The Effect of Modality and Warning on False Recognition

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Abstract

Numerous studies indicate the human brain is extremely susceptible to creating false memories. Thus, psychologists have long been intrigued by aspects that influence their prevalence. Past studies have set a standard for examining false memory creation using word lists in the Deese-Roediger-McDermott (DRM) paradigm. However, the current body of research lacks exploration of the interaction between modality and warning on recognition. Therefore, this study explores the effect of simultaneous manipulations of modality and warning on rates of correct and false recognition of studied words in the DRM paradigm. Researchers found no evidence of an interaction between modality and warning on either correct or false recognition. Despite this, there was substantial evidence of a main effect of warning on the false recognition of critical lure terms. These results support previous findings that warning likely impacts the creation of false memories, but only does so under certain circumstances. Additionally, researchers advise replicating this experiment with increased controls to mitigate internal validity concerns.

Keywords: false memories, DRM paradigm, modality, warning, recognition

The Effect of Modality and Warning on False Recognition

Have you ever experienced the Mandela effect? The Mandela effect occurs when multiple people share false memories. For example, many people remember the peanut butter brand as "Jiffy", but actually, it is "Jif." More examples of the Mandela effect include falsely remembering Curious George to have a tail, the Monopoly Man to have a monocle, and the beloved cartoons being titled *Looney Toons* when it is actually *Looney Tunes*. How is it possible that such large portions of the population share false memories? False memories have been of interest to psychologists for a long time. Explicitly, false memories are remembered events that differ from how the event actually occurred or are fabricated memories that never happened at all. These false memories can exist vividly in a person's mind and are often recalled confidently. Memories of past experiences can greatly influence decision-making and judgment formation. This may lead to false testimonies given with high confidence in legal situations, resulting in severe and potentially unjustified life consequences for numerous individuals. Therefore, determining what can influence, and ideally reduce, the creation of false memories is worth researching. This study explores the interaction between modality and warning on rates of correct and false recognition of studied words.

In 1959, James Deese pioneered the creation of materials that are commonly utilized to study false memories. He developed a series of word lists–each consisting of 12 words closely relating to a critical, nonpresented word–which tend to elicit the false recall of the critical lure words with varying degrees of success. In 1995, psychologists Kathleen McDermott and Henry Roediger developed six lists of associate words for the six target words from Deese's materials that resulted in the highest intrusion rates. Roediger and McDermott replicated Deese's findings and extended his paradigm to recognition tests; they found that recognition tests, given in the

absence of preceding recall, led to a decrease in accurate recognition of studied words and produced remarkably high rates of false recognition for critical lure terms. The false recognition rate for critical items approached the hit rate, and these critical items were frequently identified with high confidence (Roediger & McDermott, 1995). These results suggest that recognition testing alone may lead to higher susceptibility to creating false memories. This methodology for examining false memories became known as the Deese-Roediger-McDermott (DRM) paradigm. However, it is unclear whether preliminary knowledge of natural susceptibility to creating false memories in the DRM paradigm can reduce rates of false recognition.

Recognition tests alone lead to higher levels of falsely remembering critical lure terms in the DRM paradigm. Could awareness of the existence of critical lure terms, and explicit warnings to avoid them, reduce how often participants falsely recognize these terms? Gallo, Roberts, and Seamon explored precisely that. They recruited 48 undergraduates at Wesleyan University for their study. Each was placed in one of the three forewarning conditions: uninformed, cautioned to minimize all false alarms, and forewarning about falsely recognizing critical lures. The hit rate for the uninformed group was higher than those for the cautious and forewarned groups. Compared with uninformed and cautious subjects, forewarned subjects reduced their false alarm rate for critical lures (Gallo, Roberts, et al., 1997). These results demonstrate that although forewarning did not eliminate false recognition, it slightly decreased it. Forewarning seemed to diminish the false recognition effect but did not prevent susceptibility to the memory illusion. In 2001, Jeffery Neuschatz led a study to assess if warnings of varying strengths, given immediately prior to recognition testing, could reduce the false memory effect. 131 introductory psychology students across New York were assigned to either receive no warning, a moderate warning, or a strong warning right before recognition testing. They found

no effect of warning strength on the correct recognition of studied items or false recognition of critical lures (Neuschatz et al., 2001). These results suggest that warnings may be ineffective in preventing illusory memories when given *after* the word lists are presented. Jerwen Jou's research found evidence that subject-initiated corrective adjustments facilitated via a two-alternative forced choice test are more effective at reducing the false recognition of critical lures compared to explicit warnings given by the researchers (Jou et al., 2018). Thus, prior research has produced mixed results about the effectiveness of warnings in reducing the false recognition of critical lures. Exploring warning effects naturally led psychologists to wonder if other aspects, like presentation modality, could influence the creation of false memories.

