the instructions, "Did this word appear on the list you just saw? Press 1 if 'yes,' Press 2 if 'no.'" For each participant, a random half of the test words was selected for the revelation condition. These words were immediately preceded by an anagram solution task. On these trials, a scrambled word appeared, and the participants were given a rule to follow in rearranging the letters into a word. The rule, which was printed on the computer screen under the scrambled letters, was 54687321. That is, the first letter of the solution was in the eighth position in the anagram; the second letter of the solution was in the seventh position in the anagram, and so forth. For instance, if participants were given the anagram *rorwomot*, they typed *tomorrow*. After typing the solution, the test item appeared, and the participants made a recognition decision. The other half of the test trials was not preceded by the anagram solution task.

The pair recognition condition was identical to the single-word recognition condition, except that the participants studied and were tested on pairs of words and each pair was presented for 5 sec during the study phase.

Results

A revelation effect occurred both for the participants who studied individual words and for the participants who studied pairs. Test items that followed the anagram task were more likely to be attributed to the study list. The mean proportion of *yes* responses (i.e., hits and false alarms) for each condition can be found in Table 1. A significance criterion of .05 was used for all the analyses reported here. The number of *yes* responses on the recognition test was used as the dependent measure and was submitted to a $2 \times 2 \times 2$ (target/lure status $\times$ revelation condition $\times$ word/pair recognition condition) mixed analysis of variance (ANOVA). There was a main effect for the items' target/lure status: Targets were more likely to be attributed to the study list than were lures [$F(1,34) = 153.83$, $MS_e = 14.29$]. There was a main effect for the items' revelation condition. Test items that followed the anagram task were more likely to be attributed to the study list than were test items that did not follow the anagram task [$F(1,34) = 16.99$, $MS_e = 5.61$]. There was not a significant interaction between the status of the test item and its revelation condition [$F(1,34) = 1.69$, $MS_e = 4.76$]. There was not a main effect for the recognition condition [$F(1,34) < 1$, $MS_e = 26.85$, n.s.]. That is, testing words as single items or pairs did not significantly affect the number of *yes* responses overall; however, the participants in the single-word recognition condition had more false alarms than did those in the pair recognition condition, as was revealed by a significant interaction between the test items' target/lure status and the recognition condition [$F(1,34) = 5.51$, $MS_e = 14.29$]. There was not a significant interaction between a test items' revelation condition and whether items were tested as words or as pairs [$F(1,34) = 1.51$, $p > .20$]. There was also not a significant interaction between whether the participants were in the word recognition or pair recognition group, the test item's target/lure status, and its revelation condition [$F(1,34) < 1$, $MS_e = 4.76$].

EXPERIMENT 2

In Experiment 2, the participants studied nouns in their singular or plural form. Later, they received a recognition test that included the studied version of the words as targets and their alternate plural/singular form as lures.

Table 1
Proportions of Positive Responses by Test Item Status and Recognition Condition for Experiment 1

Recognition Condition	Status of Test Items			
	Target		Lure	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Item recognition				
Revelation	.70	.05	.42	.05
Control	.63	.05	.27	.06
Pair recognition				
Revelation	.72	.05	.26	.04
Control	.67	.04	.19	.02

This task has been used by other researchers to study the contribution of familiarity and recollection to recognition decisions (e.g., Hintzman & Curran, 1994; Hintzman et al., 1992). Unlike the stimuli used in Experiment 1, the targets and lures used in Experiment 2 were very similar; they differed only by one letter. For this reason, it was expected that judgments on the recognition test would reflect an attempt to recollect the singular/plural status of the test item, rather than an assessment of the familiarity of the test item. The participants were warned before the study phase about the nature of the memory test that they would later complete; they were told that they would later be tested on their memory for the singular/plural status of the studied words. This feature was included, in part, to conform to the procedures of previous research that had used this task (Hintzman & Curran, 1994, 1995). The warning was also included because it was thought that the participants in this experiment might not encode the singular/plural status of the words to the degree that would be necessary for later use of a recollection-based retrieval strategy. That is, although the plural/singular recognition test asked for judgments based on specific information from the study list, it might be that this sort of finely tuned information would not automatically have been encoded to the extent that a recollection-based retrieval strategy would have been useful. It was thought that recollection-based retrieval would be more likely to occur if the participants were instructed to encode the information that would be recollected on the test.

Method

Participants. Twenty-two students from Case Western Reserve University participated to fulfill a course requirement. The participants were tested individually.

