EFFECTS OF PRIOR WARNING AND RESPONSE DEADLINE ON FALSE MEMORY

Masao ENDO¹⁾

¹⁾*Kyoto University, Japan*

The purpose of this paper was to examine the effects of warning on performance during the Deese-Roediger-McDermott recognition test (Roediger & McDermott, 1995), by manipulating the test type. We presented subjects with lists of semantically related words, followed by a recognition test. The test was composed of studied words, related non-studied words (critical lures), and unrelated non-studied words. Half the subjects were uninformed about the false recognition effect, while the others were forewarned. During the test phase, half of each group reported on recognition of each item within 4 seconds (fast condition), and the others did so within 8 seconds (slow condition). In the slow condition, the false critical lure recognition rate was lower in forewarned subjects than in uninformed subjects. However, in the fast condition, there was no significant difference in false recognition rates. Our results demonstrate that identification of critical lures can reduce the frequency of false recognition.

Key words: false recognition, response deadline, warning

Memory distortion has long been a topic of interest to researchers. Formal research on memory distortion dates back to the work of Bartlett (1932), who provided subjects with a Native American story, “The War of the Ghosts,” and asked them to recollect it later. Subjects made systematic errors that resulted from their re-interpretation of the story based on their preexisting knowledge. Bartlett interprets these errors as evidence for his schema theory. He describes recollection as a reconstructive process that is driven by schemas. Since his work, 50 years have passed; more recently, studies about eyewitness testimony (Loftus, 1979) and recovered memories (Lindsay & Read, 1994; Loftus, 1993) have rekindled interest in memory distortion.

In 1995, Roediger and McDermott replicated a memory task that was first introduced by Deese (1959). They presented subjects with lists of words (e.g., bed, rest, awake) associated with a critical non-presented word (e.g., sleep). They gave subjects both an immediate free recall test and a delayed recognition test. They instructed subjects not to guess during the tests (to be certain that all the words could be heard). Subjects recalled the critical non-presented word with approximately the same (Experiment 1) or higher (Experiment 2) probability as their recall of presented words. In the recognition test, subjects labeled critical non-presented items that have a probability of recall similar to studied items “old”. Further, they often claim to remember the specific presentation of

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Correspondence concerning this article and requests for reprints should be addressed to Masao Endo, Department of Cognitive Psychology in Education, Kyoto University, Yoshida Honmachi, Sakyo-ku, Kyoto 606-8501, Japan (e-mail: BZY10042@nifty.ne.jp).

these critical non-presented words. Roediger and McDermott (1995) argued that these phenomena constitute a striking memory illusion, in which people recall, recognize, and claim to remember the moment of the occurrence of events that did not actually occur.

Some studies have attempted to reduce production of false memories. McDermott (1996) replicated Roediger and McDermott (1995), finding the effects of the critical lure (CL) to be inversely proportional to the number of times that the study is replicated with the same subjects. Mather, Henkel, and Johnson (1997) and Norman and Schacter (1997) instructed subjects to memorize details (e.g., the voice that presented the related lure, personal reaction to the word when it was presented). As a result, they reduced the rate of the production of false memories. Read (1996) reported that when he gave subjects instructions to remember the order of presentation, it reduced the critical lure recall. Researchers attribute successful serial recall to distinctive processing, because information corresponding to serial order differs for each item. Smith and Hunt (1998, Experiment 3) reported that assigning ratings of pleasantness to studied words reduced critical lure recall. Their results show that strengthening item-specific processing reduces the false memory effect. McDermott and Roediger (1998) examined the effects of warning on recognition in the Deese-Roediger-McDermott (DRM) paradigm, by comparing presented critical items with non-presented critical items. In their study, although warning decreased the critical lure recognition rate, the rate did not become zero. Their results show the effects of warning and also demonstrate the persistence of false memory.

Gallo, Roberts, and Seamon (1997) also examined the effects of warning on false alarms. They provided three conditions: uninformed, cautious, and forewarned. In the study phase, the procedure was similar to that of Roediger and McDermott (1995), and the tests were also recognition tests. In the uninformed condition, subjects were not given information about false memory. In the cautious condition, subjects were given information about false memory; specifically, before the test phase they were told that the list might lead to critical lures. In the forewarned condition, subjects were given this information before the study phase and the test phase. As a result, the recognition rate of critical lures was significantly lower in the forewarned condition than in the other two conditions. However, the warning did not reduce the critical lure rate to zero.

