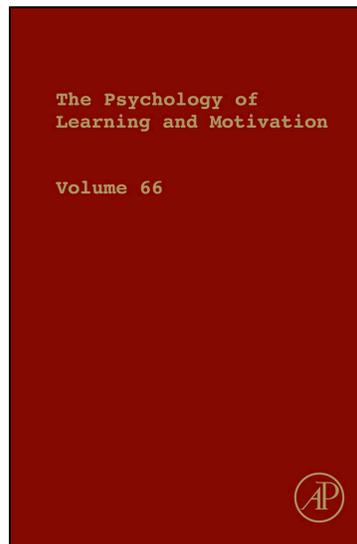


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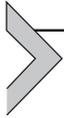
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# The Two Faces of Selective Memory Retrieval—Cognitive, Developmental, and Social Processes

Karl-Heinz T. Bäuml<sup>\*1</sup>, Alp Aslan<sup>§</sup> and Magdalena Abel<sup>\*</sup>

<sup>\*</sup>Regensburg University, Regensburg, Germany

<sup>§</sup>Martin Luther University Halle-Wittenberg, Halle, Germany

<sup>1</sup>Corresponding author: E-mail: karl-heinz.baeuml@ur.de

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## Abstract

Numerous studies from the past five decades have shown that selective retrieval of some studied items can impair recall of other items. This chapter reviews more recent work, in which it is demonstrated that selective memory retrieval has two faces and that it can both impair and improve recall of other items. In this recent work, participants' access to study context during selective retrieval was experimentally manipulated and it was examined whether such manipulation influences the effects of selective retrieval. Access to study context was manipulated using listwise directed forgetting, context-dependent forgetting and time-dependent forgetting. The results consistently showed that selective retrieval impairs recall of other memories if access to study context during retrieval is largely maintained, but that selective retrieval can improve recall if study context access is impaired. The findings are explained by a two-factor account, which claims that, in general, selective retrieval does not only trigger inhibition and blocking but also triggers context reactivation processes. The proposal is that primarily inhibition and blocking operate when study context access during selective retrieval is largely maintained, whereas primarily context reactivation processes operate when study context access is impaired. Current findings on the two faces of selective retrieval are well consistent with this theoretical view.



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## 1. SELECTIVE MEMORY RETRIEVAL CAN BE DETRIMENTAL FOR OTHER MEMORIES

Does selective retrieval of a specific episode affect memory for related episodes? For instance, during a conversation with a former classmate about times past, does remembering a particular event from the high-school days help remember other events from that time? Or imagine a police officer interrogating a person about a crime event that he or she has witnessed; is it advisable to pose a critical question at the beginning of the interrogation, or would it be better to postpone the question for a while, until the witness has recalled and responded to other, perhaps, less critical questions about the event? Dating back as far as to Aristotle (cf. [Roediger, 1978](#)), it has repeatedly been proposed that retrieval is a *self-propagating* process, and that retrieval of a particular memory can aid and guide the subsequent retrieval of other memories. Indeed, the notion that related memories can trigger each other through associative processes is not only intuitively compelling ([Bäuml & Samenieh, 2010](#); [Bjork, Bjork, & Caughey, 2007](#)), but also found its way into theoretical models of human memory and applied eyewitness interrogation techniques.

For instance, [Collins and Loftus \(1975\)](#) proposed that human memory can be modeled as an associative network consisting of concept nodes and

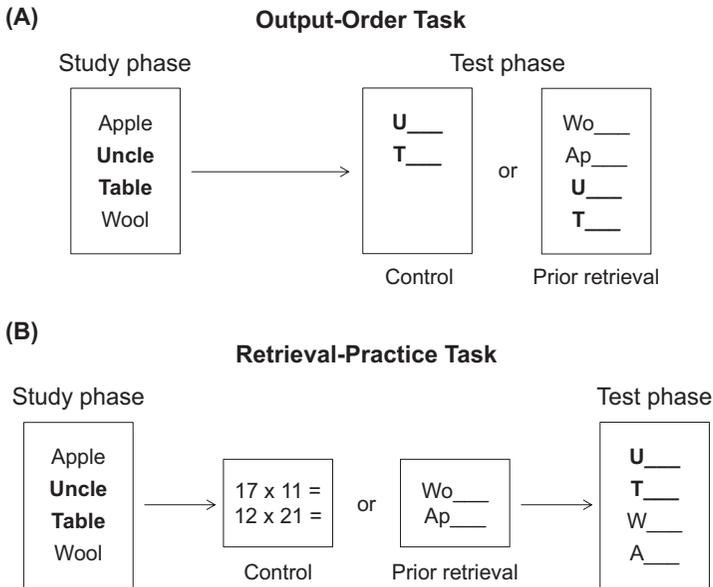
connecting paths between the nodes. When one concept is activated by means of its retrieval, the activation is supposed to spread out to related concepts, increasing the likelihood that these related concepts get retrieved as well. The theoretical idea of spreading activation is also at the heart of the cognitive interview developed by Geiselman, Fisher, MacKinnon, and Holland (1985). In this interrogation technique, eyewitnesses are explicitly encouraged to repeatedly recall and report every detail of a witnessed event that comes to their minds, regardless of how trivial or irrelevant it may appear, and to do so from different perspectives and in different chronological orders. Again, the underlying assumption (or hope) is that retrieval is a self-propagating process, and that recall of some, possibly less relevant details of an event can activate other, possibly more relevant target information.

However, despite its popularity and widespread use in memory research, previous work has often failed to find empirical support for the notion that memory retrieval is self-propagating. On the contrary, studies from the past five decades have often found selective retrieval of some information to impair rather than improve memory for other information, suggesting that memory retrieval is more like a *self-limiting*, rather than a self-propagating process (Bjork et al., 2007; Roediger, 1978). Evidence for such retrieval-induced forgetting has mainly arisen from two experimental tasks: the older output-interference task, here more neutrally termed the output-order task, and the more recent retrieval-practice task.

## 1.1 The Output-Order Task

Studies employing the output-order task examine whether recall chances of previously studied items depend on the items' serial position at test, that is, whether early selective retrieval of some items at test influences later recall of the remaining items (see Fig. 1A). In the first systematic study employing the output-order task, Tulving and Arbuckle (1963) let participants learn a list of paired associates composed of digits and words in a counterbalanced order (e.g., 5-dog, 3-tree). At test, participants were successively given the digits, again in a counterbalanced order, and were asked to recall the corresponding words (e.g., 3-, 5-). The intriguing finding was that recall performance for a given item declined monotonically with its output position in the test sequence. This finding, originally termed output interference, suggests that the preceding selective retrieval of earlier-tested items impairs, rather than improves, the succeeding recall of later-tested items.

