Consciousness and Cognition xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

Can false memory for critical lures occur without conscious awareness of list words?

Daniel D. Sadler*, Sharon M. Sodmont, Lucas A. Keefer[1]

Indiana University of Pennsylvania, Department of Psychology, Uhler Hall, 1020 Oakland Avenue, Indiana, PA 15705, United States

ARTICLE INFO

Keywords:
False memory
Semantic associates
Critical lures
Subliminal processing
Conscious awareness

ABSTRACT

We examined whether the DRM false memory effect can occur when list words are presented below the perceptual identification threshold. In four experiments, subjects showed robust veridical memory for studied words and false memory for critical lures when masked list words were presented at exposure durations of 43 ms per word. Shortening the exposure duration to 29 ms virtually eliminated veridical recognition of studied words and completely eliminated false recognition of critical lures. Subjective visibility ratings in Experiments 3a and 3b support the assumption that words presented at 29 ms were subliminal for most participants, but were occasionally experienced with partial awareness by participants with higher perceptual awareness. Our results indicate that a false memory effect does not occur in the absence of conscious awareness of list words, but it does occur when word stimuli are presented at an intermediate level of visibility.

1. Introduction

The study of false memory has grown exponentially since the introduction of the Deese-Roediger-McDermott (DRM) paradigm. The procedure originated with Deese (1959) as a technique for investigating the effects of associative context on intrusions into free recall for wordlists. The technique was later modified by Roediger and McDermott (1995) and has since become the most widely used procedure for studying associative memory errors (Gallo, 2006). The basic method entails testing recall or recognition after presenting a series of wordlists, each consisting of words that are associates of a nonpresented theme word (called the "critical lure"). Roediger and McDermott (1995) found that participants falsely recalled and falsely recognized the critical lures at very high levels. For example, participants often falsely recalled or recognized the critical lure, *sleep*, after studying a list of 15 associates, including *bed*, *rest*, *awake*, *tired*, *dream*, etc.

Among several theoretical explanations for the DRM false memory effect, an activation-monitoring account seems to have the broadest acceptance (Roediger & McDermott, 2000). By this account, list words activate their conceptual representations in a semantic memory network and this activation automatically spreads along pathways to related concepts (Collins & Loftus, 1975), including the critical lure (Roediger, Balota, & Watson, 2001). Activation from multiple list items converges on the conceptual representation for the critical lure and summates. The level of activation of the critical lure is a function of the sum of its associative strengths with list words (Roediger, Watson, McDermott, & Gallo, 2001). The greater the activation of the critical lure the more likely it will be falsely recalled or recognized. The activated critical lure may enter conscious awareness during list presentation, and subsequently be falsely recalled when participants misattribute the source of their memory of having thought of the word to its

* Corresponding author.
E-mail addresses: Daniel.Sadler@iup.edu (D.D. Sadler), Lucas.Keefer@usm.edu (L.A. Keefer).
[1] Present address: University of Southern Mississippi, Department of Psychology, 118 College Drive #5025, Hattiesburg, MS 39406, United States.

https://doi.org/10.1016/j.concog.2017.10.018
Received 7 March 2017; Received in revised form 9 October 2017; Accepted 27 October 2017

having been presented (Johnson, Hashtroudi, & Lindsay, 1993; Roediger & McDermott, 1995). Similarly, false recognition may also result from source-monitoring errors as the familiarity of a critical lure on a recognition test is mistakenly attributed to the word having been presented (Roediger & McDermott, 1995, 2000; Underwood, 1965). An additional tenet of the activation-monitoring theory is that, although activated during study, a critical lure will not necessarily become conscious, but may still be falsely recognized due to its familiarity from residual activation (Roediger & McDermott, 2000; Roediger et al., 2001). The theory also allows for unconscious activation of critical lures in the absence of conscious processing of list items (Roediger et al., 2001), and draws support from studies that have demonstrated unconscious semantic priming using a subliminal priming paradigm (e.g., Balota, 1983; Marcel, 1983).

As discussed in the review that follows, the question of whether false memory can arise from unconscious activation of critical lures has been a subject of considerable debate. Attempts to demonstrate false memory from unconscious activation of critical lures have been unable to produce unambiguous evidence. The major limitation of these earlier studies is that they have attempted to demonstrate false memory from unconscious activation of list words by trying to minimize, but not eliminate, conscious awareness of list words during study. As long as list words are being consciously processed, the possibility that critical lures are also consciously processed cannot be excluded. The rationale for the present study is that the subliminal priming paradigm offers the best hope of demonstrating that associative memory errors can arise from unconscious processing of critical lures.