Gallo et al. (1997) explained why the critical lure recognition rate is lower in the forewarned condition; post-experiment questionnaires revealed that most subjects in the cautious and uninformed conditions had employed a strategy of either maintenance or elaborative rehearsal. On the other hand, in the forewarned condition, subjects had adopted a strategy of attempting to identify the critical lures. Therefore, these forewarned subjects had identified tags for critical lures and used these to avoid false recognition during the test phase.

Many reports have indicated that warning subjects about false memory can reduce the level of false recognition. However, the reasons for this effect are unclear. In an attempt to clarify these, we begin with an examination of identifying lures.

We examined whether the effect of forewarning reported by Gallo et al. (1997) is influenced by response deadline. When subjects are forced to make a quick recognition response, their responses should be based on familiarity. On the other hand, slower

responses should be based on a mixture of recollection and familiarity (Yonelinas, 2002; Yonelinas & Jacoby, 1994). Using a similar procedure to that of Roediger and McDermott, we used recognition task and manipulated two factors: warning (uninformed or forewarned) and the test type (fast or slow).

In the uninformed condition, the rate of critical lure recognition should be high, regardless of test type. In the forewarned condition, the rate of critical lure recognition should be higher in the fast condition than in the slow condition; this is because subjects can use tags in the slow condition, but it is more difficult to do so in a fast condition.

METHOD

Subjects:

The subjects were 47 university undergraduates, who were paid volunteers. None had participated in any related memory research.

Materials:

We used 12 of Miyaji and Yama's (2002) word lists. Each list was composed of 15 words associated with a non-presented critical word (a critical lure). Within each list, the order of the words was constant. For example, the list associated with the critical lure '*itai*' (painful) was composed of the following words: *kizu* (injury), *hara* (stomach), *kayui* (itchy), *toge* (thorn), *kutsuu* (pang), *tsuneru* (pinch), *kiru* (cut), *chi* (blood), *shujutsu* (operation), *kega* (wound), *sasu* (stick), *tyusha* (injection), *atama* (head), *byouki* (sickness), and *tsurai* (hard). In order to counterbalance these, we divided the 12 lists into two sets of six lists, labeled A and B. Half the subjects in each condition received Set A for the study and the other half received Set B. The set that was not used during the study provided distracters for the recognition test.

Procedure:

During the study, we played an auditory tape for the subjects, which consisted of six lists of 15 words presented in a blocked fashion. A male voice read the words at a rate of 1.5 seconds per word. We instructed the subjects to remember the words for a recognition memory test that would follow.

After the tape had presented all 80 words, we gave subjects a visual recognition memory test consisting of 48 words. Following Roediger and McDermott's (1995) test procedure, our test contained three items from each studied list (Serial Positions 1, 8, and 10), the non-presented critical lure from each studied list, three items from each non-studied list (Serial Positions 1, 8, and 10), and the critical lure from each non-studied list. We listed the words randomly, and each word was accompanied by a set of parentheses and a set of numbers from 1 to 6.

We instructed the subjects to examine the words in a sequential order at the compulsorily paced rate and make a decision about each word on the list. We instructed them to draw a circle in the parentheses next to any word that they recognized from the study tape or to place a cross beside any word that they failed to recognize. In addition, following Roediger and McDermott's (1995, Experiment 1) test procedure, we instructed them to rate their confidence that the word had occurred on the list: 6 meaning certainty that the item was old (or studied), 5 for old, 4 for probably old, 3 for probably new, 2 for new, and 1 for certain it was new.

The key variable in this experiment was the effect of foreknowledge. Accordingly, we gave different instructions to two groups of 23 or 24 subjects before the study phase. In the uninformed condition, we did not tell the subjects about the false recognition effect. Instead, we gave them standard instructions to try to remember as many words as possible for a subsequent recognition test. This is similar to the general procedure used by Roediger and McDermott (1995, Experiment 2).