Materials and Procedure. The study and test stimuli were 100 six- to eight-letter singular nouns selected from the pool supplied by Gibson and Watkins (1988) and their plural forms. Forty additional words from the same pool were used as stimuli in the anagram completion task. The study procedure was identical to the item recognition condition of Experiment 1, except that half of the words were in plural form and half of the words were in singular form. The plural/singular form of the words on the study list was the same for all the participants, and each participant had a different random order on the study list. Before the study list was presented, the participants were told that half of the words would be in their singular form and half would be in their plural form. The participants were told to try to remember each word and also to pay close attention to whether the word was presented in its singular or its plural form. The first and last 10 serial positions on the study list were occupied by untested buffer words; half of the buffers were presented in their singular form, and half were presented in their plural form. Immediately following the study list, the participants were given a recognition test in which half of the words were presented in the singular/plural form in which they were studied (targets) and the other half of the words were in the singular/plural form in which they were not studied. The participants were asked to judge whether each word was exactly as it was studied and were instructed to press "1" if it was and to press "2" if it had been presented in its alternate singular/plural form. For instance, if the words *raindrops* and *vineyard* were studied, the test words might be *raindrops* (a target, for which a *yes* response would be correct) and *vineyards* (a lure, for which *no* would be the correct response). For each participant, a random half

of the test words was selected for the revelation condition. These words were immediately preceded by an anagram solution task identical to the task that was described in Experiment 1. On these trials, a scrambled word appeared, and the participants were given a rule to follow for rearranging the letters into a word. After typing the solution, the test word appeared, and the participants made a recognition decision. The other half of the test trials was not preceded by an anagram solution task.

Results

No revelation effect occurred in this experiment. The results are summarized in Table 2. A 2×2 (target/lure status $\times$ revelation condition) repeated measures ANOVA was conducted on the number of *old* responses for each condition. There was a main effect for the actual status of the test words; *old* words were more likely to be classified as targets than were *new* words [$F(1,21) = 23.16$, $MS_e = 31.68$]. A revelation effect did not occur; words that followed the revelation task were not more likely to be classified as *old* than were words that did not follow the task [$F(1,21) < 1$, $MS_e = 5.35$, n.s.]. There was not a significant interaction between the words' status and their revelation condition [$F(1,21) < 1$, $MS_e = 7.11$, n.s.].

A power analysis was conducted to ensure that the absence of a revelation effect in this experiment was not due to a lack of statistical power (Cohen, 1988). Power was calculated, using an alpha level of .05 and the effect size from the replication of the revelation effect reported in Experiment 1. This analysis revealed that the probability that a revelation effect the size of that reported in Experiment 1 would have been detected in the present experiment was very high (.97). Therefore, it is unlikely that the absence of a revelation effect in the plural/singular recognition task was due to a lack of statistical power.

The absence of a revelation effect here suggests that the effect will not occur on a recognition test for which the contribution of familiarity is reduced. Additional evidence for the effect of revelation on recognition tests for which the relative contribution of familiarity is minimized was sought in the next experiment. Experiment 3 tested the effect of revelation on an associative-recognition task—a task for which there is abundant evidence of a recall-like component.

EXPERIMENT 3

In Experiment 2, a revelation effect did not emerge on a plurality recognition test. These results suggest that a revelation effect will not occur on tasks that are not com-

pleted primarily on the basis of the familiarity of the test item. Experiment 3 was intended to gather more evidence for this conclusion. Experiment 3 used an associative-recognition task to study the effect of revelation on a recollection-based recognition task. Associative recognition was used because the processes that underlie performance on this task are better understood than those that underlie performance on a plurality recognition test. Its comparability to item recognition is also better known. Associative recognition has been found to differ from item recognition in many ways—for instance, in the rate of forgetting (Hockley, 1991), the time course of retrieval (Gronlund & Ratcliff, 1989), the receiver-operating characteristics (Yonelinas, 1997), and the effect of different stimulus variables on test performance (Clark, 1992; Clark & Burchett, 1994; Clark & Hori, 1995). The results of these earlier studies have provided evidence that the differences between associative recognition and item recognition occur because performance on these tasks is based differentially on recollection and familiarity during the retrieval process.