Subsequent studies replicated Tulving and Arbuckle's (1963) original finding and extended it to other experimental settings and study materials.



**Figure 1** (A) Overview of the output-order task as applied to lists of unrelated words. In the study phase, participants study an item list consisting of predefined target and nontarget items (targets are depicted in bold letters). On a later memory test, memory for the target items is assessed, either with or without prior selective retrieval of the nontarget items. For each target word, the unique initial letter is provided as a retrieval cue; for each nontarget word, the unique word stem is provided as a retrieval cue. (B) Overview of the retrieval-practice task as applied to lists of unrelated words. In the study phase, participants study an item list consisting of predefined target and nontarget items (targets are depicted in bold letters). In the subsequent retrieval-practice phase, participants perform selective retrieval practice on the nontarget items—the unique word stems are provided as retrieval cues—or are engaged in a neutral distractor task. In the final test phase, memory for both target and nontarget items is assessed. For each target word, the unique initial letter is provided as a retrieval cue. Note that, in both tasks, participants are not aware of the target–nontarget distinction.

Smith (1971) and Roediger (1978), for instance, confirmed the finding using categorized item lists and controlling testing order through presentation of the items' category labels as retrieval cues (for a review of early work on output interference, see Roediger, 1974). Bäuml and Samenieh (2010), in a more recent study, demonstrated that output interference can also arise in recall of lists of unrelated words, when testing order is controlled through presentation of the items' unique first letter(s) as retrieval cues. Moreover, although output interference has mostly been demonstrated using recall tasks, Criss, Malmberg, and Shiffrin (2011) recently reported a similar effect when using item recognition testing.

## 1.2 The Retrieval-Practice Task

Another more recent task to examine the effects of selective retrieval in episodic memory is the retrieval-practice task (Anderson, Bjork, & Bjork, 1994; see Fig. 1B). In contrast to the output-order task, in which the selective-retrieval manipulation is implemented within the test phase, in the retrieval-practice task, the selective-retrieval manipulation occurs in a separate phase some time before the test phase. In their original study, Anderson et al. (1994) let participants study items from different semantic categories (e.g., *Fruit-Orange*, *Fruit-Banana*, *Animal-Tiger*, *Animal-Duck*) and, subsequently, perform selective retrieval practice on half of the items from half of the categories given category-plus-word-stem cues (e.g., *Fruit-Or\_*). After a retention interval, memory for all previously studied items was assessed. The results showed that retrieval practice improved recall of the practised items (e.g., *Orange*) but that it impaired recall of the same categories' unpractised items (e.g., *Banana*), relative to the control items from the unpractised categories (i.e., *Tiger*, *Duck*). The impairment effect was termed retrieval-induced forgetting, again demonstrating that selective retrieval can induce forgetting of other memories.

Retrieval-induced forgetting, as observed in the retrieval-practice task, has proven to be a very robust and general finding. The effect has been reported using a wide range of study materials, including categorized word lists (Anderson et al., 1994), lists of unrelated items (Bäumel & Döbler, 2015), visuo-spatial objects (Ciranni & Shimamura, 1999), and autobiographical materials (Barnier, Hung, & Conway, 2004), and a variety of testing formats, including word-stem completion (Anderson et al., 1994), item recognition (Hicks & Starns, 2004), lexical decision (Veling & van Knippenberg, 2004) and tests using so-called independent probes, that is, novel retrieval cues not used until the test phase of the experiment (Anderson & Spellman, 1995). The results of numerous studies have further revealed that retrieval-induced forgetting is not a mere "laboratory effect" but transfers into fairly applied settings such as eyewitness memory (Shaw, Bjork, & Handal, 1995), social memory (Cuc, Koppel, & Hirst, 2007), impression formation (Macrae & MacLeod, 1999) and foreign-language-acquisition settings (Levy, McVeigh, Marful, & Anderson, 2007).

## 1.3 Accounts of Retrieval-Induced Forgetting

Retrieval-induced forgetting, as observed in the output-order task, has originally been attributed to blocking processes (Roediger, 1973;

Rundus, 1973). The (noninhibitory) blocking account assumes that retrieval of an item strengthens the memory representation of the retrieved item. This strengthening is supposed to induce a competition bias at test, leading the (relatively stronger) already-retrieved items to come to mind persistently and, in this way, block access to the (relatively weaker) not-yet-retrieved items. The blocking account has also been entertained by some authors to explain the detrimental effect of selective retrieval in the retrieval-practice task (e.g., Raaijmakers & Jakab, 2013; Verde, 2013). The similar logic is that selective retrieval of an item during the retrieval-practice phase strengthens the item's association to its cues, so that, at test, the selectively retrieved item comes to mind more readily and blocks access to the (relatively weaker) nonretrieved items (for an alternative noninhibitory explanation of retrieval-induced forgetting, see Jonker, Seli, & MacLeod, 2013).

In contrast, the more recent inhibition account (Anderson et al., 1994; Anderson & Spellman, 1995) assumes that during attempts to selectively retrieve a sought-after item, other not-(yet)-to-be-retrieved items interfere and compete for conscious recall. To overcome the interference and facilitate selection of the sought-after item, the memory representation of the interfering item gets inhibited, resulting in impaired memory for the item on a delayed memory test. Although the inhibition account was originally proposed to explain retrieval-induced forgetting in the retrieval-practice task, it can also accommodate the finding of retrieval-induced forgetting in the output-order task (e.g., Anderson et al., 1994; Bäuml, 1998).

The results of many studies support the inhibitory view on retrieval-induced forgetting. For instance, a defining feature of the inhibition account is that it attributes the forgetting to active suppression of an item's representation itself rather than to changes in the item's associative structure. Access to an inhibited item, therefore, should be impaired irrespective of which retrieval cue and memory test is used to probe the item. The aforementioned finding that retrieval-induced forgetting emerges across a wide range of testing formats (see Section 1.2) is thus consistent with the inhibition account. Another central claim of the inhibition account is that inhibitory control is recruited to overcome interference between items competing for selective retrieval. Thus, in contrast to selective retrieval, selective restudy should not induce inhibition and retrieval-induced forgetting be retrieval-specific, a prediction that has been confirmed in many studies (e.g., Bäuml, 2002; Bäuml & Aslan, 2004; Ciranni & Shimamura, 1999; Shivde & Anderson, 2001). However, there are also findings that challenge the

inhibition account. For instance, the finding that at least certain restudy formats, such as selective restudy that is accompanied by pleasantness ratings (Verde, 2013) or selective restudy that is accompanied by mental visualizations (Saunders, Fernandes, & Kosnes, 2009), can induce forgetting of other, not-repeated information, is not easily accommodated by inhibition but fits well with the blocking account.