Prior studies indicate that manipulating features of the DRM paradigm, like providing warnings, may help reduce false recognition. Scientists have theorized that the presentation modality of the word lists, visual or auditory, may also impact the rate of correct and false recognition. In 1998, Rebekah Smith and Reed Hunt designed experiments to determine if and how modality plays a role. Twenty volunteers were recruited and randomly assigned to visual or auditory presentation conditions. Their results showed that false identification of critical lures was reliably higher following auditory presentation than visual (Smith & Hunt, 1998). Their findings indicate that the production of false memories in recognition depends on the manner of original list encoding. To further investigate this topic, Gallo studied the effect of manipulating modality within-subject by randomizing the presentation method for each list, for each participant. This study found extremely robust levels of false recognition across both modalities. Additionally, false alarms for critical items were equal to hit rates for list items in all conditions. They also reported no modality effect on recognizing list items and only a small modality effect on falsely recognized critical lures, with visual presentation leading to slightly less frequent false

identification. (Gallo, McDermott, et al., 2001). These studies imply that visual presentation may reduce false memories compared to auditory presentation, but these modality effects are most prevalent when manipulated between-subject rather than within-subject. Although psychologists have manipulated many elements within the DRM paradigm to see their effect on creating false memories, certain combinations of effects have yet to be considered.

The creation of false memories in the DRM paradigm has been abundantly replicated and studied. Previous research has focused on the effects of modality and warning on correct and false recognition when manipulated independently. However, the interaction between modality and warning has been left unexplored thus far. This study aims to investigate the simultaneous manipulation of modality and warning in the DRM paradigm and identify whether an interaction between modality and warning exists. The following hypotheses will be tested in this study:

1. There is no difference between visual and auditory list presentation on correctly recognizing studied list items. [No modality effect on correct recognition.]
2. Warnings given prior to word list presentation will result in a slight decrease in correct recognition. [Small warning effect on correct recognition.]
3. Warnings will have little to no effect on correct recognition when lists are presented auditorily, but will have a slightly stronger effect on correct recognition when lists are presented visually. [Interaction between modality and warning on correct recognition.]
4. Visual presentation will slightly reduce false recognition of critical lure terms compared to auditory presentation. [Small modality effect on false recognition.]
5. Warnings given before word list presentation will slightly decrease the false recognition of critical lure terms. [Small warning effect on false recognition.]

6. Warnings will slightly decrease the rate of falsely recognized critical lure terms for auditory presentation, but warnings will drastically decrease the rate of falsely recognized critical lure terms for visual presentation. [Interaction between modality and warning on false recognition.]

Method

Participants

Participants in this study were recruited by students in the Research Design and Analysis course at Montana State University (MSU) during the spring semester of 2023. Through convenience sampling, data was collected on a total of 80 participants, 39 of which were male and 41 were female. Participants' ages ranged from 18 to 80 years old, as those younger than 18 were excluded from the sample. The mean age of participants was 27.99 years old, with a standard deviation of 14.42 years.

Materials & Measures

Four word lists were selected from those created by Roediger and McDermott. Each of the four lists contained 15 words relating to a non-represented critical lure term. For example, a list may consist of the following words: table, sit, legs, seat, couch, desk, recliner, sofa, wood, cushion, swivel, stool, sitting, rocking, bench. These are all related to the word "chair" which was not presented in the list and, thus, not studied by the participants. The four lists were specifically chosen because they tended to elicit the highest average rate of false recognition in previous studies.

For the recognition portion of the study, participants were instructed to circle either "yes" or "no" next to each word, depending on whether they remembered it being presented. The recognition test was scored to measure two dependent variables: (1) the number of correctly

recognized list items and (2) the number of falsely recognized critical lure terms. These two measures represent the construct of false memory creation in the DRM paradigm.

Procedure

Each student in the Research Design and Analysis class at MSU during the spring of 2023 recruited four people they knew to participate in the study. Age was a selection criterion for participation, as all participants must be at least 18 years of age. Participants were all run individually at locations agreed upon by each student-participant pair.