The likelihood that participants will employ a recollection-based recognition strategy may depend on the extent to which the information that could easily discriminate targets from lures had been encoded during the study phase. Therefore, a second purpose of Experiment 3 was to investigate the effect of encoding instructions on a recollection-based recognition test. Two groups of participants were used in Experiment 3: One group was warned about the nature of the memory test prior to the study phase, and the other group was unwarned. The participants studied pairs of words and then completed an associative-recognition test. Pairs of words were presented on the recognition test; half of the pairs comprised two words that had been paired together during the study phase, and half of the pairs comprised words that had been paired with different words during the study phase. Half of the participants were warned about the nature of the memory test and were instructed to try to remember which words were presented and which words were paired together (the procedure typically used in experiments on associative recognition; e.g., Clark, Hori, & Callan, 1993; Clark & Shiffrin, 1992; Hockley, 1994). The other half of the participants were told only that they should try to remember the words that were presented for a memory test that would be given later. It was expected that a recollection-based retrieval strategy would be more likely for the group that was instructed to encode the items as pairs than for the group that was given no such instructions.

Method

Participants. Thirty-six students from Case Western Reserve University participated to fulfill a course credit. The participants were randomly assigned to either the warning or the no-warning condition. The participants were tested individually.

Materials and Procedure. The stimuli were 300 words from the pool supplied by Gibson and Watkins (1988). Two hundred sixty words were paired randomly, and none of the pairings resulted in two words with any obvious relationship with each other. The list

Table 2
Proportions of Positive Responses by Test Item Status and Recognition Condition for Experiment 2

Recognition Condition	Status of Test Items			
	Target		Lure	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Plurality recognition				
Revelation	.66	.03	.47	.04
Control	.65	.03	.46	.04

of 130 pairs was presented for study. The first and last 5 pairs were buffers and were the same for all the participants. The other 120 pairs were presented in a different random order for each participant. The study procedures were identical to those in Experiment 2, except that half of the participants were told before the study list was presented that they would later have to remember which words had been paired together (warned group). This group was told that they would later have to discriminate between a pair of words that had been presented together on the study list and two words that had been presented with different words on the study list. The other half of the participants were in the unwarned group. This group was told only that they would be tested on their memory for the words but was not given information about the nature of the memory test that would be given.

Immediately following the study list, the participants were given instructions for the revelation task and the associative-recognition test. Eighty pairs of words were presented on the associative-recognition test. Pairs were presented individually, along with the instructions, "Did these words appear together on the list? Press 1 for 'yes' and 2 for 'no.'" Forty test pairs were shown exactly as they had been presented on the study list (targets). The other 40 test pairs (lures) consisted of two words that had been presented on the study list but had been paired with different words. When the test pair was a lure, the right-left order of the words was preserved; that is, the two words occupied the same position on the screen as they had occupied on the study list, when they had appeared with different words. All of the words on the test appeared only once.

For each participant, a random half of the test pairs was selected for the revelation condition. These words were immediately preceded by an anagram solution task. On these trials, a scrambled word appeared (as in Experiment 1, this was not a word that had previously been studied, nor was it a word that was tested), and the participants were given a rule to follow for rearranging the letter into a word. After typing the solution, the test pair appeared, and the participants made an associative-order recognition decision. The other test trials were not preceded by an anagram solution task.

Results

A revelation effect was found for the group that was unwarned about the nature of the memory task that was to follow, but the effect did not occur for the group that was warned. The results are summarized in Table 3. The numbers of *yes* responses for each condition were submitted to a $2 \times 2 \times 2$ (target/lure status $\times$ revelation condition $\times$ warning condition) mixed ANOVA. There was no main effect for warning condition [$F(1,34) = 1.67$, $MS_e = 11.26$, $p > .20$]. There was a main effect for target/lure status. Targets were more likely to be classified as targets than were lures [$F(1,34) = 82.66$, $MS_e = 25.97$]. There was a main effect for the revelation condition; pairs that followed the anagram solution task were more likely

to be classified as targets than were pairs that did not follow the anagram task [$F(1,34) = 6.56$, $MS_e = 3.81$]. More important, there was a significant interaction between warning and revelation [$F(1,34) = 4.53$, $MS_e = 3.81$]. An inspection of the means reveals that a revelation effect occurred for the group that was told to remember the words on the list but did not receive information about the nature of the memory test [$t(17) = 3.18$, $p < .01$]. However, a revelation effect did not occur for the group that was instructed to remember the specific pairings and was warned about the nature of the memory test [$t(17) = 0.32$, $p > .75$]. The interaction between the encoding instructions and the effect of the revelation task is informative. When the participants were instructed to pay attention to the word pairings during the study phase, a revelation effect did not occur. However, when the participants received no specific encoding instructions, a revelation effect did occur. Because a recollection-based retrieval strategy seems more likely when the information that would be most useful for discriminating targets from lures (in this case, information about the word pairings) was encoded during the study phase, the absence of the revelation effect when the participants were encouraged to encode the pairings supports the notion that a recollection-based retrieval strategy will eliminate the effect.