Rupperecht and Bäuml (2016) recently suggested a two-factor account assuming that inhibition and blocking conjointly contribute to retrieval-induced forgetting (for similar arguments, see Anderson & Levy, 2007; Aslan & Bäuml, 2010; Bäuml, 2008; Grundgeiger, 2014; Schilling, Storm, & Anderson, 2014; Storm & Levy, 2012). According to this account, inhibition operates during selective retrieval, whereas blocking (additionally) operates at test. Critically, the relative contribution of the two processes to the total amount of forgetting is supposed to depend on how memory is assessed. The proposal is that the (additional) contribution of blocking is larger in tests that leave room for interference, such as free or category-cued recall, and smaller, if present at all, in tests that leave not much room for interference, like tests using item-specific letter cues, item recognition and cue-independent tests. Consistently, a recent metaanalysis found that, across studies, the size of the forgetting effect was larger in free and category-cued recall than in letter-cued tests and tests of item recognition (Murayama, Miyatsu, Buchli, & Storm, 2014). This finding fits well with the proposed two-factor account, suggesting that whereas in the latter type of tests, the detrimental effect of selective retrieval is primarily driven by inhibition, in the former type of tests, not only inhibition but also blocking may contribute to the observed forgetting.



## **2. CAN SELECTIVE MEMORY RETRIEVAL ALSO BE BENEFICIAL FOR OTHER MEMORIES?**

### **2.1 The Possible Role of Context for Retrieval Dynamics**

A feature shared by most previous studies on retrieval-induced forgetting is that the context at study and the context during selective retrieval were highly overlapping. Indeed, in many studies there was no delay at all between study and selective retrieval and subjects immediately after study were asked to retrieve some of the previously studied items (e.g., Abel & Bäuml, 2014; Anderson et al., 1994; Jonker et al., 2013; Román, Soriano, Gómez-Ariza, & Bajo, 2009). In most of the other studies there were short

retention intervals of up to 5 min between the two experimental phases, mostly filled with simple counting or calculation tasks to minimize the possible contribution of short-term memory during selective retrieval (e.g., Bäuml, 2002; Cuc et al., 2007; Hicks & Starns, 2004; Spitzer & Bäuml, 2007); simple counting and calculation tasks are fairly neutral with respect to context and typically do not induce a major change in subjects' mental states (Klein, Shiffrin, & Criss, 2007). In contrast to all these studies, there were hardly any studies, in which context conditions after study were changed, so that study context access would have been impaired during selective retrieval (for an exception, see MacLeod & Macrae, 2001).

Against this background, the results of a study by Goernert and Larson (1994) appear interesting. These researchers examined part-list cuing impairment, i.e., the demonstration that providing a subset of previously studied items as retrieval cues at test can impair recall of the remaining items (for a review, see Bäuml, 2007). Research on part-list cuing impairment is of general relevance for research on retrieval-induced forgetting, because cuing may lead people to covertly retrieve the cue items (e.g., Anderson et al., 1994; Bäuml & Aslan, 2004; Roediger, 1973; Rundus, 1973), so that the effects of selective retrieval and part-list cuing can be similar, if not equivalent (e.g., Bäuml & Aslan, 2004; Bäuml & Kuhbandner, 2003; Zellner & Bäuml, 2005). On the basis of the suggested parallels, Goernert and Larson's work may be of direct relevance for the study of the effects of selective retrieval because it indicates that study context access during retrieval may influence retrieval dynamics.

Goernert and Larson (1994) examined the effect of part-list cuing in listwise directed forgetting. Listwise directed forgetting is the demonstration that people can intentionally forget previously studied material if cued to do so (e.g., Bjork, 1989). In this paradigm, participants typically study a list of unrelated words and, after studying the list, receive a cue to either forget or continue remembering the list. After subsequent study of another list of words, a recall test is conducted in which participants are asked to recall the first list items, regardless of whether participants were originally cued to remember or to forget the items. The core finding is that, compared with remember-cued participants, forget-cued participants typically show impaired recall of the first list items (for reviews, see Bäuml, Pastötter, & Hanslmayr, 2010; MacLeod, 1998; Sahakyan, Delaney, Foster, & Abushanab, 2014).

Goernert and Larson (1994) employed the standard listwise directed forgetting task but used two different testing conditions. In the one condition, participants were asked to recall all first list items in the absence of any

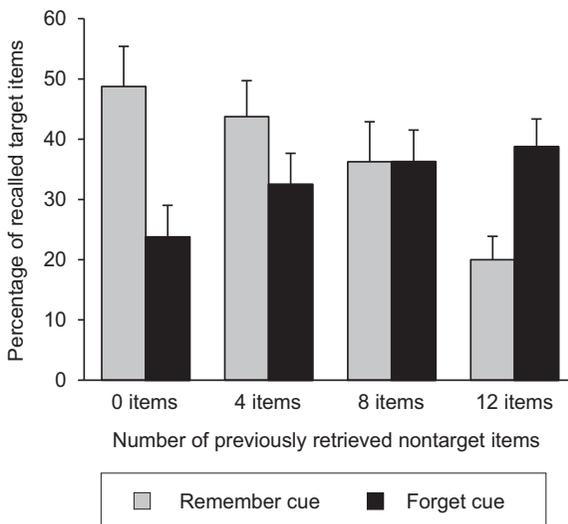
retrieval cues (*control condition*); in the other condition, participants were provided some of the first list items as retrieval cues for recall of the list's remaining (target) items (*part-list cuing condition*). Importantly, the effects of part-list cuing on target recall varied with the interlist instruction. When part-list cues were provided at test, part-list cuing impairment arose in the remember condition, whereas part-list cuing improvement showed up in the forget condition, relative to the control conditions. The finding has recently been replicated by [Bäuml and Samenieh \(2012a\)](#) and indicates that the effects of part-list cuing can differ for to-be-remembered and to-be-forgotten memories. In particular, the results suggest that part-list cuing can enhance recall of to-be-forgotten items.

The findings by [Goernert and Larson \(1994\)](#) are interesting for research on selective retrieval because, if they generalized from part-list cuing to selective retrieval, they would indicate that there are circumstances under which selective retrieval does not necessarily impair recall but rather may improve recall of other items. Moreover, because the forget cue in listwise directed forgetting is often assumed to impair context access to first list items ([Geiselman, Bjork, & Fishman, 1983](#); [Sahakyan & Kelley, 2002](#)), Goernert and Larson's finding may point to a critical role of study context access for the effects of selective retrieval, raising the possibility that whenever access to the study context is impaired, selective retrieval improves, rather than impairs, recall of other items.