To begin each session, participants received the informed consent document, had an opportunity to read it and ask questions, and submitted a copy of their signed consent form to the student administrator. Then, the student read scripted instructions to the participant. Depending on the warning condition the participant was assigned to, these instructions either intentionally included or excluded a warning of human susceptibility to falsely recognizing critical lure terms in the DRM paradigm. Participants were given the opportunity to ask any questions before the presentation of the word lists began. Four separate word lists were presented to each participant (either auditorily or visually), with words appearing for approximately 2 seconds, a short pause in between each word, and a slightly longer pause separating each list. Regardless of modality condition, the same words were presented to each participant in the same order at approximately the same speed. The order of the lists and words within each list remained constant across participants as well.

Immediately following the presentation of all word lists, students read a scripted prompt to instruct their participant to complete math problems–a distractor task–for the duration of 2 minutes. The students notified the participant as soon as their time was up and read scripted

instructions for completing the recognition task. Participants were given as long as they needed to complete the recognition task, which was subsequently collected by the student.

After completing the recognition task, participants were fully debriefed about the purpose of the study. Then, students were individually responsible for scoring the recognition task of their participants by counting and recording the number of critical lure terms falsely identified and the number of correctly recognized list items. These activities took, at most, approximately 30 minutes per participant.

Results

To assess whether presentation modality (auditory or visual) and warning (present or absent) impact the creation of false memories, we operationalized false memories in two ways: (1) correct recognition of studied list items and (2) false recognition of critical lure terms. For each participant, we calculated the proportion of correctly recognized list words and the proportion of falsely recognized lures. The individual participant proportions were then separately aggregated into group averages based on their modality and warning conditions.

Participants presented with words lists visually ($M = 0.748$, $SD = 0.031$) correctly recognized list items in only slightly higher proportions, on average, than those presented with words auditorily ($M = 0.713$, $SD = 0.031$). The average proportion of correctly recognized list items was slightly lower in the warning group ($M = 0.729$, $SD = 0.031$) than in the no-warning group ($M = 0.732$, $SD = 0.031$). The mean proportion of correctly recognized items is further broken down by the condition sub-categories in Table 1.

The average proportion of falsely recognized critical lures was lower in the visual condition ($M = 0.594$, $SD = 0.057$) than in the auditory condition ($M = 0.713$, $SD = 0.057$). Those who received a warning falsely recognized lower proportions of critical lures ($M = 0.563$,

SD = 0.057) compared to those who were not warned (M = 0.744, SD = 0.057), on average. The mean proportions of falsely recognized critical lure terms are further broken down into the four possible condition combinations in Table 2.

A 2x2 ANOVA was performed to determine the effect of modality, warning, and their interaction on correct recognition. As hypothesized, there was no evidence to support the existence of a main effect of modality on the correct recognition of studied list items, $F(1, 76) = 0.658$, $MSE = 0.025$, $p = 0.420$, $\eta_p^2 = 0.009$. However, warnings had a slightly different effect than hypothesized; There was no evidence of a main effect of warning on the correct recognition of studied list items, $F(1, 76) = 0.005$, $MSE = 0.000$, $p = 0.946$, $\eta_p^2 = 0.000$. Contrary to my original prediction, there was also no evidence of an interaction between modality and warning on the correct recognition of studied list items, $F(1, 76) = 0.502$, $MSE = 0.019$, $p = 0.481$, $\eta_p^2 = 0.007$. The lack of any main effects or interaction on correct recognition is visualized in Figure 1.

Next, a 2x2 ANOVA was run to investigate the effect of modality, warning, and their interaction on false recognition of critical lures. Counter to my prediction, there was no evidence of a main effect of modality on the false recognition of critical lures, $F(1, 76) = 2.185$, $MSE = 0.282$, $p = 0.143$, $\eta_p^2 = 0.028$. As postulated, there was strong evidence to support the existence of a main effect of warning on the false recognition of critical lures, $F(1, 76) = 5.090$, $MSE = 0.657$, $p = 0.027$, $\eta_p^2 = 0.063$. Additionally, there was no evidence of an interaction between modality and warning on the false recognition of critical lures, $F(1, 76) = 0.490$, $MSE = 0.063$, $p = 0.486$, $\eta_p^2 = 0.006$–which is incongruous with my initial hypothesis. The existence of a main effect for warning on the false recognition of critical lures is further supported by the plots in Figure 2.

