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RESEARCH REPORT

The Two Faces of Selective Memory Retrieval: Recall Specificity of the Detrimental but Not the Beneficial Effect

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Depending on the degree to which the original study context is accessible, selective memory retrieval can be detrimental or beneficial for the recall of other memories (Bäuml & Samenieh, 2012). Prior work has shown that the detrimental effect of memory retrieval is typically recall specific and does not arise after restudy trials, whereas recall specificity of the beneficial effect has not been examined to date. Addressing the issue, we compared in 2 experiments the effects of retrieval and restudy on recall of other items, when access to the study context was (largely) maintained and when access to the study context was impaired (in Experiment 1 by using the listwise directed-forgetting task, in Experiment 2 by using a prolonged retention interval). In both experiments, selective retrieval but not restudy induced forgetting of other items when context access was maintained, which replicates prior work. In contrast, when context access was impaired, both selective retrieval and restudy induced beneficial effects on other memories. These findings suggest that the detrimental but not the beneficial effect of selective memory retrieval is recall specific. The results are consistent with a recent 2-factor account of selective memory retrieval that attributes the detrimental effect to inhibition or blocking but the beneficial effect to context reactivation processes.

Keywords: retrieval, restudy, forgetting, context, reactivation

During the past four decades, researchers have repeatedly shown that selective retrieval of some memories can induce forgetting of other memories (for reviews, see M. C. Anderson, 2003; Bäuml, Pastötter, & Hanslmayr, 2010; Roediger & Neely, 1982). Evidence for such retrieval-induced forgetting has arisen mainly from the output-interference paradigm and the retrieval-practice paradigm. Research using the output-interference paradigm typically shows that recall performance at test declines as a function of the items' testing position, suggesting that the prior recall of other (nontarget) list items can impair subsequent recall of target information (e.g., Roediger, 1974; Smith, 1971). Research using the retrieval-practice paradigm demonstrates that intervening retrieval practice on a subset of previously studied items can cause forgetting of related unpracticed items on a later memory test (e.g., M. C. Anderson, Bjork, & Bjork, 1994; M. C. Anderson & Spellman, 1995).

However, selective memory retrieval can not only impair but also improve recall of other items (Aslan & Bäuml, 2014; Bäuml & Samenieh, 2010, 2012; Dobler & Bäuml, 2012). Using the listwise directed-forgetting task (e.g., Bjork, 1970), Bäuml and Samenieh (2012) asked subjects to study a list of items (e.g., *rose, dragon, wool, hunter*) and then provided subjects a cue either to continue remembering or to forget the list. After they studied a second list, participants were asked to recall predefined target items from the first list (e.g., *rose, wool*), with or without prior recall of the list's remaining nontarget items (e.g., *dragon, hunter*). Prior retrieval of the nontargets impaired subsequent recall of to-be-remembered targets but improved recall of to-be-forgotten targets. In the same study, similar results arose when using a diversion task (e.g., Sahakyan & Kelley, 2002) in lieu of a forget cue. Subjects conducted an imagination task to change their mental contextual state or performed a counting task as a baseline control. Whereas in the counting condition prior retrieval of nontargets attenuated recall of the target items, retrieval of nontargets improved target recall in the imagination condition. Because both the forget cue and the imagination task seem to impair access to the original study context (e.g., Geiselman, Bjork, & Fishman, 1983; Sahakyan & Kelley, 2002), the results were interpreted as evidence that selective retrieval is detrimental in the absence of impaired context access but can be beneficial if access to the study context is impaired.

Bäuml and Samenieh (2012) suggested a two-factor account to explain the two opposing effects of selective memory retrieval. According to this account, selective memory retrieval generally triggers two processes, inhibition or blocking of interfering memories (e.g., M. C. Anderson, 2003; Roediger & Neely, 1982) and reactivation of the study context (e.g., Howard & Kahana, 1999,

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2002).[1] Which of the two types of processes dominates in an experimental situation is assumed to depend on whether access to the study context is (largely) maintained or impaired. When access to the original study context is (largely) maintained—as may occur after a remember cue or an intervening counting task—then interference between items may be high enough to trigger inhibition or blocking processes, whereas not much room is left for context reactivation processes. As a net result, prior nontarget recall may reduce subsequent target recall. In contrast, when access to the original study context is impaired and interference between the single items is low—as may occur after a forget cue or an intervening imagination task—then not much room is left for inhibition or blocking processes and more room is left for context reactivation. Retrieval of the nontarget items may reactivate the study context, which may then serve as a retrieval cue for the remaining target items and thus improve subsequent target recall.