Seamon, Luo, and Gallo (1998) examined whether false recognition memory in DRM studies can arise from unconscious activation of the critical lure by creating study conditions that minimized conscious processing of list items. They manipulated conscious awareness of list items by varying two factors: exposure duration of items (2 s, 257 ms, or 20 ms) during list presentation and concurrent memory load (either no load or retention of a single sequence of seven digits throughout the presentation of all study lists). Corrected recognition rates were calculated for studied words by subtracting the false alarm rates for nonstudied list words from the hit rates for studied list words and for critical lures by subtracting the false recognition rates for unrelated critical lures from the false recognition rates for related critical lures. Their results showed a decrease in correct recognition for studied words, but not false recognition of critical lures, as exposure duration decreased from 2 s to 20 ms. At 20 ms, the false recognition rate for critical lures was significantly higher than the correct recognition rate for studied words. While claiming that this finding is consistent with the hypothesis that unconscious activation of critical lures at study can produce a false memory effect, they noted that memory for studied words had been reduced, but not eliminated. They claimed to provide further evidence for the unconscious activation hypothesis from a comparison of subjects classified as good- and poor-memory subjects on the basis of a median split on studied word recognition performance in the 20 ms memory load condition. Whereas good-memory subjects had similar corrected recognition rates for studied words (.22) and critical lures (.27), poor-memory subjects had a significantly higher false recognition rate for critical lures (.20) than their near zero rate for studied words (.03).

Seamon et al. (1998) concluded that their results support the view that false recognition of critical lures can be caused by unconscious activation of these items at study. The main support for their conclusion was the finding that poor-memory subjects in the 20 ms memory load condition demonstrated false memory for critical lures while showing virtually no correct recognition of studied words. As an explanation for the obvious question of why participants would forget the studied words that produced the unconscious activation of critical lures, they proposed that, whereas activation of briefly presented studied words may be short lived, activation of a critical lure may be stronger and more persistent due to its repeated activation as an unconscious associative response to the semantically related list words. At test, with their activations having decayed, studied words are not recognized, while the still unconsciously activated critical lures lead to false recognition.

The conclusion by Seamon et al. (1998) that false memory for critical lures can arise from unconscious associative responses to list words is based on the assumption that the lack of explicit memory for list words in the poor memory subjects implies that critical lures were not consciously activated during list presentation. However, the evidence for a lack of explicit memory for list words in the poor-memory subjects is questionable due to the problematic use of a median split on correct recognition for list words to define good and poor memory (Zeelenberg, Plomp, & Raaijmakers, 2003). It is likely that this technique capitalizes on chance. When a list of 15 words is presented at the very rapid rate of 20 ms per word, during the 300 ms presentation of the entire list, subjects may be able to consciously identify only a few words. Given that the subset of identified words will vary across subjects, those who, by luck, happen to fairly consistently identify one or more of the three words selected for the recognition test (the first, third, and tenth items in Seamon et al., 1998) can be expected to have higher correct recognition rates at test than those who have worse luck by identifying the same number of words in lists, but words that were less often included among the three test words selected from each list. Thus the lack of evidence for explicit memory in poor-memory subjects may simply be an artifact of the median-split technique and a recognition test that included only 20 percent of list words, and their false memory for critical lures may be due to conscious activation of those words arising from conscious activation of several list words that were not later tested for recognition.

The goal of presenting word lists at the rate of 20 ms per item with a 0 ms interstimulus interval (ISI) would seem to be to test whether unconscious semantic priming of critical lures might lead to false memory in the absence of conscious awareness of list words. However, Gallo and Seamon (2004) have stated that the purpose of the 20 ms condition in the Seamon et al. (1998) study was not to eliminate perception of items, but rather to minimize conscious processing of items by making it extremely difficult, and thereby minimize conscious generation of critical lures. This goal is implicitly based on the assumption that there is some minimal level of conscious processing of list words that is sufficient to activate the critical lure, but will not bring it into conscious awareness. Zeelenberg et al. (2003) have questioned the validity of this assumption, arguing that as long as there is any conscious awareness of list items, the possibility that critical lures were consciously generated cannot be ruled out. Their study was designed to determine whether unconscious semantic priming of critical lures would occur when conscious awareness of list words is eliminated. Like Seamon et al. (1998), they used rapid presentation of list items: a 20 ms exposure duration with a 0 ISI. Stimuli were presented using