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Examining the dynamics of strategic search from long-term memory

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ABSTRACT

In two experiments the dynamic nature of strategic search from long-term memory was examined. Participants retrieved exemplars from various categories over several minutes. Periodically during retrieval participants were presented with a probe asking what strategies, if any, they were currently using to retrieve the desired information. This novel thought probe technique allowed for insights into the nature of in-the-moment retrieval strategies. Across both experiments it was found that participants reported using a variety of strategies, but depending on the task certain strategies were used more often than others. In particular, some strategies were used more frequently in one task than another, whereas other strategies seemed to cut across tasks. Furthermore, examining the time course of strategies suggested that participants often started off using one strategy, but then switched to using other strategies during the retrieval period. Finally, individual differences in general retrieval abilities were shown to be due to unique and joint contributions of search strategies and working memory capacity. These results provide evidence for the notion that when retrieving information from long-term memory, participants use various search strategies that are tailored to the task at hand and these strategies dynamically change throughout the retrieval period.

Introduction

Throughout the day we are constantly being asked to retrieve facts, events from our life, names of acquaintances, and other important information. The ability to retrieve this information, generally in the absence of potent external cues, is vital for the success of many everyday tasks. As such, strategic retrieval processes are critical aspects of the overall cognitive system. In the current study we examined retrieval processes in a variety of tasks to better examine the dynamics of strategic search from long-term memory (LTM).

Strategic search processes

A number of models of LTM retrieval assume that a search process is used to find and select information from LTM (e.g., Howard & Kahana, 2002; Polyn, Norman, & Kahana, 2009; Raaijmakers & Shiffrin, 1980; Shiffrin, 1970; Williams & Hollan, 1981; Wixted & Rohrer, 1994). In these models, retrieval relies on a cyclical search process in which the generated information is used as an additional cue to refine the search (e.g., Davelaar & Raaijmakers, 2012; Raaijmakers & Shiffrin, 1980; Williams & Hollan, 1981). In particular, the search process begins with an overarching general cue and then proceeds by utilizing information generated by this cue to further cue the memory system (Graesser & Mandler, 1978; Gruenewald & Lockhead, 1980; Herrmann & Pearle, 1981; Hills, Jones, & Todd, 2012; Hills, Todd, & Jones, 2015;

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Reiser, Black, & Abelson, 1985; Whitten & Leonard, 1981; Williams & Hollan, 1981; Wixted & Rohrer, 1994). An important aspect of search frameworks is the notion that there are both directed and random components to the overall search process (Shiffrin, 1970; Shiffrin & Atkinson, 1969). The directed component refers to strategic processes that are under direct control of the individual. These directed control processes include setting up a retrieval plan, selecting and generating appropriate cues to search memory with, as well as various monitoring strategies and decisions to continue searching or not. The random component refers to the probabilistic nature of the search process in which a subset of information is activated by the cues and representations are subsequently sampled and recovered from this subset (Raaijmakers & Shiffrin, 1980; Shiffrin, 1970). Thus, directed control processes are critically important for successful retrieval from LTM (Atkinson & Shiffrin, 1968; Benjamin, 2008; Hintzman, 2011; Nelson & Narens, 1990).

To examine strategic search processes, researchers have relied on a number of different techniques including using think-aloud protocols, manipulating strategy use by instructing participants to use specific retrieval strategies, or directly asking what strategies participants used after the retrieval task. Each of these methods has provided important information on which strategies are likely to be used and the overall effectiveness of particular strategies. For example, Williams and Hollan (1981) had participants name individuals they went to high school with while utilizing a think aloud procedure in which participants were instructed to say everything that came to mind during recall. Williams and Hollan (1981) found that participant's utilized a number of different strategies to generate names including thinking of different activities individuals participated in, thinking of different locations individuals were associated with, thinking of names that began with each letter of the alphabet, generating and mentally scanning pictures from yearbooks, as well as starting with a given individual and thinking of people associated with that individual. Thus, rather than merely automatically retrieving information from LTM, search strategies allowed individuals to dynamically search LTM via multiple different routes. Importantly, Williams and Hollan also noted that participants typically adopted strategies for some time and then shifted to other strategies when the current strategy was no longer generating usable information. In a similar vein, Whitten and Leonard (1981) had participants name their teachers while thinking aloud and found that participants used a variety of different strategies (including a visual location strategy). Similarly, Walker and Kintsch (1985) found that participants used a number of different strategies (again including a visual location strategy) when retrieving a variety of different items from LTM (including retrieving types of automobiles, types of soups, and types of detergent). Importantly, these studies demonstrate that when asked to retrieve information from LTM in a prolonged retrieval task, participants spontaneously use a variety of different strategies, many of which are tailored to the specific task, and some that seem to cut across tasks (such as a visual location strategy).

In addition to using think-aloud procedures to determine in-the-moment strategies, a number of studies have instructed participants to use various retrieval strategies as a means of determining the effectiveness of different strategies. For example, Whitten and Leonard (1981) had participants name their teachers either in a backward order, a forward order, or in a random order. Whitten and Leonard found that a backward search resulted in better retrieval than the other orders. Similarly, Gronlund and Shiffrin (1986) had participants retrieve information from LTM via different instructed strategies. For example, participants had to retrieve animal names using no strategy (free recall), in alphabetic order, or in order based on size. Gronlund and Shiffrin found that that the free recall condition resulted in much better performance than the alphabetic or size strategy conditions suggesting that some retrieval strategies can lead to poor retrieval. Following up on this research we (Unsworth, Brewer, & Spillers, 2014) had participants retrieve animal names using an alphabetic strategy, a semantic strategy (retrieve animals based on shared semantic characteristics), a size strategy, a visual location strategy (retrieve animals by visualizing different locations where you may find animals), or no strategy. Similar to Gronlund and Shiffrin (1986) we found that the free retrieval condition was better than the alphabetic or size conditions. Interestingly we found that the free and visualization conditions resulted in identical performance and the semantic condition was not quite as good (perhaps due to the ambiguous nature of this condition whereby participants could have interpreted it differently). In an additional experiment we had participants name their friends with a variety of different strategy instructions and found that free retrieval and various visualization conditions resulted in the same levels of performance, which was much better than various ordered strategies (e.g., alphabetic, forward chronological, backward chronological). Thus, across various retrieval tasks some strategies (visualization) seem to produce better performance than other strategies (ordered search).

Finally, examining retrospective strategy reports suggests that participants use a variety of different strategies and some strategies correlate with overall retrieval levels better than others. For example, Schelble, Therriault, and Miller (2012) had participants name animals and then fill out a questionnaire regarding the various search strategies they used to perform the retrieval task. Schelble et al. found that participants reported a number of different strategies with the most common being environments, locations, classification, animals that live with humans, and personally relevant animals. Similarly, Unsworth et al. (2014) had participants name animals and fill out a retrospective questionnaire on various strategies. We found that the most common strategies were visualization of various locations, semantic strategies (similar to Schelble et al.'s classification), and no strategy (i.e., items passively came to mind). In a subsequent experiment naming friends, we similarly found that participant reported using visualization strategies, personal relevance, and again a high proportion indicated using no strategy during some aspects of the retrieval. Similar to the results from think-aloud procedures and from strategy instruc-