Results from numerous studies suggest that the detrimental effect of memory retrieval is recall specific. These studies, for instance, compared the effects of retrieval practice with the effects of restudy of the same previously studied items on later recall of related unpracticed items. Typically, retrieval practice but not restudy impaired recall of the unpracticed items (e.g., Bäuml, 2002; Ciranni & Shimamura, 1999; Hulbert, Shivde, & Anderson, 2011; for related results comparing competitive with noncompetitive retrieval practice, see M. C. Anderson, Bjork, & Bjork, 2000, or Hanslmayr, Staudigl, Aslan, & Bäuml, 2010; see also Raaijmakers & Jakab, 2012, or Verde, 2013). Recall specificity of the detrimental effect of memory retrieval is consistent with the inhibition account of the effect; according to this proposal, the not-to-be practiced items interfere during retrieval practice and are inhibited to reduce the interference (e.g., M. C. Anderson, 2003). Recall specificity of the effect is also consistent with blocking, at least if one assumes that retrieval practice leads to much higher levels of strengthening of practiced items and thus to more forgetting of unpracticed items than restudy does (e.g., Raaijmakers & Jakab, 2012).

To date, no study has yet examined recall specificity of the beneficial effect of selective memory retrieval. On the basis of Bäuml and Samenieh's (2012) two-factor account and the comprised view that the beneficial effect is driven by reactivation of the retrieved items' study context, one may expect that the beneficial effect is not recall specific and that both retrieval and restudy of previously studied items can improve recall of other items. This expectation arises from context retrieval theory (e.g., Greene, 1989; Thios & D'Agostino, 1976) and more recent computational models that embody variants of the theory (Howard & Kahana, 2002; Polyn, Norman, & Kahana, 2009). Context retrieval theory assumes that when a previously studied item is repeated, be it by virtue of reexposure or its successful recall, it retrieves the context in which it was originally presented. Such retrieval is then supposed to update the current state of context, which, in turn, is used to cue recall. Results on the contiguity effect and the spacing effect, for instance, support such proposal (e.g., Greene, 1989; Howard & Kahana, 1999; Kahana & Howard, 2005).

In this study, we report the results of two experiments designed to examine whether the two opposing effects of selective memory retrieval differ in recall specificity. Concretely, we tested the hypothesis that the detrimental effect of memory retrieval is recall specific but the beneficial effect is not. Experiment 1 used the retrieval-practice task to study recall specificity (e.g., Ciranni & Shimamura, 1999) and the listwise directed-forgetting task to create impaired access to the study context (e.g., Bjork, 1970). Participants studied a list of items, consisting of predefined target and nontarget items, and then received a cue to either forget or remember the list. After subsequent study of a second list, participants either repeatedly retrieved the first list's nontarget items (*prior retrieval condition*), restudied the nontarget items (*prior restudy condition*), or completed an unrelated distractor task (*control condition*). Finally, participants were asked to recall the first list's target items (see Figure 1A). Experiment 2 used the output-interference task to study recall specificity (e.g., Smith, 1971) and delayed testing to create impaired access to the study context (e.g., Estes, 1955). Participants studied a list of target and nontarget items and were then tested on the target items after a short (4 min) or a prolonged (48 hr) retention interval. In both retention interval conditions, participants recalled the target items after prior retrieval of the nontarget items (*prior retrieval condition*), after prior restudy of the nontarget items (*prior restudy condition*), or without any repetition of the nontarget items (*control condition*; see Figure 1B).

On the basis of the two-factor account of memory retrieval and prior work indicating that the detrimental effect is recall specific (e.g., M. C. Anderson et al., 2000; Ciranni & Shimamura, 1999), we expected selective retrieval but not restudy to impair recall of the other items when access to the original study context was largely maintained, that is, after a remember cue was provided (Experiment 1) and in the short-delay condition (Experiment 2). In contrast, on the basis of the two-factor account and context retrieval theory (e.g., Greene, 1989; Howard & Kahana, 1999), we expected both retrieval and restudy to improve recall of other items when access to the original study context was impaired, that is, after a forget cue was provided (Experiment 1) and in the long-delay condition (Experiment 2). If so, recall specificity would arise for the detrimental but not the beneficial effect of selective memory retrieval.