## 2.2 First Evidence That Selective Retrieval Can Be Beneficial for Recall of Other Memories

Motivated by [Goernert and Larson's \(1994\)](#) findings and the previously observed parallels between part-list cuing impairment and retrieval-induced forgetting, we pursued the goal in recent years to examine in more detail (1) whether selective retrieval is "always" self-limiting or can also be self-propagating, and, if so, (2) what are the conditions under which selective retrieval can improve recall of other memories. In the first step of this research project ([Bäuml & Samenieh, 2010](#)), we examined the effects of selective retrieval in listwise directed forgetting to investigate whether the effects of selective retrieval can depend on the memory status of the encoded material and be different for to-be-remembered and to-be-forgotten memories. Because in listwise directed forgetting the forget cue impairs study context access for the first list items (see below), this study also examined whether the effects of selective retrieval differ when study context access is maintained versus when access is impaired. We employed the output-order task to examine the effects of selective retrieval.

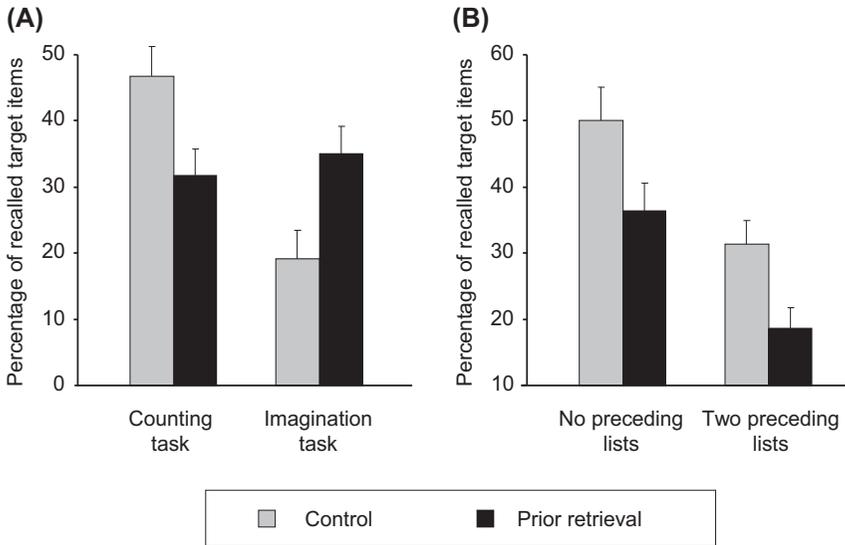
As is typical for listwise directed forgetting, participants in the [Bäuml and Samenieh \(2010\)](#) study were given two lists of unrelated items for study. The first list consisted of predefined target and nontarget items, a distinction that was known to the experimenter but was unknown to the subjects. Between study of the two lists, subjects received a cue to either forget or continue remembering the items of the first list. Later, memory for the target items from the original list was tested. Testing differed in whether participants were asked to recall 0, 4, 8 or 12 of the list's nontarget items before they recalled the target items. As expected, when target items were recalled first, recall was higher in the remember than in the forget condition, replicating the basic directed forgetting effect. However, retrieval dynamics differed between cue conditions. Whereas recall of to-be-remembered targets decreased linearly, recall of to-be-forgotten targets increased linearly, as more and more of the nontargets were previously retrieved (see [Fig. 2](#)). This finding suggests that typical retrieval-induced forgetting may arise if access to study context is largely maintained, but that retrieval-induced recall improvement can arise if study context access is impaired.



**Figure 2** Effects of selective retrieval in listwise directed forgetting. Prior selective retrieval of nontarget items impaired recall for to-be-remembered targets, but improved recall for to-be-forgotten targets. Error bars represent standard errors. From [Bäuml, K.-H. T., Samenieh, A. \(2010\). \*The two faces of memory retrieval\*, Psychological Science, 21, 793–795.](#)

In the second step of this research project, [Bäuml and Samenieh \(2012b\)](#) extended their previous study and examined in more detail the circumstances under which selective retrieval may show the self-propagating property. *A priori* several possibilities arose. For instance, memory retrieval may be beneficial for all types of forgetting, so that the beneficial effect may not be restricted to listwise directed forgetting but may show up whenever participants' memory for previously studied information is impaired. Or, the beneficial effect of selective retrieval may arise for some forms of forgetting but not for others. For example, it may arise whenever the forgetting includes a certain contextual effect and may not occur for all other forms of forgetting and in the absence of any induced memory impairment. Indeed, listwise directed forgetting has repeatedly been related to some form of contextual forgetting, arguing that the forget cue causes the original (first) list context to get inhibited (e.g., [Geiselman et al., 1983](#); [Kimball & Bjork, 2002](#)) or arguing that the forget cue induces a change in participants' internal context, which then impairs later recall of the original list due to a mismatch between the context at encoding and the context at retrieval ([Sahakyan & Kelley, 2002](#)).

Following such context views on listwise directed forgetting, [Bäuml and Samenieh \(2012b\)](#) examined retrieval dynamics in context-dependent forgetting employing the output-order task and [Sahakyan and Kelley's \(2002\)](#) imagination task. Participants studied two item lists and, between study of the two lists, counted backward from a three-digit number or performed a mental imagination task. The mental imagination task is assumed to create a change in participants' internal context, which leads to a contextual mismatch between participants' testing context and participants' study context during first-list learning, and thus to forgetting of the first list items (e.g., [Pastötter & Bäuml, 2007](#); [Sahakyan & Kelley, 2002](#)). After the study of the second list, subjects were asked to recall predefined target items from the first list, either first or after preceding guided cued recall of the list's remaining (nontarget) items. As expected, when target items were recalled first, recall was higher in the counting condition than in the imagination condition, replicating basic context-dependent forgetting. More important, whereas recall of targets decreased after preceding selective retrieval of the nontargets in the counting condition, in the imagination condition target recall increased after preceding nontarget recall (see [Fig. 3A](#)). These results suggest that selective retrieval impairs recall of other memories if access to the study context is largely maintained, whereas selective retrieval can improve recall of other items if access to the study context is impaired.