There was also a significant interaction between an item's target/lure status and the warning condition [$F(1,34) = 8.10$, $MS_e = 25.97$]. Warning the participants about the nature of the memory test decreased the number of lures incorrectly classified as targets (i.e., warning the participants reduced false alarms). There was no significant interaction between target/lure status and revelation condition [$F(1,34) < 1$, $MS_e = 3.42$] or between target/lure status, revelation condition, and warning condition [$F(1,34) < 1$, $MS_e = 3.42$].

The primary purpose of this study was to determine whether a revelation effect would occur on recognition tests that are likely to be based on the recollection of specific information from the study episode, rather than on the global familiarity of the test item. The results of Experiment 3 suggest that a revelation effect will not occur when recognition judgments are not based solely on the familiarity of the test item (as long as the information that is to be recollected was thoroughly encoded during the study phase). The absence of a revelation effect on recognition tests on which the relative contribution of familiarity to judgments is reduced (as compared with a standard item recognition test) is consistent with the view that the revelation effect is caused by an enhanced sense of familiarity that occurs for the test items that follow the revelation task.

GENERAL DISCUSSION

The revelation effect is a robust phenomenon that has been difficult to explain theoretically. Several investigators have proposed that the revelation effect is due to an enhanced sense of familiarity for words that follow the revelation task (Luo, 1993; Peynircioglu & Tekcan, 1993; West-

Table 3
Proportions of Positive Responses by Test Item Status
and Recognition Condition for Experiment 3

Recognition Condition	Status of Test Items			
	Target		Lure	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Associative recognition				
Unwarned				
Revelation	.66	.04	.38	.04
Control	.57	.04	.32	.04
Warned				
Revelation	.70	.04	.21	.04
Control	.71	.04	.19	.03

erman & Greene, 1998). The purpose of the present study was to test the viability of a familiarity account by testing for revelation effects on memory tasks that are not likely to be based (entirely) on the familiarity of the test item. In this study, a revelation effect was absent in two experiments that used recognition tests for which there is strong evidence that judgments are not based on an assessment of global familiarity but, rather, seem to involve a recall-like retrieval process (Clark, 1992; Clark & Burchett, 1994; Clark & Hori, 1995; Gronlund & Ratcliff, 1989; Hintzman & Curran, 1994; Hintzman et al., 1992; Hockley, 1991). In Experiment 2, the recognition task required the participants to discriminate between target words and their alternate plural/singular forms. In Experiment 3, a test of associative recognition required the participants to discriminate between intact and rearranged pairs of words. A revelation effect did not occur in either experiment. The absence of a revelation effect in these experiments is noteworthy in and of itself, since this is the first yes/no episodic memory task that has been found to be *unaffected* by a revelation task.

The absence of a revelation effect on a plural/singular recognition test and on an associative-recognition test has implications for a theoretical account of the phenomenon. Previous studies on the revelation effect have demonstrated the effect by using memory tests that can be completed on the basis of the familiarity of the test items (e.g., item recognition, frequency judgment). In the present study, a revelation effect was not found with memory tasks that involved a recall-like retrieval process rather than (or in addition to) a familiarity assessment process. This finding is consistent with a familiarity account of the revelation effect. If the revelation effect reflects an enhanced sense of familiarity for test items that follow the revelation task, the revelation effect should be reduced when the contribution of familiarity to the recognition decision is reduced.

The present results also suggest that the likelihood that participants will employ a recollection-based recognition strategy depends on the extent to which the information that could easily discriminate targets from lures had been encoded during the study phase. The interaction between the encoding instructions and the effect of revelation in Experiment 3 demonstrates this. When the participants were instructed before the study phase to pay close attention to the word pairings (the instructions typically used in tests of associative recognition; e.g., Clark et al., 1993; Clark & Shiffrin, 1992; Hockley, 1994), a revelation effect did not occur. However, when the participants were given general encoding instructions without being informed about the nature of the memory test to follow, a revelation effect occurred. Because the recollection of the information that would best discriminate targets from lures seems more likely if the participants had encoded this information during the study phase, the absence of the revelation effect when participants were warned about the associative-recognition test supports the notion that a recollection-based retrieval strategy will eliminate the effect. These results show how the effect of revelation can be overcome by an (encoding) or recogni-

tion strategy that is based on the recollection of the study episode, rather than on the familiarity of the test items.

