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Why seemingly more difficult test conditions produce more accurate recognition of semantic prototype words: A recognition memory paradox?

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ABSTRACT

Subjects studied Deese-Roediger-McDermott semantic-associate lists and took a recognition test. The makeup and number of test probes were manipulated. In Experiments 1 and 2A, one of three or all three distractors were semantically related to the list theme. In Experiment 2B, 6 or 30 related probes were used at test. Results showed that semantically related distractors and a longer list of test words both had a beneficial effect on the accurate discrimination of the prototype lures from the studied semantic associates and on the discrimination of studied from unstudied prototype words. These findings are inconsistent with predictions of memory interference and activation theories. We propose that the counterintuitive findings can be explained by the notion of old/new recognition as categorization learning and that relatedness and a larger number of test probes provide more accurate information about the prototype lure as a distractor, thereby improving its classification as a distractor.

1. Introduction

In the Deese-Roediger-McDermott (Deese, 1959; Roediger & McDermott, 1995, DRM henceforth) paradigm, subjects study 15 semantically associated words (e.g., bed, rest, awake, tired, dream, wake, snooze, blanket, doze, slumber, snore, nap, peace, yawn, drowsy) but not the thematic or prototype word *sleep*. At test, they produce very high percentages of false recall or false recognition of the prototype words, sometimes at levels comparable to those of the studied words. In the standard DRM recognition-test paradigm, for each list of semantic associates, three target and three distractor words are generated as 6 test words. Of the three distractor words one is the prototype lure for the list, and two were words unrelated to the theme. In this study, we manipulated semantic relatedness of the two non-prototype distractors, and examined how it affected the recognition-memory performance for the prototype words (the critical words) in a modified Deese-Roediger-McDermott (DRM) (1995) paradigm. In addition, we varied the number of related test words (both targets and distractors) and examined its effect on the recognition performance of the prototype word.

We now define what we mean by "more difficult test conditions" in the recognition test. There are two competing recognition-memory theories that are relevant to the present purpose, the *item noise* and the *context noise* model. According to the class of *item noise* models of recognition memory derived from the concept of *global matching* as the process of recognition (Malmberg, Criss, Gangwani, & Shiffrin, 2012; Gillund & Shiffrin's, 1984 SAM; Hintzman's, 1988 MINERVA; Neely, Schmidt, & Roediger, 1983; Shiffrin

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& Steyvers, 1997 RAM; see Clark & Gronlund, 1996 for a review), the more numerous, and the more similar, the *items on the study list* are, the greater the item noise in memory, and the poorer the recognition performance will be. According to the *context noise* model (Dennis & Humphreys, 2001), the more numerous and the more similar *the test contexts* in which a test probe is previously presented, the more noise or interference the recognition of that probe will suffer and the lower the recognition accuracy for that probe will be. This is so because all the traces of the items encountered prior to a particular test item will be retrieved during the decision making for that probe and can cause interference for the recognition of that particular item (Criss, Malmberg, & Shiffrin, 2011). A reconciled position between the two opposing views reaches the conclusion that both item and context noises contribute to the decrement in recognition performance (Criss & Shiffrin, 2004). The essence of this principle is the same as the well-known concept of proactive interference that posits that when increasingly more similar items are studied and retained in memory in a continuous learning and test paradigm, memory interference builds up (Watkins & Watkins, 1975; Wickens, 1972). But when the study materials are changed to an unrelated category, memory gets a release from interference, a phenomenon known as the release from proactive interference (Wickens, 1972; Wickens, Born, & Allen, 1963; Wickens, Dalezman, & Eggemeier, 1976). Therefore, by more difficult test conditions we mean either a test condition that contains distractors that are semantically related to the targets compared to one in which they are unrelated to the targets, or a test condition that has a long list of related test words of both targets and distractors compared to one that has a short list of test words.