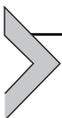


**Figure 3** (A) Effects of selective retrieval in context-dependent forgetting. Prior selective retrieval of nontarget items impaired recall for targets with the intermittent counting task, but improved recall for targets with the intermittent imagination task. (B) Effects of selective retrieval in proactive interference. Both with and without study of the two preceding lists selective nontarget recall impaired recall for target items. Error bars represent standard errors. *From Bäuml, K.-H. T., Samenieh, A. (2012b). Selective memory retrieval can impair and improve retrieval of other memories, Journal of Experimental Psychology: Learning, Memory, and Cognition, 38, 488–494.*

This study was also able to exclude that selective retrieval may be beneficial for all types of forgetting. The hypothesis was rejected by examining the role of selective retrieval in proactive interference. Proactive interference refers to the finding that the preceding study of other lists reduces recall of a subsequently studied critical list, compared with a condition in which no such preceding study occurs (e.g., [Underwood, 1957](#)). According to most accounts of proactive interference, proactive interference should not be caused by impaired access to the critical list study context but rather by impaired temporal discrimination. According to this view, the buildup of proactive interference reflects a growing impairment in the ability to distinguish items that appeared on the most recent list from those that appeared on earlier lists; such impairment is supposed to increase the size of the search set at test and thus to reduce recall of the critical list's items (e.g., [Baddeley, 1990](#); [Crowder, 1976](#); [Wixted & Rohrer, 1993](#)). As it turned out, selective retrieval of some of the items of the critical list impaired recall of the list's

remaining items, regardless of whether proactive interference was induced or not (see Fig. 3B). Selective retrieval thus does not seem to be beneficial for all types of forgetting. Rather, impaired study context access may be crucial to see beneficial effects of selective retrieval.

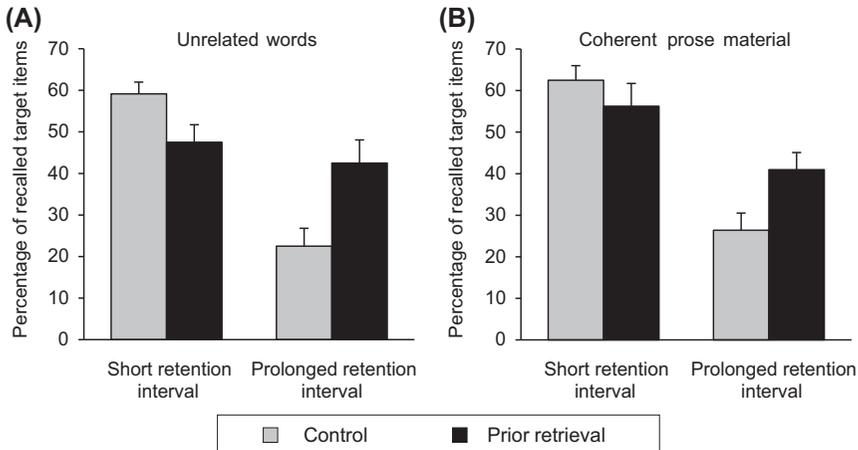
In the final, third step of this research project, Bäuml and Schlichting (2014) examined whether the results on the effects of selective retrieval generalize from listwise directed forgetting and context-dependent forgetting to time-dependent forgetting. Indeed, Bäuml and Samenieh's (2012b) finding that changes in context between encoding and selective retrieval can induce beneficial effects of selective retrieval suggests that after prolonged retention intervals—in which often a considerable amount of external and internal contextual change arises and external as well as internal contextual elements of the study phase can become inaccessible over time (e.g., Estes, 1955; McGeoch, 1932; Mensink & Raaijmakers, 1988)—retrieval may also be self-propagating. Bäuml and Schlichting let participants study a list of unrelated words in Experiment 1 and more integrated prose material in Experiment 2. After a short retention interval of few minutes or a prolonged retention interval of 48 h, participants then recalled predefined target items of the study material. Employing the output-order task, these target items were recalled first or after prior selective retrieval of some of the material's other (nontarget) items. In both experiments, selective retrieval was found to impair recall of other studied items after the short retention interval but to improve recall of the other items in the prolonged retention interval condition (see Fig. 4). Again these results demonstrate that retrieval dynamics depend critically on situation and that selective retrieval does not always impair recall of other items. The results also show that the retrieval dynamics observed with unrelated words generalize to more integrated prose material, which reflects the complex information that we are confronted with many times a day better than lists with unrelated words do.



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### **3. THE TWO FACES OF SELECTIVE MEMORY RETRIEVAL**

The results of these previous studies show that selective retrieval can both impair and improve recall of other memories, suggesting the existence of two faces of selective retrieval. In particular, the results indicate that whether selective retrieval is detrimental or incremental for recall of other memories depends on whether during selective retrieval access to the

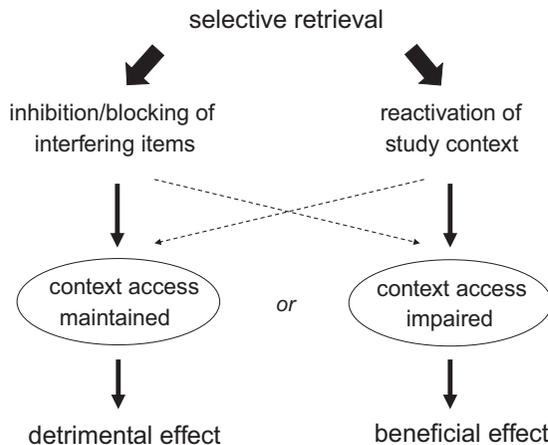


**Figure 4** Effects of selective retrieval in time-dependent forgetting. Prior selective retrieval of nontarget items impaired recall for targets after the short retention interval, but improved recall for targets after a prolonged retention interval. (A) Lists of unrelated words were employed as study material. (B) More coherent prose material was used as study material. Error bars represent standard errors. From Bäuml, K.-H. T., Schlichting, A. (2014). *Memory retrieval as a self-propagating process*, *Cognition*, 132, 16–21.

memories' original study context is impaired or not. Consistently, selective retrieval in these previous studies enhanced recall of other memories if the memories were subject to impaired study context access—as supposedly is the case in listwise directed forgetting, context-dependent forgetting and time-dependent forgetting—whereas selective retrieval impaired recall in all other cases; i.e., when the forgetting was caused by proactive interference and when no forgetting was induced at all. These findings point to a critical role of study context access for the effects of selective memory retrieval.

