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Retrieval-induced forgetting in item recognition: Retrieval specificity revisited

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ABSTRACT

Retrieval-induced forgetting (RIF) refers to the finding that retrieval practice on a subset of studied items can induce later forgetting of related unpracticed items. Although previous studies indicated that RIF is retrieval specific – i.e., it arises after retrieval practice but not after reexposure cycles -, the results of more recent work suggest otherwise, indicating that some reexposure formats can induce RIF very similar to how retrieval practice does. Whereas this prior work employed recall at test, here we revisited retrieval specificity of RIF employing item recognition. The results of three experiments are reported, which examined the effects of retrieval practice and some of the recently suggested reexposure formats on unpracticed items' recognition. In each of these experiments, we showed RIF after retrieval practice but did not find any evidence for RIF-like forgetting after reexposure. These findings demonstrate retrieval specificity of RIF in item recognition, challenging strength-based accounts of RIF and indicating a critical role of inhibition in RIF. Together with the results from the recent recall studies, which we replicated in three further experiments, the present findings are consistent with a two-factor account of RIF, which assigns a role for both inhibition and strength-based blocking in RIF. While both inhibition and blocking may contribute to RIF in certain recall formats, only inhibition may induce RIF in item recognition.

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Introduction

Selective retrieval of a subset of studied items can lead to forgetting of related, but not retrieved items. This effect has repeatedly been demonstrated in the retrieval practice paradigm (Anderson, Bjork, & Bjork, 1994). In this paradigm, subjects often learn a categorized item list (e.g., FURNITURE – *lamp*, INSECT – *hornet*, INSECT – *termite*, etc.) in an initial study phase, and, after study, repeatedly retrieve some of the items of some of the categories providing the items' category label and word stem as retrieval cues (e.g., INSECT – *te*___). On a later category-cued recall test, all originally studied items are tested. The typical finding is that recall for the practiced items (e.g., *termite*) is enhanced, but recall for the unpracticed items from the practiced categories (e.g., *hornet*) is impaired, relative to the control items from the unpracticed categories (e.g., *lamp*). The recall impairment for the unpracticed items has been termed *retrieval-induced forgetting* (RIF) and has been shown over a wide range of materials and settings (e.g., Ciranni & Shimamura, 1999; Healey, Ngo, & Hasher, 2014; Levy, McVeigh, Marful, & Anderson, 2007; Storm & Angello, 2010) and a variety of testing formats (e.g., Anderson et al., 1994; Anderson & Spellman, 1995; Hicks & Starns, 2004; Veling & van Knippenberg, 2004).

Anderson et al. (1994) suggested that RIF is induced by active inhibition operating at the retrieval practice stage. According to this view, during retrieval practice, the

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practiced categories' not-to-be-retrieved items interfere and are actively inhibited to reduce the interference. Such inhibition is supposed to impair the memory representation of the unpracticed items, reducing access to these items on a later memory test (e.g., Anderson, 2003; Bäuml, Pastötter, & Hanslmayr, 2010; Storm & Levy, 2012). An alternative, noninhibitory account of RIF attributes the forgetting to strength-based blocking processes. Proponents of this view argue that, in the practice phase, the cue-item associations of the practiced items are strengthened, and such strengthening introduces interference of these items during recall of the unpracticed items, thus reducing unpracticed items' recall performance (e.g., Raaijmakers & Jakab, 2013; Verde, 2013). More recently, another noninhibitory account has been suggested, which assumes that the attempt to retrieve items in the practice phase induces a shift in context, thus creating distinct study and practice contexts. According to this account, subjects access the practice context at test when searching for the (practiced and unpracticed) items of the practiced categories but access the study context when searching for the control items, so that memory for the unpracticed items may be reduced relative to the control items and RIF may arise (Jonker, Seli, & MacLeod, 2013; see also Anderson & Bjork, 1994, for an early outline and rejection of a highly similar account). The primary focus of the present study was to contrast the inhibition and blocking accounts of RIF, and it was therefore designed to examine these two accounts. Although the study was not designed to examine the context account, the results will also bear implications for this account. Finally, the results will also allow evaluation of a more general two-factor account of RIF, according to which at least two mechanisms may contribute to RIF (see General discussion section).