Discussion

The study discovered a singular meaningful effect; Warnings influences the rate of falsely recognized critical lures. Participants who received an explicit warning to avoid critical lure terms reported remembering them approximately 18% less often than participants who did not receive warnings. In regards to correct recognition, it was hypothesized that participants who received warnings might recognize list words in slightly lower proportion since they may be more hesitant to identify words they are not confident in remembering, as Gallo, Roberts, and Seamon found (1997). However, there was no evidence of a main effect of warning on correct recognition—potentially suggesting that subjects may have developed alternative strategies for remembering list items. The lack of a warning main effect on correct recognition is consistent with the results found by Neuschatz (2001).

There was no evidence of a modality main effect on the correct recognition of list words or on false recognition of critical lures. This was consistent with the hypothesis that there would be no difference between visual and auditory list presentation on correctly recognizing studied list items. However, the results are contrary to initial predictions that visual presentation would slightly reduce false recognition of critical lure terms compared to auditory presentation. This discrepancy may be due to procedural differences in this experiment compared to previous research. The literature basis for this hypothesis included a free recall period prior to the recognition test (Smith & Hunt, 1998). The absence of a recall task prior to recognition testing in this experiment may have contributed to the lack of a modality main effect of false recognition. Gallo, McDermott, Percer, and Roediger (2001)—who also had recall prior to the recognition task—reported smaller effects than previously found by Smith and Hunt (1998), potentially suggesting that our null effect is not unreasonable.

In contrast to hypothesized results, there were no interactions between modality and warning on correct or false recognition in the DRM paradigm. A variety of lacking controls in the experimental procedures could potentially introduce issues with internal validity, and, therefore, may lead to the null interaction effects found.

Limitations

Broadly speaking, this experiment involved a convenience sample, and thus we cannot assume the results generalize to larger populations. Further, participants were not randomly assigned to modality and warning conditions, and therefore, causality cannot be inferred. In addition to general issues with causality, there were many procedural matters of concern with internal validity as well. These issues can be categorized into two groups: experimenter differences and presentation inconsistencies.

The experimenter differences could have occurred during any part of running participants. It is likely there were differences in reading of the instructions to participants, or that some experimenters may have deviated from the scripted instructions. There are currently no measures in place to account for these things, despite efforts to standardize the instructions. Also, there was no way to standardize answers to questions across participants. Therefore, answers to questions varied in clarity, length, and effectiveness.

There are also substantial presentation inconsistencies in this study. For the visual condition, the exact presentation timing of words likely varied both within-experimenters and between-experimenters. Since no standard was set for font size and font style of the printed words, we can be confident that these factors also differed between experimenters. For the auditory condition, the volume and speed that word lists were read presumably varied between-experimenters, and possibly even within-experimenters. Lastly, the length of the pause

separating the word lists was not standardized either. Although this is not expected to have much, if any, impact, it was still not controlled for.

Altogether, there are various elements of this study that lacked control and may constitute internal validity concerns. Therefore, the researchers advise the replication of this experiment with improved controls to increase internal validity. Specifically, it is recommended that future recreations of the experiment use a computer to administer instructions and word lists; Computer presentation would allow for the standardization of (a) instruction reading, (b) font and text size, (c) volume, (d) time words are presented for, (e) time between words, and (f) time between lists.

Future Research

For future research, it would be interesting to examine differences in modality effects across studies with both recall and recognition testing compared to those with only recognition tests. For studies that involve both recall and recognition tests, it may be intriguing to see if randomizing the order in which participants complete these tests reveals any previously undiscovered order effects that may be lurking in past research.

It is also recommended that incorrectly recognized list words—other than critical lure terms—be investigated as a third response variable. This suggestion stems from the speculation that since no main effect of warning on correct recognition was found, there is potential that subjects may have developed alternative strategies for identifying studied list items. For example, after completing this experiment, one participant mentioned that receiving the warning led them to develop a strategy: they would determine the absent lure word for each list while the words were being presented. Then, they circled “yes” for all words related to the topic, excluding the critical lure term, on the recognition test. Including this additional response variable would allow researchers to assess if participants who receive warnings often adopt this strategy.

Conclusion

Despite the limitations, this research is the first step in exploring simultaneous manipulations of modality and warning on the creation of false memories. Overall, the results of this study indicate that modality has no meaningful effect on the creation of false memories when assessed only with recognition testing. Warnings about human vulnerability to creating false memories seem to impact their rate of intrusion, but only under certain circumstances. Thus far, there is no evidence that the effect of warning on false memory creation differs by modality either. We hope this research inspires further investigation of interactions between modality and warnings on false memories in a variety of circumstances.