### 3.1 A Two-Factor Account of the Effects of Selective Retrieval

Bäuml and Samenieh (2012b) suggested a two-factor account to explain the two opposing effects of selective memory retrieval (see Fig. 5). According to this account, selective retrieval generally triggers two types of processes, inhibition and blocking of interfering memories (e.g., Anderson, 2003; Roediger & Neely, 1982; Rupperecht & Bäuml, 2016) and reactivation of the study context (e.g., Howard & Kahana, 1999, 2002; Raaijmakers & Shiffrin, 1981). Critically, the relative contribution of the two types of processes is supposed to depend on access to study context during selective



**Figure 5** The two-factor account of selective memory retrieval. This account assumes that selective retrieval generally triggers inhibition and blocking as well as context reactivation processes. The relative contribution of the two types of processes is supposed to depend on study context access. When study context access is (largely) maintained, the relative contribution of inhibition and blocking is larger and selective retrieval thus induces a detrimental effect on other items. In contrast, when study context access is impaired, the relative contribution of context reactivation processes is larger and selective retrieval thus induces a beneficial effect on other items.

retrieval. The proposal is that the relative contribution of inhibition and blocking is larger when access to the study context is (largely) maintained—as may occur after a remember cue, an intervening counting task or when there is no delay at all between study and selective retrieval. In such case, interference between items may be high enough so that selective retrieval triggers inhibition and blocking of the other items, whereas not much room is left for context reactivation processes. As a net result, selective retrieval may reduce recall of the other items and retrieval-induced forgetting may arise. In contrast, the relative contribution of context reactivation processes is proposed to be larger when access to the study context is impaired—as may occur after a forget cue, an intervening imagination task or a prolonged retention interval. In such case, interference between the single items may be reduced, so that less room is left for inhibition and blocking processes, whereas much room is left for context reactivation. Selective retrieval may thus reactivate the study context, which may serve as a retrieval cue for recall of the remaining items and thus improve subsequent recall. The results on the two faces of selective retrieval in listwise directed forgetting, context-dependent forgetting and time-dependent forgetting (e.g., Bäuml & Samenih, 2010, 2012b; Bäuml & Schlichting, 2014) are consistent with this two-factor account.

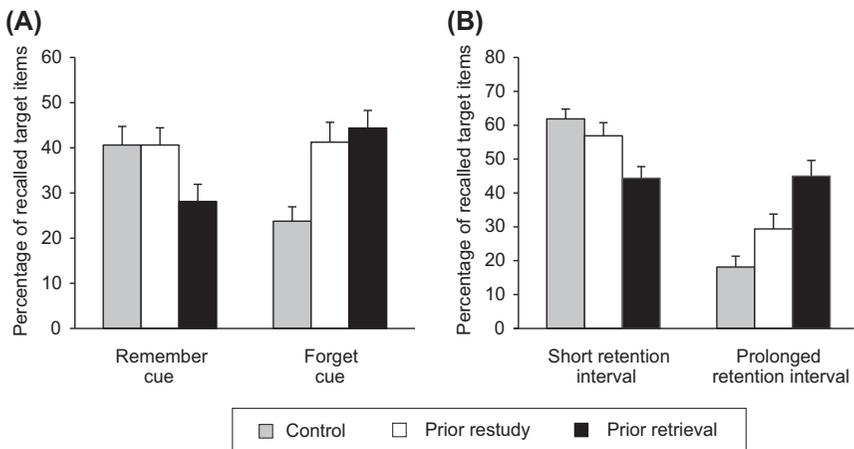
### 3.2 Testing the Two-Factor Account: Retrieval Specificity

Results from numerous studies in the literature on retrieval-induced forgetting suggest that the detrimental effect of selective retrieval is largely retrieval specific. These studies compared the effects of selective retrieval with the effects of selective restudy of the same previously studied items on later recall of the remaining items. Selective retrieval but not selective restudy impaired recall of the other items, at least when standard restudy trials were employed (e.g., Bäuml & Aslan, 2004; Ciranni & Shimamura, 1999; see Section 1.3). The critical question that arises is whether retrieval specificity of the detrimental effect of selective retrieval generalizes to the beneficial effect of selective retrieval. On the basis of Bäuml and Samenieh's (2012b) 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 retrieval 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).

Bäuml and Dobler (2015) reported the results of two experiments, in which it was examined whether the two opposing effects of selective retrieval differ in retrieval specificity. Experiment 1 employed the listwise directed forgetting task, and study context access was manipulated by providing subjects a remember or a forget cue after study of the first list items; Experiment 2 employed time-dependent forgetting, and study context access was manipulated by introducing a short 4-min or a prolonged 48-h retention interval. In both experiments, participants studied lists of unrelated items, consisting of predefined target and nontarget items, and at test were asked to recall the (first list) target items, in the presence or the absence of preceding practice on the list's nontarget items. Experiment 1 employed the retrieval-practice task, Experiment 2 the output-order task. Nontarget items were practised by guided cued recall of the items (*selective*

retrieval condition) or they were practised by reexposure of the items for restudy (*selective restudy condition*).

The results of both experiments support retrieval specificity of the detrimental effect. Both in the remember condition of Experiment 1 and the short-delay condition of Experiment 2 preceding recall of nontargets, but not preceding restudy of nontargets, impaired recall of the target items. In contrast, both in the forget condition of Experiment 1 and the prolonged retention interval condition of Experiment 2, preceding recall and preceding restudy of the nontargets improved recall of the target items (see Fig. 6). These findings indicate that the beneficial effect of selective retrieval is not retrieval specific and both selective retrieval and selective restudy can improve recall of other studied items. These results provide a first experimental dissociation between the two effects of selective retrieval. In particular, they are consistent with the two-factor account of selective retrieval, which suggests that the detrimental effect, but not the beneficial effect, of selective retrieval is retrieval specific.



**Figure 6** Effects of selective retrieval and selective restudy in listwise directed forgetting (A) and time-dependent forgetting (B). Prior retrieval, but not prior restudy, impaired target recall after a remember cue and in the short-retention interval condition; in contrast, both prior retrieval and prior restudy improved target recall after a forget cue and in the prolonged-retention interval condition. Error bars represent standard errors. From Bäuml, K.-H. T., Dobler, I. M. (2015). *The two faces of selective memory retrieval: recall specificity of the detrimental but not the beneficial effect*. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 41, 246–253.

### 3.3 Testing the Two-Factor Account: the Role of Delay Between Selective Retrieval and Recall of the Other Items

Another factor that may dissociate the two faces of selective retrieval is the delay interval between selective retrieval (of some nontargets) and subsequent recall of the remaining (target) items. Numerous studies on retrieval-induced forgetting have shown that the detrimental effects of selective retrieval are not restricted to cases in which target recall follows selective retrieval of nontargets immediately but generalize to situations in which a delay is introduced between recall of the two types of items. In fact, several studies reported robust retrieval-induced forgetting for delay intervals of 20 min (e.g., Anderson et al., 1994; Anderson & Spellman, 1995) or even days (Garcia-Bajos, Migueles, & Anderson, 2009; Storm, Bjork, & Bjork, 2012; but see Abel & Bäuml, 2014; or MacLeod & Macrae, 2001), suggesting that the detrimental effect of selective retrieval can last for quite a while. In contrast, the previous studies reporting beneficial effects of selective retrieval (e.g., Bäuml & Dobler, 2015; Bäuml & Samenieh, 2012b; Bäuml & Schlichting, 2014) employed conditions, in which target recall followed preceding selective retrieval immediately, thus leaving it open whether the beneficial effect of selective retrieval generalizes to situations in which target recall is delayed.

