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Exploring the role of attention during implicit memory retrieval

Jeffrey P. Lozito [a], Neil W. Mulligan [b,*]

[a] SA Technologies, Marietta, Georgia, United States
[b] Department of Psychology, University of North Carolina, Chapel Hill, NC 27599, United States

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ABSTRACT

The role of attention during implicit memory retrieval was assessed using a test-phase division of attention. Implicit retrieval is dissociable into perceptual and conceptual forms. Implicit retrieval is further dissociable into tests that involve stimulus identification or stimulus production. The present study used implicit tests that varied on these dimensions. Experiment 1 used a perceptual identification test; Experiment 2 used a word-stem completion test; and Experiment 3 used a category-exemplar production test. Attention was divided with one of several secondary tasks. None of the secondary tasks reduced levels of priming for any of the implicit tests. Furthermore, implicit retrieval generally facilitated secondary task performance rather than producing secondary task costs as is typical with explicit memory. A fourth experiment indicated that explicit recall was negatively affected by most of the secondary tasks, and exhibited a different pattern of secondary task costs. All of the above is consistent with the idea that implicit retrieval is automatic.

Introduction

Memory retrieval is a frequent occurrence during the course of a typical day. Given that daily demands dictate that we often juggle several tasks simultaneously, it is likely that some memory retrieval occurs whilst doing something else at the same time (e.g., maintaining a conversation with someone while simultaneously trying to remember who exactly they are!). A common belief is that people cannot perform two tasks concurrently as well as they could perform each task independently. With this in mind, it is important to understand the effects of distraction on remembering.

In laboratory studies, the effects of distraction are assessed by comparing a divided attention (DA) condition, in which participants carry out a memory task while simultaneously performing a secondary task, and a full attention (FA) condition, in which participants perform only the memory task. Attention can be divided during the encoding phase, the retrieval phase, or both. It has long been recognized that dividing attention during memory encoding has a large, deleterious effect on subsequent performance (see Mulligan (2008), for review). Examining attention during retrieval, however, is a more recent development in the literature and has yielded mixed results with some studies finding large DA effects (e.g., Fernandes & Moscovitch, 2000, 2003; Hicks & Marsh, 2000; Lozito & Mulligan, 2006) and others little effect (e.g., Baddeley, Lewis, Eldridge, & Thompson, 1984; Craik, Govoni, Naveh-Benjamin, & Anderson, 1996).

Initial research found that DA had little effect on memory retrieval prompting the conclusion that memory retrieval is largely automatic (e.g., Baddeley et al., 1984). Subsequent research by Craik, Naveh-Benjamin and colleagues disputed this by showing that although the secondary task failed to affect retrieval, retrieval produced large and consistent costs to secondary task performance (Craik et al., 1996; Naveh-Benjamin, Craik, Gavrilescu, & Anderson, 2000). The secondary task costs imply that retrieval requires attentional resources, prompting Craik et al. (1996) to conclude that retrieval is attention-demanding yet obligatory (Anderson, Craik, & Naveh-Benjamin, 1998; Craik, Naveh-Benjamin, Ishaik, & Anderson, 2000; Craik et al., 1996; Naveh-

* Corresponding author.
E-mail address: nmulligan@unc.edu (N.W. Mulligan).

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Benjamin & Guez, 2000; Troyer & Craik, 2000). In contrast, other studies have found large, deleterious effects of DA on recall and recognition (Carrier & Pashler, 1995; Fernandes & Moscovitch, 2000, 2003; Hicks & Marsh, 2000; Jacoby, 1991; Lozito & Mulligan, 2006), showing that at least under some circumstances, memory retrieval can be disrupted by DA.

Fernandes and Moscovitch (2000) and Fernandes, Moscovitch, Zeigler, and Grady (2005) documented one such set of conditions. These researchers varied the match between the materials used on the memory test (words) and the materials used in the secondary task (words or digits). These authors found that when the materials used on the memory test and secondary task matched (i.e., both used word stimuli), DA significantly reduced recall and recognition, but when the materials were of different types (e.g., a word-based memory test and a number-based secondary task), memory performance was not reduced (a pattern referred to as *material-specific interference*). Other work suggests that the type of retrieval is critical (Hicks & Marsh, 2000; Lozito & Mulligan, 2006), with retrieval primarily driven by recollection being highly susceptible to DA, and familiarity-driven retrieval less so.