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Table 1

Descriptive Statistics for Each Modality-Warning Condition Combination on Correct Recognition of List Items.

Proportion of Correctly Recognized List Items by Condition

Modality Condition	Warning Condition	Mean	Standard Deviation	95% Confidence Interval
Auditory	No Warning	0.730	0.225	(0.624, 0.835)
Auditory	Warning	0.696	0.187	(0.608, 0.783)
Visual	No Warning	0.734	0.172	(0.654, 0.814)
Visual	Warning	0.762	0.196	(0.670, 0.854)

Table 2

Descriptive Statistics for Each Modality-Warning Condition Combination on False Recognition of Critical Lure Terms.

Proportion of Falsely Recognized Critical Lures by Condition				
Modality Condition	**Warning Condition**	**Mean**	**Standard Deviation**	**95% Confidence Interval**
Auditory	No Warning	0.775	0.255	(0.656, 0.894)
Auditory	Warning	0.650	0.348	(0.487, 0.813)
Visual	No Warning	0.713	0.374	(0.537, 0.888)
Visual	Warning	0.475	0.436	(0.271, 0.679)

Figure 1

Line Graph and Bar Graph for Effects of Modality and Warning on Correct Recognition.

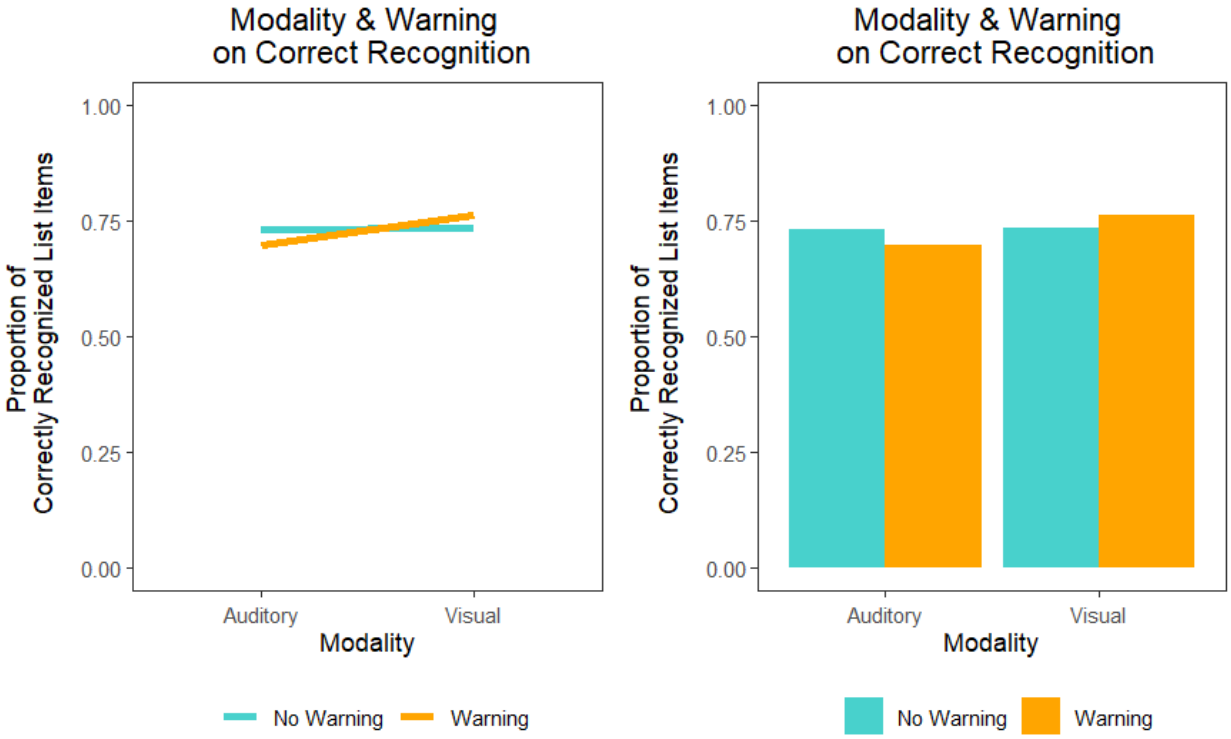

Figure 2

Line Graph and Bar Graph for Effects of Modality and Warning on False Recognition.