In the forewarned condition, we provided subjects with detailed information and examples of the false recognition effect prior to presentation of the study lists. As we had specifically forewarned subjects that we had designed the study lists to try to make them falsely recognize related but non-presented words, subjects had a chance to devise strategies to reduce or eliminate the false recognition effect. As part of the forewarning procedure, subjects participated in a false recognition demonstration before we gave them the

instructions for the actual experiment. We read the subjects a sample list of words and told them that they would be given a practice recognition test to familiarize themselves with the procedure. We obtained the list from Roediger and McDermott (1995) and did not use it elsewhere in this experiment. Following the presentation of the sample list, we gave subjects an eight-word recognition test, constructed in the same manner as our actual test. Three of the words were from the sample list (Serial Positions 1, 8, and 10), one was the non-presented critical lure, and four were unrelated distracters taken from another Roediger and McDermott list; these words were not used elsewhere in this experiment. After the subjects had completed the sample recognition test, we identified the critical lure, and observed the false recognition effect.

We also informed these subjects that prior research had demonstrated that presenting lists of words semantically associated with non-presented words led to high levels of false critical lure recognition. We followed this by reading another Roediger and McDermott sample list of 15 related words, along with its critical lure; again, we did not use them elsewhere in this experiment. We told the subjects that we had constructed the lists that they would hear during the study phase in the same fashion as the sample lists. Their task was to minimize false critical lure recognition without sacrificing their recognition of words presented during the study. We took care to ensure that subjects understood how the study lists were constructed, the nature of the false recognition effect, and the goal of minimizing false critical lure recognition. We reminded them of their task prior to the recognition test. Together, these procedures provide a strong test of any possible effect of forewarning.

The second key variable was the type of test: the effects on false memory of extending the time for recognition of each word during the test phase. Before the recognition test, we instructed subjects to examine the words in sequential order at a compulsorily paced rate and make a decision about each word on the list.

We gave each half of the subjects in the informed and uninformed groups different instructions for the test. In the fast condition, the experimenter signaled every 4 seconds; we asked subjects to complete the following tasks for each item within 4 seconds: they had to decide whether the word was old or new, and draw a circle in the parentheses beside the word that they recognized from the study tape, or place a cross beside any word that they failed to recognize. In addition, we asked them to rate each word with regard to their confidence that it had occurred in the list: 6 meaning certain that the item was old (or studied), 5 for old, 4 for probably old, 3 for probably new, and 1 for certain it was new.

In the slow condition, the experimenter signaled every 5 seconds, and then made another signal after a further 3 seconds. We instructed subjects to consider whether the word was old or new within the first 5 seconds, and then in the latter 3 seconds they had to draw a circle in the parentheses beside any word that they recognized from the study tape, or place a cross beside any words that they failed to recognize. In addition, we asked them to rate each word with regard to their confidence that it had occurred on the list. Subjects thus had more time to consider the tasks in the slow condition than in the fast condition.

RESULTS

The data consist of the subjects' responses in each condition of the recognition test. Table 1 shows the results for each condition and response measure; it shows mean recognition scores for studied and non-studied words and the critical lures in each condition. We judged that an item was recognized if there was a circle beside it, or if the confidence rating for the item was between 4 and 6. We judged an item as not recognized if there was a cross beside it, or the confidence rating was between 1 and 3.

We analyzed each response measure (studied words, critical lures, and unstudied words).

Studied Words

The results of our 2 (test type: fast, slow) $\times$ 2 (warning: uninformed, forewarned) ANOVA show that test type and warning had no significant main effects; there were also no interaction effects between test type and warning ($F_s < 1$).

Table 1. Mean Recognition for Studied Words, Non-Studied Words, and Critical Lures

Condition		Studied	Critical Lures	Non-studied
Slow condition	Uninformed	.70	.87	.10
	Forewarned	.69	.59	.06
Fast condition	Uninformed	.76	.83	.07
	Forewarned	.71	.80	.08

Critical Lures

The results of our 2 (test type)×2 (warning) ANOVA show that test type ($F(1, 43)=4.45, p<.05$) and warning ($F(1, 43)=12.79, p<.05$) had significant main effects. We observed a significant interaction effect between test type and warning ($F(1, 43)=8.08, p<.05$). In the forewarned condition, there was a simple main effect of test type ($F(1, 43)=12.27, p<.05$: fast>slow). There was also a simple main effect of warning in the slow condition ($F(1, 43)=20.60, p<.05$: uninformed>forewarned). The critical lure recognition rates were lower in the slow and forewarned condition than in the other conditions.

Unstudied Words

The results of our 2 (test type)×2 (warning) ANOVA show that test type and warning had no significant main effects. We did not observe any interaction effects between test type and warning ($Fs<1$).