Experiment 1

Method

Participants. We had 96 undergraduates participate in the experiment (M_{age} = 22.68, range: 18–29 years). All participants spoke German as native language, took part on a voluntary basis, and received monetary reward (€7) or course credits for participation.

Materials. Four study lists (A–D) were constructed, each containing 15 unrelated concrete German nouns (e.g., Bäuml & Samenieh, 2010). Lists A and B were designated to be used as List

[1] Although during the past years, retrieval-induced forgetting has typically been explained by inhibition (e.g., M. C. Anderson, 2003), there is recent debate in the literature about whether the effect may actually reflect noninhibitory blocking (e.g., Raaijmakers & Jakab, 2013). The present experiments were not designed to distinguish between these views, and so here both accounts are mentioned as possible mechanisms to explain retrieval-induced forgetting. Most recently, retrieval-induced forgetting has also been attributed to context change processes (Jonker, Seli, & MacLeod, 2013). Again, however, the present experiments were not designed to evaluate this account.

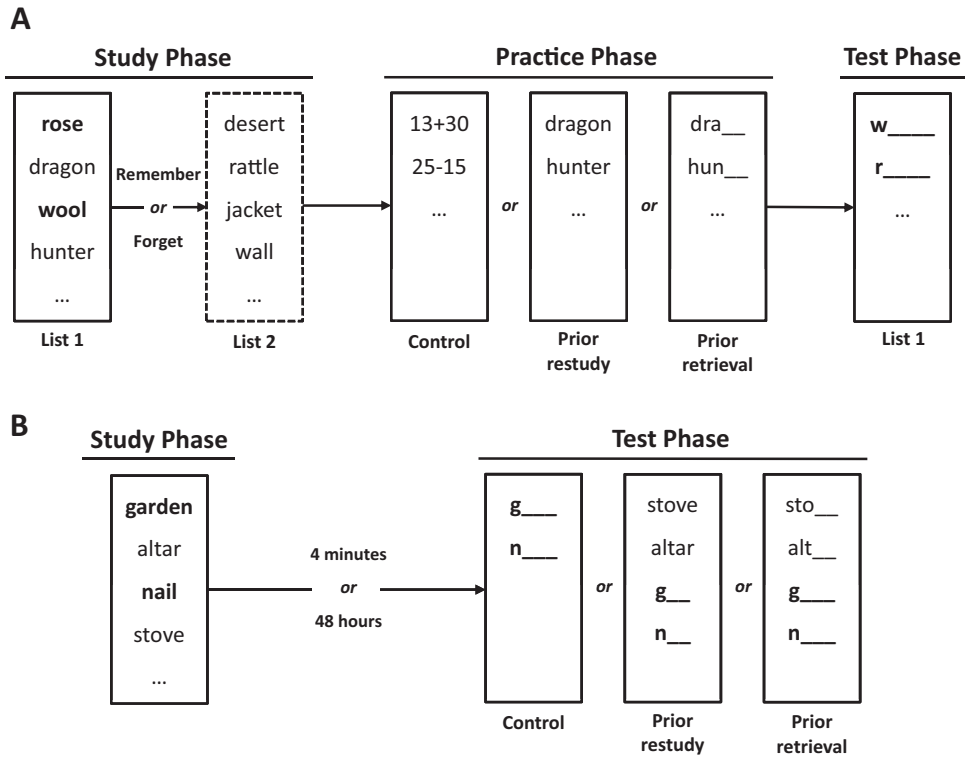

Figure 1. A: Procedure of Experiment 1. Participants studied a first list of items, received a cue either to forget or to continue remembering the list, and then studied a second list of items. Subsequently, participants completed a distractor task (control), restudied predefined nontarget items from List 1 (prior restudy), or practiced retrieval of these nontarget items (prior retrieval). In the test phase, participants were asked to recall the predefined target items from List 1. Predefined target items are depicted in bold letters. B: Procedure of Experiment 2. Participants studied a list of items. After 4 min (short retention interval) or 48 hr (long retention interval), participants were asked to recall predefined target items from List 1. The target items were tested immediately (control), after prior restudy of the list's predefined nontarget items, or after prior retrieval of these nontarget items. Predefined target items are depicted in bold letters.