1.1. *Purposes of the study and a review of related previous studies*

There are two main purposes in this study. The first purpose is to find out how, in general, distractor relatedness and test-word list length affect the recognition performance for the prototype lure in a semantic-associate list learning paradigm. The second purpose is to shed light on a recognition-test design feature that may have played an important role in creating the very high rate of false memory in the DRM paradigm. In this study, we used the DRM semantic associate lists as materials (Roediger & McDermott, 1995; Stadler, Roediger, & McDermott, 1999) to examine how the makeup and the number of test probes can affect the correct recognition of the prototype words and that of the semantic associates. Specifically, how does semantic similarity of distractors to the studied semantic associates as well as the number of test words affect the accurate recognition of the prototype lure and semantic associates? The prototype word in this paradigm has some memory property that makes it different from the semantic associates, namely, its strong potential to create vivid memory illusions (Roediger, 1996). This non-studied thematic word of a semantic-associate list is commonly called the *critical lure* in the DRM paradigm. Although we use the semantic-associate lists in the DRM paradigm as materials, the focus of this research is not to study DRM false memory in the traditional sense. Therefore, we followed the example in Whittlesea (2002) to call this word by a more generic term *prototype lure* since we are studying a broader issue than the DRM false memory. Because our aim was to study a more general issue of how the semantic relatedness of test probes and the number of test probe words affect the recognition of the prototype words (and, parenthetically, the recognition of the semantic associates) rather than the DRM false memory per se, our experimental procedures also differed considerably from the DRM procedures. The findings of the present study should help better understand the mechanism underlying the recognition of the semantic prototype words and the nature of the DRM false memory.

Some previous studies have shown that when the number of semantic associates on the DRM study list is increased, false recall and recognition of the prototype lure also increases (Hancock, Hicks, Marsh, & Ritschel, 2003; Jou, Arredondo, Li, Escamilla, & Zuniga, 2016; Robinson & Roediger, 1997; for a review, see Neely & Tse, 2007). This finding suggests that activation spreading is likely the underlying mechanism generating the false memory (Roediger, Balota, & Watson, 2001; Underwood, 1965). Assuming that spreading activation is driving the DRM false memory, researchers then ask the question of whether the number of semantic associates prior to the presentation of the prototype lure on the list of test probes will also contribute to the generation of the false memory since the larger the number of semantic associates is processed before the prototype lure, the greater the level of spreading activation should be from the earlier processed test words. The important question is whether this effect of spreading activation derives only from the encoding phase of the task or from both the encoding and the testing phases. In addition, the level of spreading activation can be a function of not only the number of semantic associates one encodes, but also a function of the strength of the semantic association of the words. Therefore, whether the test probes are related or unrelated to the target words may also be a contributing factor if indeed spreading activation is the underlying mechanism generating false recall and recognition of the prototype lure.

Regarding how the composition of the test probes affects the recognition performance of the prototype lures as well as the semantic associates, some previous study (Gunter, Ivanko, & Bodner, 2005) found that related distractors in the DRM paradigm, in comparison to unrelated distractors, can lower the FA rate of the prototype lures. Moreover, Gunter et al. (2005) suggested that the effect is the same as that of giving warnings to subjects, since both procedures make subjects more cautious in endorsing a probe item. They further indicated that using related distractors lowers not only the FA rate of the prototype lures, but also the hit rate of the studied semantic associates, which, they argued, indicates that the related distractors do not increase the discriminability between the prototype lures and the studied semantic associates.

We found that although Gunter et al. (2005) examined the distractor relatedness effect on the FA rate of the prototype lures, they did not look into the possibility that the lower FA rate of the prototype lures in the related-distractor condition could possibly be due to an improvement in the discrimination between the studied semantic associates and the prototype lures, not just due to a raise in the judgment criterion. When all the distractors (except for the prototype lure) are unrelated to the studied semantic associates as in the standard DRM paradigm (Roediger & McDermott, 1995, Experiment 2), subjects may use categorical or thematic information to decide on whether the test probe is on the list or not. The heuristic they use may be: If it is associated with the theme, it is probably on