Although most accounts of the revelation effect have attributed the phenomenon to an enhanced sense of familiarity for test items that follow the revelation phase (LeCompte, 1995; Luo, 1993; Peynircioğlu & Tekcan, 1993; Westerman & Greene, 1998), an alternative to a familiarity account has recently been offered. Hicks and Marsh (1998) have proposed that the revelation effect is due *both* to a change in the familiarity of the test item and to a shift in participants' recognition criteria. Hicks and Marsh's account is similar to the activation misattribution account offered by Westerman and Greene (1998), insofar as it proposes that the task performed during the revelation phase causes other (nontarget) memory traces to become temporarily active. Unlike the misattributed activation account, however, Hicks and Marsh's account assumes that the activation of additional traces reduces the familiarity of the test item by reducing the signal-to-noise ratio for that item. The reduction of the signal-to-noise ratio for the test item makes the recognition decision more difficult. In response to a more difficult discrimination task, participants temporarily adopt a more liberal recognition criterion and, thus, give more *old* responses to the test items in the revelation condition. Hicks and Marsh reported the results of several experiments that are consistent with their explanation. In their experiments, participants studied a word list and then were given a forced-choice recognition test. Each recognition test trial required participants first to solve a word fragment and then to make a forced-choice recognition judgment. The forced-choice test trial consisted of two alternatives; one alternative was the solution to the word fragment that participants had just completed, and the other alternative was a word that did not match the solution to the word fragment. The results showed that participants were not more likely to choose a word that matched the solution to the word fragment than they were to choose an unmatching word. In other words, if participants solved the word *vineyard* from a fragment, they were not more likely to choose *vineyard* on a subsequent test trial that included the alternatives *raindrop* and *vineyard*. Indeed, in two experiments that included null test trials (i.e., both alternatives were targets or both alternatives were lures), participants were more likely to pick the word that *did not* match the word fragment. Because forced-choice recognition—unlike yes/no recognition—does not involve criterion setting (in forced-choice recognition, participants simply choose the alternative with the higher familiarity level), Hicks and Marsh interpreted their results as evidence against an account that attributes the revelation effect to an enhanced familiarity of the test items. They argue that if the revelation effect were due to the enhanced familiarity of the test items in the revelation condition, participants would more often have chosen the alternative that matched the revealed word than the alternative that did not match the revealed word.

However, another interpretation of Hicks and Marsh's (1998) findings is also possible. As was discussed earlier

in this article, the revelation effect is not limited to situations in which the revealed word matches the test word. Indeed, a robust revelation effect has been found when the revealed word does not match the test word that follows it (Westerman & Greene, 1996, 1998). Because the revelation effect is a general effect that occurs for both matching and nonmatching test words, it is possible that both alternatives in a forced-choice test trial were affected by the revelation task, and the seeming absence of a revelation effect in forced-choice recognition may actually be due to the revelation task's affecting both alternatives in the forced-choice recognition task.

As Hicks and Marsh (1998) have pointed out, a familiarity account and a criterion-shift account of the revelation effect make similar predictions; therefore, results that would unambiguously discriminate between the two accounts are difficult to obtain. Although the results of the present study are consistent with a familiarity account, they do not rule out a criterion-shift account of the revelation effect, such as that offered by Hicks and Marsh. A criterion-shift account is based on the assumption that participants set a criterion for the level of familiarity that will lead to a positive response. If the familiarity level of a test item reaches or exceeds the criterion, a positive response is given; if the familiarity level does not reach the criterion, a negative response is given. Because a criterion-shift account would not predict a revelation effect when responses are not based on the familiarity of the test items, a criterion-shift account could also explain the results of the present study. One hopes that future research will provide data that will help to distinguish between these accounts.

To fully understand human memory, we must learn why people sometimes claim to remember something that did not actually occur. The revelation effect has been difficult to understand, both intuitively and theoretically. The results of the present study increase our understanding of this phenomenon. Previous research has shown that the revelation effect is a very robust and general phenomenon in recognition memory. The present study shows that there are at least some yes/no recognition judgments that are *not* affected by a cognitive task that is performed just before the recognition judgment. When the contribution of familiarity to recognition decisions is reduced by factors that encourage recognition judgments to be based on recollection of the study episode, rather than on the familiarity of the test item, a revelation effect does not occur. These results also show that a recollection-based recognition strategy can allow an individual to overcome this robust memory illusion.

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