1, whereas Lists C and D were designated to be used as List 2. Lists A and B consisted of five target and 10 nontarget items each. Among all items, each target item began with a unique initial letter and each nontarget item had a unique word stem.

Design. The experiment had a 2 × 3 mixed factorial design. Cue (remember, forget) was manipulated within participants and practice type (prior retrieval, prior restudy, control) was varied between participants. In the remember condition, List 1 was followed by a cue to remember the list for a later recall test, whereas in the forget condition, List 1 was followed by a cue to forget the list; a software crash was simulated, and participants were told that the wrong data file was opened and the preceding items should be forgotten (e.g., Dobler & Bäuml, 2012). Participants completed the two cue conditions successively, with an 8-min break between conditions. Order of conditions as well as assignment of lists to conditions were counterbalanced (e.g., Bäuml & Samenieh, 2010, 2012). Practice conditions differed in activity during the intermediate practice phase, with participants retrieving nontargets, restudying nontargets, or completing an unrelated distractor task.

Procedure. In the study phase, the items of the two lists were presented individually and in random order for 4 s each, separated by a cue to either remember or forget the first list. After study of the second list, a 30-s backward-counting task followed, which served as a recency control. In the subsequent practice phase, participants either repeatedly retrieved the first list's nontarget items (prior retrieval), repeatedly restudied these nontargets (prior restudy), or solved arithmetic problems as a distractor task (control). In the prior retrieval condition, each nontarget item was cued with its word stem, which was done to increase recall chances and thus boost possible detrimental or beneficial effects on later target recall. The cues were presented individually and in random order for 5 s. During two successive practice cycles, retrieval of all nontargets was practiced. In the prior restudy condition, each single nontarget item was reexposed for further learning for 5 s across two successive practice cycles. In both conditions, subjects were informed that items from the first studied list should be practiced. Finally, in the third phase, participants were asked to recall the first list's target items. Recall order of target items was controlled through presentation of the items' unique initial letter. The item cues were presented successively and in random order for 6 s each. Responses were given orally. Subsequent to target recall, participants in the restudy and control conditions were also asked

to recall the first list's nontarget items, and subjects in all three conditions were asked to finally recall List 2 items. These results are not reported.[2]

Results

Figure 2A shows mean recall rates for the target items. A 2 × 3 analysis of variance with the within-subjects factor of cue (remember, forget) and the between-subjects factor of practice type (prior retrieval, prior restudy, control) showed no main effects of cue, $F(1, 93) < 1$, and practice type, $F(2, 93) = 1.943$, mean square error (MSE) = 0.063, $p = .149$, but revealed a significant interaction between the two factors, $F(2, 93) = 13.615$, $MSE = 0.032$, $p < .001$, $\eta_p^2 = .226$, suggesting that cue condition affected target recall in the three practice type conditions differently. Planned comparisons showed that, in the control condition, target recall was higher after the remember cue than after the forget cue (40.6% vs. 23.8%), $t(31) = 4.190$, $p < .001$, $d = 0.754$, thus showing the standard directed-forgetting effect. More important, both prior retrieval and prior restudy of nontargets affected target recall rates. In the remember condition, prior retrieval impaired recall of the target items relative to the control items (40.6% vs. 28.1%), $t(62) = 2.248$, $p = .028$, $d = 0.562$, thus showing retrieval-induced forgetting, whereas prior restudy did not affect target recall (40.6% vs. 40.6%), $t(62) = 0$, $p = 1.00$. In contrast, in the forget condition, both prior retrieval (23.8% vs. 44.4%), $t(62) = -4.114$, $p < .001$, $d = 1.034$, and prior restudy (23.8% vs. 41.3%), $t(62) = -3.231$, $p = .002$, $d = 0.818$, improved recall of the target items relative to the control items, and there was no difference in recall level between retrieval and restudy conditions (44.4% vs. 41.25%), $t(62) = 0.533$, $p = .596$.

Practice type was manipulated between subjects, whereas cue was manipulated within subjects in this experiment. It is important to note that none of the reported statistical effects interacted with subjects' testing order, all ps > .184, which is consistent with prior work (e.g., Bäuml & Samenieh, 2010, 2012).