Retrieval specificity: the first line of studies

Over the years, several RIF findings have been suggested to be indicative for a critical role of inhibition in RIF (for an overview, see Anderson, 2003). One of these is *retrieval specificity*, the finding that retrieval practice but not restudy may induce forgetting of the unpracticed items. While strength-based accounts of RIF predict that the forgetting of unpracticed items is not restricted to retrieval practice but, in principle, can arise after any kind of strengthening of the cue-item associations of the practiced items, inhibition advocates suggest that the forgetting is retrieval specific. According to this view, retrieval practice, but not restudy of the practiced items, should induce interference and inhibition of the unpracticed items during practice, and thus impair memory for the unpracticed items at test.

Two methods have originally been employed to examine retrieval specificity of RIF: restudy and noncompetitive retrieval practice. In both methods, the to-be-practiced items are reexposed intact with the goal of strengthening the items' associations to their cue without inducing interference and inhibition of related unpracticed items. When employing the restudy method, some of the originally studied category-item pairs were reexposed (e.g., INSECT – *termite*) and participants were instructed to study the word pairs once again. When employing the noncompetitive retrieval practice method, some of the originally studied items were reexposed and subjects were asked to recall the items' category label given the category's word stem as a retrieval cue (e.g., IN___ – *termite*). The results of many studies reported (i) forgetting of unpracticed items after standard (competitive) retrieval practice but not after restudy cycles (e.g., Bäuml & Aslan, 2004; Ciranni & Shimamura, 1999; Dobler & Bäuml, 2013; Hulbert, Shivde, & Anderson, 2012; Staudigl, Hanslmayr, & Bäuml, 2010) and (ii) forgetting of unpracticed items after standard (competitive) retrieval practice but not after noncompetitive retrieval practice (e.g., Anderson, Bjork, & Bjork, 2000; Ferreira, Marful, Staudigl, Bajo, & Hanslmayr, 2014; Hanslmayr, Staudigl, Aslan, & Bäuml, 2010). These findings support retrieval specificity and the inhibition account of RIF and challenge strength-based explanations of RIF.

Retrieval specificity: the second line of studies

More recently, some researchers argued that the previous findings on retrieval specificity may not necessarily contradict assumptions of strength-based accounts of RIF, because reexposure format may be critical for whether reexposure induces forgetting or not (e.g., Raaijmakers & Jakab, 2012; Verde, 2013). Indeed, plain reexposure may not induce forgetting of the unpracticed items, because it may strengthen the representation of the practiced items without strengthening the items' associations to the cue, which may not be sufficient to cause blocking at test. In contrast, RIF may no longer be found to be retrieval specific if retrieval practice was compared to reexposure formats that, like retrieval practice is supposed to do, enhance the cue-item associations of the practiced items. In such case, forgetting of the unpracticed items may arise after both retrieval practice and reexposure, which would be consistent with strength-based accounts of RIF and challenge retrieval specificity and the inhibition view of RIF.

Results from two recent studies support such a view. Employing a modification of the original noncompetitive retrieval practice condition, Raaijmakers and Jakab (2012) had subjects study category-exemplar pairs (e.g., ROUND – *ball*) and asked the subjects in the practice phase to recall a pair's category label presenting the exemplar as a retrieval cue (e.g., ___ – *ball*). In contrast to Anderson et al.'s (2000) original design, the word stems of the category labels were not presented as retrieval cues and items of relatively low frequency within their categories were employed, conditions that likely make noncompetitive retrieval practice more demanding than in the original studies. Doing so, Raaijmakers and Jakab found reduced recall of the unpracticed items after noncompetitive retrieval practice, indicating that the strengthening of the category-exemplar associations can be sufficient to induce the RIF finding (for a related result, see Jonker & MacLeod, 2012).

In the second study, Verde (2013) employed a modification of the original restudy condition, testing the hypothesis that reexposure formats that strengthen category-item associations can induce forgetting similar to how retrieval practice does. Verde designed two reexposure tasks supposed to enhance the category-item associations of

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