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Recall latencies, confidence, and output positions of true and false memories: Implications for recall and metamemory theories ☆

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Abstract

Recall latency, recall accuracy rate, and recall confidence were examined in free recall as a function of recall output serial position using a modified Deese–Roediger–McDermott paradigm to test a strength-based theory against the dual-retrieval process theory of recall output sequence. The strength theory predicts the item output sequence to be in the descending order of memory strength. The dual-retrieval process theory postulates two phases in a free recall, a first direct access phase in which items are output verbatim in the weakest-to-strongest order (cognitive triage) and a second reconstructive phase in which reconstructed items are output in the strongest-to-weakest order. In four experiments, all three indicators of memory strength (latency, accuracy, and confidence) consistently showed a descending-strength order of recall both for true and false memories. Additionally, false memory was found to be output in two phases and subjects' confidence judgment of their own memory to be unaccountable by retrieval fluency (recall latency).

Keywords: Recall latencies; Recall output position; False memory; Metamemory

The main purpose of this study is to examine the relationship between memory strength of remembered items and their sequential output order in free recall. Research results have been inconsistent regarding the relationship between these two variables. Two theoretical perspectives make different predictions. The first view will be termed *memory strength* theories (Anderson, 1976, 2005; Dosher, 1984; Gillund & Shiffrin, 1984; Norman, 2002; Wixted, Ghadisha, & Vera, 1997). These theories hold that the output sequence of items in a free recall follows the decreasing order of memory strength or activation of the items, i.e., recall output order is from the strongest to the weakest item. Also, according to these theories, the retrieval time for stronger memory is shorter than for weaker memory. The other perspective will be termed the *dual-retrieval processes* theory (Brain-

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erd, 1995; Brainerd, Olney, & Reyna, 1993; Brainerd, Reyna, Howe, & Kevershan, 1991; Brainerd, Wright, Reyna, & Payne, 2002). This theory holds that there are two phases in the process of a free recall, a first verbatim retrieval, or direct access phase, and a second gist-based, constructive or reconstructive phase. Also, according to this theory, the direct retrieval process is subject to output interference, whereas the reconstructive process is not subject to this interference. Moreover, in the first verbatim phase of recall, the item with the weakest memory trace is output first and the item with the strongest memory trace is output last. This strategic recall process of giving the top priority to the weakest item is known as *cognitive triage* (Brainerd, 1995; Brainerd, Reyna, & Howe, 1990a; Brainerd et al., 1991) and its function is to minimize the output interference for the weakest item. Although the output order in the first phase is from the weakest to the strongest, in the second reconstructive phase, the output order follows the decreasing order of strength, i.e., the strongest constructed item is output first, and the weakest one the last. Brainerd and his associates have demonstrated the cognitive triage phenomenon of the dual-retrieval recall process in many developmental studies (Brainerd et al., 1990a, 1993; Brainerd, Reyna, Howe, & Kevershan, 1990b, 1991). Similarly, Barnhardt, Choi, Gerkens, and Smith (2006) recently demonstrated the same phenomenon with adult subjects and found no evidence supporting the strength theory. Brainerd (1995) and Brainerd et al. (1990a) argued that cognitive triage in free call is not just a memory strategy but rather a *basic* memory interference minimizing process because neither children as young as age 6 (before they start to use any memory strategy) nor adults have conscious awareness of using a deliberate strategic control when cognitive triage can be observed in their recall.

On the other hand, in a free recall study using frequency of presentation as a strength manipulation, Wixted et al. (1997) found that items (in a strong and weak items mixed list) with greater memory strength yielded a shorter recall latency than items with weaker memory strength, providing strong evidence supporting the strength theory, and no evidence at all for the dual-retrieval processes theory. Therefore, this issue deserves further investigation. The primary goal of the present study is to further investigate this issue and test the two theories.

In previous studies, memory strength was either measured by the proportion of accurate recall (Brainerd, 1995) or defined by the number of times an item was studied (Dosher, 1984; Wixted et al., 1997) or by study time (Rohrer & Wixted, 1994). Also, confidence rating was found to be negatively correlated with latency but positively correlated with accuracy both in recognition (Jou, Matus, Aldridge, & Rogers, 2004; Robinson, Johnson, & Herndon, 1997) and recall (Koriat, 1993; Nelson, Gerler, & Narens, 1984; Nelson & Narens, 1990). Hence, accuracy, recall latency, and confidence have been used as indices of memory strength by researchers. In the present study, all three measures were used as indices of memory strength and as converging evidence for testing the theories. In addition, the materials and a modified procedure in the Deese–Roediger–McDermott (DRM) (Deese, 1959; Roediger & McDermott, 1995) paradigm were used because the high rate of false memory this procedure generates insured the occurrence of high frequency of constructed memories in the recall output for testing the dual-retrieval processes theory.

Also to be examined in this study is the question of whether recall latency or output serial position (SP) can account for the confidence judgments subjects make of their memory. One possibility is that subjects heavily rely on the *retrieval fluency* (Kelly & Rhodes, 2002), or the ease and quickness with which information comes to mind as the basis of confidence judgment (Kelly & Lindsay, 1993; Lindsay & Kelley, 1996; Mazzoni & Nelson, 1995). Nelson and Narens (1990) referred to this idea as *confidence-determined-entirely-by-latency* hypothesis. Another possibility is that the retrieval or recall latency cannot account for the confidence or lack of confidence subjects indicate for the recalled words. In that case, subjects may use other cues to evaluate the validity of their memory and they have the conscious access to the difference in the sources of the correct and incorrect memories (Koriat, 1993, 2007).

Jou et al. (2004) showed that false memory as defined in the DRM paradigm produced a significantly longer recognition latency than true memory, and suggested that the activation level of false memory is lower than true memory. Therefore, still another purpose of this study is to determine whether such a latency difference between true and false memory also exits in recall. A recall latency was measured in this study as the time elapsed between the end of typing a word and the end of typing the next word in a self-paced sequential free recall test. It is assumed that the pause before typing the word contributes significantly to the word's production time. If recall latency for false memory is indeed longer than for true memory, then the distinction in response time between true and false memories can be generalized across recognition and recall. If false memory can be shown to have longer recognition and recall latencies than true memory, then false memory can be considered a weaker form of memory than true memory from the strength point of view (Wixted et al., 1997).

Experiment 1

Experiment 1 used the DRM materials and a modified DRM procedure to measure the recall latencies