Discussion

The results of Experiment 1 replicate prior work by showing that retrieval of previously studied nontargets can impair subsequent target recall if the items are to be remembered but can improve subsequent target recall if the items are to be forgotten (e.g., Bäuml & Samenieh, 2010, 2012). Going beyond the prior work, the results show that selective restudy of nontargets may not affect recall of to-be-remembered targets but can improve recall of to-be-forgotten targets. These findings confirm prior work by showing a recall-specific detrimental effect of selective memory retrieval (e.g., M. C. Anderson et al., 2000; Bäuml, 2002; Ciranni & Shimamura, 1999), and they extend prior work by showing a beneficial effect of selective memory retrieval that is not recall specific. These results are consistent with the two-factor account of selective memory retrieval, which attributes the detrimental effect to inhibition or blocking and the beneficial effect to context reactivation processes.

Our goal in Experiment 2 was to replicate this pattern of results, using a different experimental setup. Prior work reported evidence for the two effects of selective memory retrieval using both the retrieval-practice task (e.g., Dobler & Bäuml, 2012) and the output-interference task (e.g., Bäuml & Samenieh, 2012). Experiment 1 used the retrieval-practice task, whereas Experiment 2 used the output-interference task. Prior work examined the two opposing effects of selective memory retrieval by impairing context access through presentation of a forget cue or subjects' participation in a diversion task (e.g., Bäuml & Samenieh, 2012). Experiment 2 impaired access to the study context by means of a prolonged retention interval, assuming that considerable contextual change occurs during prolonged retention intervals and external as well as internal contextual elements of the study phase become inaccessible over time (e.g., Estes, 1955; McGeoch, 1932).

Experiment 2

Method

Participants. One hundred ninety-two undergraduates participated in the experiment (M_{age} = 22.14 years, range: 18–29 years). All participants spoke German as native language, took part on a voluntary basis, and received a monetary reward (€7) for their participation.

Materials. Two new study lists (A and B) were constructed, each containing 15 unrelated concrete German nouns. Again the lists consisted of five target and 10 nontarget items each. Half of the participants studied List A; the other half studied List B. Again, each target item began with a unique initial letter and each nontarget item had a unique word stem.

Design. The experiment had a 2 × 3 design with the between-participants factors of retention interval (short, long) and practice type (prior retrieval, prior restudy, control). In the short retention interval condition, participants were tested on the study list 4 min after study, whereas they were tested after an interval of 48 hr in the long retention interval condition. At test, participants were either asked to recall the nontargets first and the targets second (prior retrieval), restudy the nontargets before recalling the targets (prior restudy), or recall the targets immediately (control). Assignment of lists to conditions was counterbalanced.

Procedure. Items were studied individually and in random order for 5 s each. After a short unrelated distractor task (4 min), half of the participants were tested immediately, whereas the other half were asked to participate in the second part of the experiment 48 hr later. At test, in all three practice conditions, recall order of target items was controlled through presentation of the items' unique initial letters, which were presented successively and in random order, for 6 s each. Responses were given orally. In the prior retrieval condition, nontargets were tested before target items, providing the nontargets' word stems as cues; the stems were presented successively and in random order, for 6 s each. In the restudy condition, participants were asked to study the list's nontarget items a second time, for 6 s each, before being tested on

[2] Typically, presenting a forget cue after the first list does not only cause List 1 forgetting but also List 2 enhancement (e.g., Geiselman et al., 1983). In Experiment 1, we focused on the forgetting of the first list, so participants were always asked to recall List 1 items first and List 2 items second. However, because prior List 1 recall typically influences List 2 enhancement (Golding & Gottlob, 2005; Pastötter, Kliegl, & Bäuml, 2012), we ignored List 2 recall data in this experiment.