On the basis of the view that the beneficial effect of selective retrieval arises because preceding selective retrieval reactivates the retrieved items' study context (e.g., Bäuml & Samenieh, 2012b; Howard & Kahana, 2002), the expectation may arise that the beneficial effects may not easily generalize to situations in which target recall is delayed. Indeed, although reactivation of the retrieved items' study context may make this context a potentially powerful retrieval cue for target recall, the reactivated context cue may be effective only if the retrieval process was not interrupted, for instance, by means of an interpolated distractor task (Polyn et al., 2009). Indeed, such disruption might reduce the context's activation level and thus reduce the cue's effectiveness in reactivating the target items. If so, the beneficial effect of selective retrieval might be present primarily when target recall follows selective retrieval of the nontargets immediately, and be reduced, if not eliminated, when target recall is delayed.

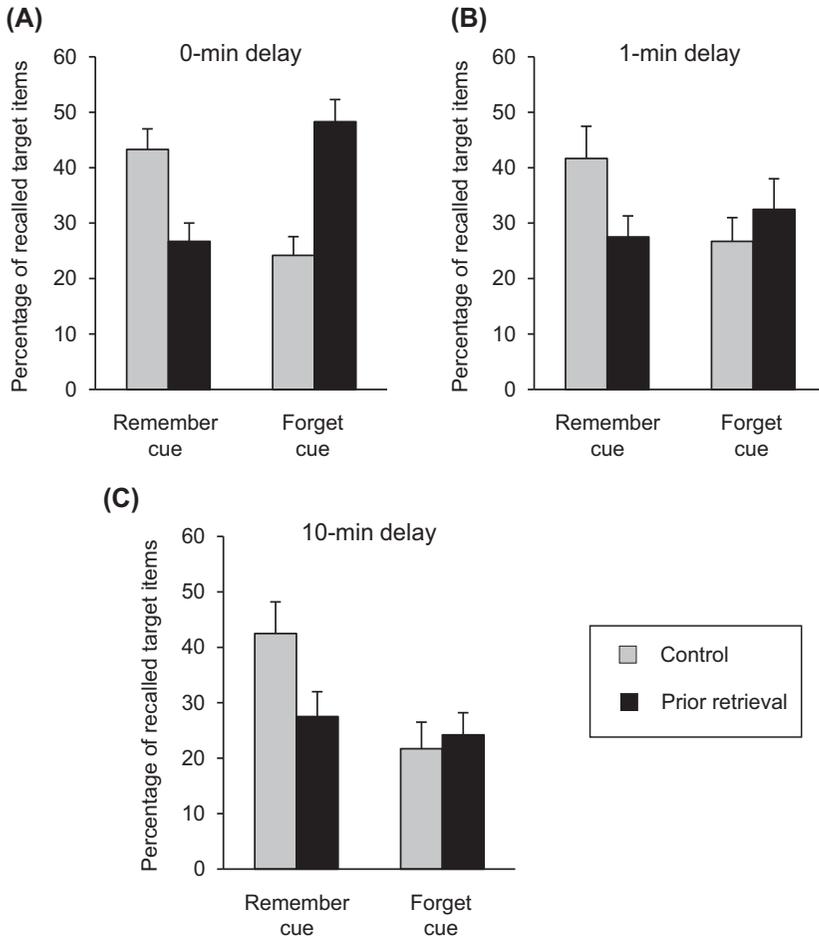
Dobler and Bäuml (2012) addressed the issue using the listwise directed forgetting task to manipulate study context access. To study the effects of selective retrieval the retrieval-practice task was employed. Participants studied two lists of items with a remember or forget cue in between.

Then, participants either repeatedly retrieved some of the first list's items, or they completed an unrelated distractor task. Finally, participants were asked to recall the first list's remaining (target) items. Importantly, participants differed in the delay that separated selective retrieval from recall of the target items, which was 1 min or 10 min. In addition, a 0-min delay condition was included to serve as a replication of the prior work. As expected, selective retrieval impaired target recall in the remember condition and this effect did not vary with the length of the delay interval. In contrast, selective retrieval improved target recall in the forget condition, though mainly if no delay was introduced between recall of the two types of items. When a delay interval was introduced, the effect was numerically reduced and statistically no longer present (see Fig. 7). These results provide another dissociation between the two effects of selective retrieval, indicating that delay between selective retrieval and recall of the other items can influence the two effects differently.

### 3.4 Testing the Two-Factor Account: the Role of Study Context Reinstatement

Although the assumption of the two-factor account that context reactivation underlies the beneficial effect of selective retrieval is consistent with several lines of findings (see aforementioned), there is no direct evidence yet supporting this proposal. More direct evidence for context reactivation processes as underlying mechanisms would arise if, after inducing impaired study context access—for instance, by increasing the retention interval between study and selective retrieval—, participants' study context was mentally reinstated immediately before selective retrieval starts. (Partial) reinstatement of the study context should reduce the room for further retrieval-induced context reactivation processes and, following the two-factor account, should thus reduce or eliminate the beneficial effect of selective retrieval. Moreover, if reinstatement of the study context was complete, even detrimental effects of selective retrieval should arise. In fact, a complete reinstatement of the study context should also reinstate interference between the items and thus trigger inhibition and blocking, leading to retrieval-induced forgetting.

Wallner and Bäuml (2016) addressed the issue in an experiment, in which effects of selective retrieval were measured after a 10-min retention interval that, in addition to other unrelated distractor tasks, included an imagination task to enhance contextual drift. Subjects studied a list of unrelated words consisting of predefined target and nontarget items, and,

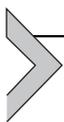


**Figure 7** Effects of selective retrieval in listwise directed forgetting when the delay between selective retrieval and test is varied. (A) *0-min delay condition*: Prior nontarget retrieval impaired recall for to-be-remembered targets, but improved recall for to-be-forgotten targets. (B) *1-min delay condition*: Prior nontarget retrieval impaired recall for to-be-remembered targets, but left recall for to-be-forgotten targets unaffected. (C) *10-min delay condition*: Prior nontarget retrieval impaired recall for to-be-remembered targets, but left recall for to-be-forgotten targets unaffected. Error bars represent standard errors. From Dobler, I. M., Bäuml, K.-H. T. (2012). *Dissociating the two faces of selective memory retrieval*. *Memory*, 20, 478–486.

at test, recalled the target items first or after preceding retrieval of the nontarget items. Besides, there were two critical testing conditions: in the one testing condition, subjects retrieved the single items without any preceding mental reinstatement of the study context; in the other testing

condition, subjects tried to mentally reinstate the study context before they retrieved the single items. In the context reinstatement condition, subjects were told to take a minute to recall their thoughts, feelings and emotions prior to the beginning of the study phase and to remember the strategies they used during study of the single items (see [Sahakyan & Kelley, 2002](#)). In the no-context-reinstatement condition, participants solved arithmetic problems for the same duration of time.