Next, we analyzed the results of each condition. In the uninformed — slow condition, the results of a one-way ANOVA (studied words, critical lures, and non-studied words) show a significant main effect ($F(2, 22)=106.45, p<.01$). The results of our secondary analysis (the Newman-Keuls test) reveal that subjects recognized critical lures (.87) significantly more frequently than non-studied words (.10); subjects recognized studied words (.70) significantly more frequently than non-studied words; and subjects recognized critical lures significantly more frequently than studied words. In the forewarned — slow condition, the results of our one-way ANOVA (studied words, critical lures, and non-studied words) show a significant main effect ($F(2, 20)=106.45, p<.01$). In the uninformed — fast condition, the results of our one-way ANOVA (studied words, critical lures, and non-studied words) show a significant main effect ($F(2, 22)=160.84, p<.01$). In the forewarned — fast condition, the results of our one-way ANOVA (studied words, critical lures, and non-studied words) show a significant main effect ($F(2, 22)=130.72, p<.01$). In these three conditions, the results of our subordinate analysis show that subjects recognized critical lures significantly more frequently than non-studied words, they recognized studied words significantly more frequently than non-studied words, and there was no significant difference between critical lures and studied words. Therefore, all of our conditions demonstrated the persistence of the false memory effect.

DISCUSSION

When we examined the data for studied and non-studied words, we found no significant differences in recognition rates between the conditions. Our interest is, therefore, focused on critical lures.

Our study reveals several important findings pertaining to critical lures. First, when subjects were uninformed about the memory illusion, they demonstrated the false recognition effect strongly. These subjects falsely recognized critical lures at a rate comparable to their hit rate for studied words when they were in the fast condition. Moreover, subjects falsely recognized critical lures more frequently than studied words when they were in the slow condition. Second, when subjects were forewarned about the memory illusion, they still falsely recognized critical lures at a rate comparable to their hit rate for studied words. However, they demonstrated a diminished false recognition effect in the slow condition: the rates of false critical lure recognition were lower in comparison with the other conditions. Third, even if subjects were forewarned about the memory illusion, they did not demonstrate a diminished false recognition effect in the fast condition.

In the slow condition, the critical lure recognition rate was higher in the uninformed condition than in the forewarned condition. This result supports Gallo et al.'s (1997) results. In a forewarned condition, participants might identify and make a mental note of a critical lure. During the test, they might remember that an item had not been presented, and not falsely recognize it. The effect of the warning may be the use of this strategy.

In the fast condition, the critical lure recognition rate was not lower in the forewarned condition than in the uninformed condition. In the fast condition, it seemed that subjects could not use the critical lure tags that they had identified in the study phase. As a result, the warning had no effect.

Some researchers claim that recognition of critical lures is related to automatic processing. Roediger and McDermott (1995, Experiment 2) examined the effects of false memory on the recognition test using Tulving's (1985) "remember versus know" judgment task. For any recognized word, subjects had to indicate whether they specifically remembered the word's occurrence during the study (a "remember" judgment) or whether they merely knew that the word had been presented, in the absence of any specific recollection (a "know" judgment). During the "remember versus know" judgment task, subjects selected "remember" responses more frequently than "know" responses for critical lures that they recognized. Hence, subjects had specific memories about recognized critical lures.

McDermott and Roediger (1998) examined the effects of warning on recognition in the DRM paradigm by comparing presented critical items with non-presented critical items. They wrote, "In Gallo et al.'s (1997) experiment, the critical linking word was never presented in any of the lists; therefore, if subjects were able to confidently identify the English word that most effectively linked all the presented words, they could be confident that the word had not been presented. That is, the effect of the warning manipulation observed by Gallo et al. (1997) might have been overestimated by the fact

that subjects did not necessarily have to perceive or remember whether or not the critical item had been presented in any of the lists" (p. 518). The paradigms of the types of test in the two reports are different from each other; in Gallo et al.'s study and in our study, identification of critical lures is a useful strategy. It would be interesting to manipulate the test type (fast/slow) in McDermott and Roediger's (1998) paradigm.

Our study demonstrates that providing information about false memory reduces the level of false recognition, because subjects use identifying lures. We can examine the effects of warning on the recognition test in the DRM paradigm (Roediger & McDermott, 1995) by manipulating the type of test. Our results suggest that when we know about false memory, identifying critical lures is a good strategy to avoid producing false memories. We would like to examine whether this strategy could be useful for other paradigms (e.g., McDermott & Roediger, 1998) about false memory.

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