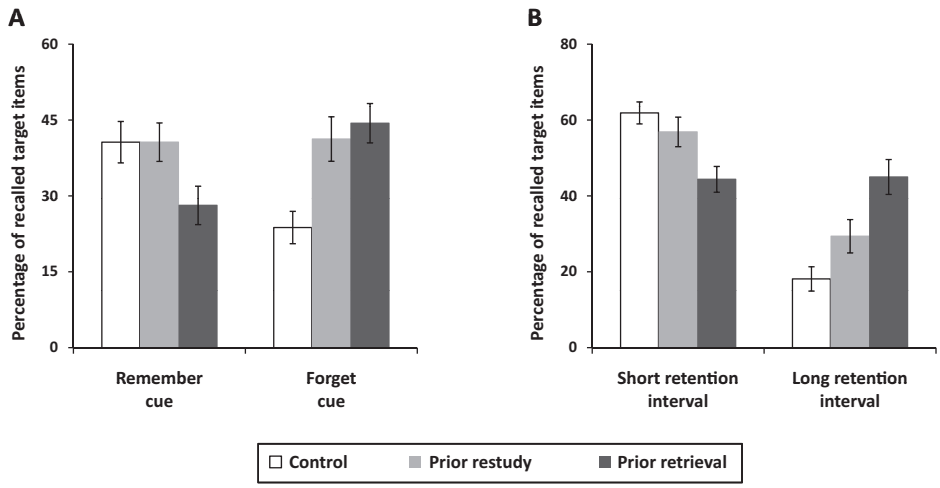

Figure 2. A: Results of Experiment 1. Percentage of recalled target items is shown as a function of cue (remember, forget) and practice type (control, prior restudy, prior retrieval). B: Results of Experiment 2. Percentage of recalled target items is shown as a function of retention interval (short, long) and practice type (control, prior restudy, prior retrieval). Error bars represent standard errors.

the list's target items. In the control condition, targets were tested immediately at the beginning of the test phase. In the restudy and control conditions, target recall was followed by nontarget recall, the results, however, are not reported.[3]

Results

Figure 2B shows recall rates for the target items. A 2 × 3 analysis of variance with the between-subjects factors of retention interval (short, long) and practice type (prior retrieval, prior restudy, control) revealed a main effect of retention interval, $F(1, 186) = 58.049$, $MSE = 0.046$, $p < .001$, $\eta_p^2 = .238$, and a significant interaction between the two factors, $F(2, 186) = 17.598$, $MSE = 0.046$, $p < .001$, $\eta_p^2 = .159$. There was no main effect of practice type, $F(2, 186) < 1$. The main effect of retention interval reflects higher recall rates after the short than the long retention interval (54.4% vs. 30.83%); the interaction suggests that retention interval affected target recall in the three practice type conditions differently. Planned comparisons showed that prior retrieval and prior restudy of nontargets affected target recall rates. In the short retention interval condition, prior retrieval impaired recall of the target items relative to control items (61.9% vs. 44.4%), $t(62) = 3.890$, $p < .001$, $d = 0.976$, thus showing typical output interference, whereas prior restudy left target recall unaffected (61.9% vs. 56.9%), $t(62) = 1.026$, $p = .309$. After the prolonged retention interval, both prior retrieval (18.1% vs. 45.0%), $t(62) = -4.832$, $p < .001$, $d = 1.228$, and prior restudy (18.1% vs. 29.4%), $t(62) = -2.078$, $p = .042$, $d = 0.526$, improved recall of the target items relative to the control items, although participants recalled more target items after prior retrieval than prior restudy of the nontarget items (45.0% vs. 29.4%), $t(62) = 2.461$, $p = .017$, $d = 0.615$.[4]

Discussion

The results of Experiment 2 replicate the results of Experiment 1 by showing that after a short retention interval in which no forget cue is provided and no change in mental context is induced, retrieval of target items can be impaired by prior nontarget recall but is left unaffected by prior restudy of nontarget items, thus providing another demonstration of recall specificity of retrieval-induced forgetting. More important, the results of Experiment 2 extend the prior work by showing that, after a prolonged retention interval, prior retrieval of nontarget items improves recall of the target items and such improvement is not recall specific. Indeed, both retrieval and restudy of nontargets proved beneficial for target recall, although the benefits were more pronounced after retrieval than restudy of nontarget items. These results mimic the findings of Experiment 1 in the forget condition, indicating that after contextual change between study and test, both retrieval and restudy can be beneficial for other items.[5] These findings are in line with the two-factor account of selective memory retrieval.