Although a growing body of research has explored the role of attention during memory retrieval, a critical limitation is that virtually all of this research has focused on explicit memory. Little research has focused on the role of attention during implicit retrieval. Explicit memory refers to conscious or intentional recollection of prior events, assessed with tests such as recall and recognition; implicit memory refers to unintentional or unconscious influences of memory, typically assessed on tests of repetition priming (Mulligan, 2003b; Schacter, 1987).

Implicit retrieval is dissociable into perceptual and conceptual forms. *Perceptual priming* reflects implicit memory for stimulus form and includes tests such as word-stem completion and perceptual identification. *Conceptual priming* reflects implicit memory for stimulus meaning and includes the test of category-exemplar production. Because perceptual tests reflect visual or auditory information about a stimulus, such tests are general sensitive to changes between study and test items in perceptual information, such as changes in modality (visual vs. auditory) or form (e.g., picture vs. word), and generally insensitive to conceptual encoding manipulations. Because conceptual priming is heavily reliant on semantic information about the items, it generally exhibits the opposite pattern. Conceptual tests are sensitive to encoding manipulations that emphasize semantic features of stimuli and are insensitive to perceptual manipulations such as changes in study modality (see Mulligan (2003b) and Roediger and McDermott (1993), for reviews). Importantly, dividing attention at study has dissociated perceptual and conceptual implicit tests. DA at study consistently reduces conceptual priming (Gabrieli et al., 1999; Mulligan, 1997, 1998; Mulligan & Hartman, 1996) whereas perceptual priming is less likely to be disrupted by the same DA manipulations (Mulligan, 2003a; Mulligan & Hartman, 1996; Mulligan & Hornstein, 2000; Russo & Parkin, 1993).

Another distinction, orthogonal to the perceptual-conceptual distinction, differentiates between production and identification priming (Fleischman et al., 2001; Gabrieli et al., 1999; LaVoie & Faulkner, 2008). *Identification priming tasks* instruct participants to identify a test stimulus, or verify an attribute of the stimulus. Identification tests can involve the analysis of either the form or the meaning of a stimulus, which may be presented normally or in degraded form. An example is perceptual identification, in which participants attempt to identify a fragmented or briefly presented stimulus. In identification tests, the retrieval cue and task requirements determine a single correct response. *Production priming tasks* are those in which test cues do not uniquely define the information to be retrieved but merely delimit a class of possible correct answers. An example is the word-stem completion task in which the word stems (e.g., *sto__*) match many legitimate completions (e.g., *store*, *stone*, *stole*, *storm*, etc.). For production tests, cues map onto (or activate) many potential responses.

The identification—production distinction is supported by a number of dissociations (e.g., Fleischman et al., 2001; Gabrieli et al., 1999; LaVoie & Faulkner, 2008). Critically for present purposes, it has been argued that identification and production tasks differ in attentional demands during retrieval (Fleischman et al., 2001). According to this view, production tests require the selection of a response from an array of potential responses, eliciting a degree of response competition not present in identification tests. Increased response competition is claimed to induce heavier attentional demands during retrieval for production tests relative to identification tasks (Fleischman et al., 2001; Gabrieli et al., 1999). Gabrieli et al. (1999) demonstrated that dividing attention during study affected production tasks more than identification tasks (see also, Mulligan & Peterson, 2008). However, the notion that production tests require attention at retrieval has not been evaluated.

The foregoing analyses suggest that some types of priming (e.g., conceptual or production) may rely on attention during retrieval. Other lines of research imply that implicit retrieval should be generally automatic (*the automaticity hypothesis*) (e.g., Gooding, Mayes, van Eijk, Meudell, & MacDonald, 1999; Jacoby, 1991; Moscovitch, 1992). First, Logan (1990) argued that repetition priming and automaticity result from a common underlying mechanism—the storage and retrieval of representations of individual exposures to (or instances of) specific items. Logan argued that the re-exposure of an old item on an implicit test decreases the demands for processing that item. As a result, the improvement in performance (i.e., priming) is due to increased automaticity. Second, neuroimaging research supports the notion of increased automaticity in the processing of old items. Compared to new items, old items exhibit less neural activation, indicating that the priming component of implicit tests reflects a *decrease* in brain activity (a phenomenon referred to as *repetition suppression*; Grill-Spector, 2008; Horner & Henson, 2008). Finally, other analyses also imply that non-conscious retrieval is largely automatic (e.g., Jacoby, 1991; Voss & Paller, 2009; Yonelinas, 2002).

Prior research on attention and implicit retrieval is quite limited but has produced some support for the automaticity hypothesis (e.g., Clarke & Butler, 2008; Gooding