[3] Consistent with prior work (e.g., Bäuml & Samenieh, 2010, 2012), the present experiments used initial letters as retrieval cues for targets and multiletter stems as retrieval cues for nontargets. The finding of the two faces of memory retrieval, however, does not depend on this procedural detail. Using prose material in very recent experiments, we replicated the effects in the absence of any item-specific cues.

[4] In both Experiment 1 and Experiment 2, mean success rates for the nontarget items in the prior retrieval conditions were high (84.5% and 86.5%) and did not differ between cue conditions, $t(31) = 1.953$, $p = .060$, or retention-interval conditions, $t(62) = -1.251$, $p = .216$, respectively.

[5] In principle, forgetting after prolonged retention intervals can be attributed to a number of factors, but contextual change and increased interference are supposed to play particularly critical roles (e.g., J. R. Anderson, 2000). Using short retention intervals, Bäuml and Samenieh (2012) recently showed that increased interference at test causes detrimental effects of selective retrieval, whereas inducing a context change between study and test induces beneficial effects. The present results in the long retention-interval condition parallel the previous finding after contextual change, indicating that the beneficial effect is due to contextual change rather than variation in interference level.

General Discussion

The results of the two experiments replicate and extend prior work on the two faces of selective memory retrieval. They replicate prior work by demonstrating that selective memory retrieval can impair memory for other to-be-remembered items but can improve memory for other to-be-forgotten items (Bäuml & Samenieh, 2010, 2012). They extend prior work by showing that the two opposing effects of selective memory retrieval are also present when retention interval is varied; selective memory retrieval can be detrimental for other items when the retention interval is short and be beneficial when the retention interval is prolonged. Selective memory retrieval has recently been shown to be beneficial if subjects' mental context is changed between encoding and test (Bäuml & Samenieh, 2012). Because the presentation of a forget cue impairs access to the study context as well (Geiselman et al., 1983; Sahakyan & Kelley, 2002) and such impairment is also present with prolonged retention interval (e.g., Estes, 1955; McGeoch, 1932), results support the view that selective memory retrieval is detrimental when access to the study context is (largely) maintained but is beneficial when context access is impaired.

In particular, the results of the two experiments replicate and extend prior work on recall specificity of the effects of memory retrieval. Consistent with prior work, they show that retrieval-induced forgetting is recall specific, that is, the forgetting arises after selective retrieval but not after prior restudy of nontarget items (e.g., M. C. Anderson et al., 2000; Bäuml, 2002; Ciranni & Shimamura, 1999). Going beyond the prior work, the results show that the beneficial effect is not recall specific. In fact, both selective retrieval and restudy induced beneficial effects in the present study, which were equivalent in amount in Experiment 1 but were larger after retrieval than after restudy in Experiment 2. These findings are the first demonstration that the detrimental but not the beneficial effect of selective memory retrieval can be recall specific.

Bäuml and Samenieh's (2012) two-factor account of the two effects of selective memory retrieval assumes that the detrimental effect is caused by inhibition or blocking of the target items and arises if access to the study context is still maintained. In such situations, interference between items may be high and retrieval of the nontargets may inhibit or block recall of the target items. Inhibition is generally assumed to be recall specific (e.g., M. C. Anderson, 2003), and even blocking may be recall specific, at least if retrieval strengthened the nontargets to a much higher degree than restudy does (e.g., Raaijmakers & Jakab, 2012). In addition, the two-factor account assumes that the beneficial effect of selective memory retrieval is caused by reactivation of the targets' study context and arises if access to the study context is impaired. In such situations, interference between items should be low and recall of the nontargets retrieves the study context, which may then serve as a retrieval cue for recall of the target items. Following context retrieval theory (e.g., Greene, 1989; Howard & Kahana, 2002; Thios & D'Agostino, 1976), such reactivation should not be recall specific and arise after both retrieval and restudy of nontarget items. By showing that the detrimental but not the beneficial effect of memory retrieval is recall specific, the present results thus support the two-factor account.

Results from a recent study further strengthen the view that the beneficial effect of selective memory retrieval is mediated by context reactivation processes. Using the listwise directed-forgetting task, Dobler and Bäuml (2012) examined the role of delay between nontarget and target recall for the detrimental and beneficial effects of prior nontarget retrieval on subsequent target recall. They varied the delay interval by introducing unrelated distractor tasks of 0-min, 1-min, or 10-min duration. As expected from previous studies on retrieval-induced forgetting and the view that the detrimental effect of memory retrieval is mediated by inhibition or blocking, prior recall of nontargets impaired recall of to-be-remembered targets regardless of delay interval (e.g., M. C. Anderson et al., 1994; M. C. Anderson & Spellman, 1995). In contrast, prior recall of nontargets improved recall of to-be-forgotten targets if target recall followed nontarget recall immediately but left target recall unaffected if a delay of 1 min or 10 min was introduced. This result is consistent with a particular version of context retrieval theory, the context maintenance and retrieval model (Polyn et al., 2009), according to which accessibility of previously studied items can be disrupted if, during recall, the task is shifted to another task and the temporal context that is associated with the studied items is pushed out in favor of novel information. The results are thus consistent with the view that the beneficial effect of memory retrieval is mediated by context reactivation processes.

Strict versions of context retrieval theory may assume constant retrieval for items, regardless of lag between original presentation and repetition and regardless of type of repetition. Such versions of the theory may be too strict. Indeed, there is evidence from prior work that the amount of context retrieved for a repeated item can decrease as a function of its lag (e.g., Pavlik & Anderson, 2005), and there is evidence from the present work that type of repetition may affect context retrieval. By showing equivalent beneficial effects of retrieval and restudy, the results of the present Experiment 1 indicate that retrieval and restudy may, in fact, induce the same amount of context retrieval, whereas the results of Experiment 2 suggest that, under certain circumstances, retrieval can induce a higher amount of context retrieval than restudy does. Thus, depending on how exactly contextual change is induced, repetition by virtue of restudy may differ in context retrieval from repetition by virtue of retrieval.

The present results do not provide an answer on why the beneficial effects of retrieval and restudy may be equivalent under some circumstances but differ in size under others. However, two speculations arise. The one speculation is that retrieval may be generally better able than restudy to reactive the study context, but the difference may manifest itself mainly after major contextual change. The view is consistent with the present results, because the prolonged retention interval condition of Experiment 2 created much more forgetting than the presentation of the forget cue in Experiment 1 (44% vs. 17%), which may indicate that the longer retention interval created a higher degree of contextual change than the forget cue did. The other speculation is that the contextual effects in the two experiments may have differed qualitatively. For instance, longer retention intervals may create larger contextual drift than shorter retention intervals do (Estes, 1955; McGeoch, 1932), whereas a forget cue may create context inhibition (Geiselman et al., 1983; Kimball & Bjork, 2002). If retrieval and restudy were differently responsive to different forms of context change

effects, then retrieval and restudy may be equivalent under some circumstances (e.g., contextual inhibition) but differ in size under others (e.g., contextual drift). Future researchers should give high priority to examining in more detail when exactly the beneficial effects of retrieval and restudy are equivalent and when they are not. Such findings would impose restrictions on context retrieval theory and the two-factor account of memory retrieval.

There is recent debate in the literature about whether the detrimental effect of selective memory retrieval is really recall specific. This debate is motivated by findings that show that some restudy formats—for example, asking subjects to rate how they feel about a reexposed item or asking subjects to decide whether an exposed category is the first category to choose for a simultaneously reexposed item—can induce recall impairment for other items, very similar to how retrieval does (Verde, 2013; see also Raaijmakers & Jakab, 2012). These findings are of direct relevance for the question of whether the detrimental effect of selective memory retrieval is mediated by inhibition or blocking. In particular, they indicate that some restudy formats may induce a different pattern of recall specificity than the standard restudy format does. Future work is required to investigate these restudy formats in more detail, examine exactly which mechanisms are involved in creating the detrimental effects, and examine whether these formats also affect the amount of context reactivation and thus the beneficial effects of memory retrieval.

To conclude, depending on the degree to which the original study context is accessible, selective memory retrieval can be detrimental or beneficial for other memories. If access to the study context is (largely) maintained, retrieval is detrimental for other memories, and this effect is recall specific. In contrast, if access to the study context is impaired, retrieval is beneficial for other memories and this beneficial effect generalizes to restudy trials. These results are consistent with a two-factor account of selective memory retrieval, according to which the detrimental effect of memory retrieval is caused by inhibition or blocking, whereas the beneficial effect is mediated by context reactivation processes.

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