The results of the study replicated the findings from prior work by demonstrating a beneficial effect of selective retrieval after prolonged retention interval when there was no mental reinstatement of the study context before selective retrieval started ([Bäuml & Dobler, 2015](#); [Bäuml & Schlichting, 2014](#)). The results also showed an effect of mental context reactivation, because recall of target items when tested first was higher in the presence than the absence of mental context reinstatement ([Jonker et al., 2013](#); [Sahakyan & Kelley, 2002](#)). Above all, however, the results showed a detrimental effect of selective retrieval when study context was mentally reinstated before selective retrieval started. These results underline the critical role of study context access for the beneficial effect of selective retrieval and indicate that, when study context access is impaired—for instance, by a prolonged retention interval between study and selective retrieval—selective retrieval induces beneficial effects on target recall only when study context is not reinstated before selective retrieval starts. The finding supports the context reactivation interpretation of the beneficial effect of selective retrieval and thus supports the two-factor account of selective memory retrieval.



## **4. DEVELOPMENTAL TRAJECTORIES OF THE TWO EFFECTS OF SELECTIVE RETRIEVAL**

### **4.1 Developmental Trajectory of the Detrimental Effect**

The detrimental effect of selective retrieval has not only attracted the interest of cognitive psychologists, but has also been widely employed in developmental research, primarily to examine age-related changes in inhibitory control capabilities. Indeed, a prominent view in both cognitive development and cognitive aging is that inhibitory control capabilities vary substantially over the lifespan, being efficient and at peak in young adults, but fairly inefficient in children and older adults ([Bjorklund & Harnishfeger, 1990](#); [Hasher & Zacks, 1988](#)). Following this view and the proposal that the detrimental effect of selective retrieval (partly) reflects the operation of

inhibitory control processes (e.g., Anderson & Spellman, 1995), the intriguing prediction arises that the effect should be reduced, if not eliminated, in children and older adults, relative to young adults.

Zellner and Bäuml (2005) tested this prediction in first, second and fourth graders and young adults, employing both the retrieval-practice and the output-order task and using categorized word lists as study material and category-cued recall at test. In both experiments, study and selective retrieval were separated by a short retention interval, thus largely maintaining study context access. The authors found significant retrieval-induced forgetting in all four age groups, with no age differences in amount of forgetting, suggesting intact inhibition in school-age children's selective retrieval (for similar results, see Lechuga, Moreno, Pelegrina, Gómez-Ariza, & Bajo, 2006).

However, the finding of retrieval-induced forgetting in “interference-rich” tests, like category-cued recall, does not by itself implicate the existence of efficient inhibition but, as described earlier (see Section 1.3), could also be the result of blocking effects at test (e.g., Rupperecht & Bäuml, 2016). To address this possibility, Aslan and Bäuml (2010) examined selective-retrieval effects in kindergartners, second graders and young adults, using both “interference-rich” recall and (largely) “interference-free” item recognition testing. They employed the retrieval-practice task with a short retention interval between study and selective retrieval. Results revealed that although all three age groups showed significant retrieval-induced forgetting in recall, only adults and second graders, but not kindergartners, showed forgetting in item recognition. Because inhibition-based retrieval-induced forgetting should be present in recall and recognition (Hicks & Starns, 2004; Spitzer & Bäuml, 2007), these findings indicate that in adults and second graders, but not in kindergartners, retrieval-induced forgetting is mediated by (efficient) inhibition. The results are consistent with the proposal of an inhibitory deficit in kindergartners', though not school-age children's, selective memory retrieval.

Studies examining the effects of selective retrieval at the other end of the lifespan have generally found reliable retrieval-induced forgetting in older adults that often was indistinguishable in size from that of young controls. In particular, the forgetting was not only found in “interference-rich” memory tests, like category-cued recall (e.g., Aslan, Bäuml, & Pastötter, 2007; Moulin et al., 2002; Experiment 1), but also in (largely) “interference-free” memory tests, like item recognition (Ortega, Gómez-Ariza, Román, & Bajo, 2012; Experiment 1) or independent-probe tests (Aslan et al., 2007;

Experiment 2), indicating that older adults' retrieval-induced forgetting (partly) is inhibition-based, and this inhibition does not decline with age. However, the studies reporting age invariance in retrieval-induced forgetting mostly examined older adults who, with regard to their age, corresponded roughly to what has been called "young-olds" in the cognitive aging literature, that is, individuals between 60 and 75 years of age. In a more recent study, [Aslan and Bäuml \(2012\)](#) compared such young-old adults with a group of "old-old" adults, that is, individuals above 75 years of age. They employed the retrieval-practice task with a short retention interval between study and selective retrieval. Doing so, Aslan and Bäuml replicated the finding of intact retrieval-induced forgetting in the group of young-olds, but found an elimination of the effect in the group of old-olds, indicating that retrieval-induced forgetting may be a "late-declining" capability.

Inhibitory control capabilities vary not only between different age groups, but also between individuals within the same age group. In particular, it has repeatedly been proposed that the efficiency of inhibitory control processes is related to individuals' working memory capacity (WMC), so that individuals with higher WMC are better able to deal with interference and inhibit task-irrelevant information than individuals with lower WMC (for a review, see [Redick, Heitz, & Engle, 2007](#)). Consistently, several recent studies examining the role of WMC in retrieval-induced forgetting have reported a positive relationship between the two variables, with high-WMC individuals showing more forgetting than low-WMC individuals ([Aslan & Bäuml, 2011, 2012](#); [Storm & Bui, 2016](#); but see [Mall & Morey, 2013](#)). Because WMC is known to vary greatly with age, and to be reduced at both ends of the lifespan (e.g., [Case, Kurland, & Goldberg, 1982](#); [Craik & Salthouse, 2008](#); [Siegel, 1994](#)), these findings suggest that age-related changes in WMC may play a critical role for the age-related changes in the detrimental effect of selective retrieval.

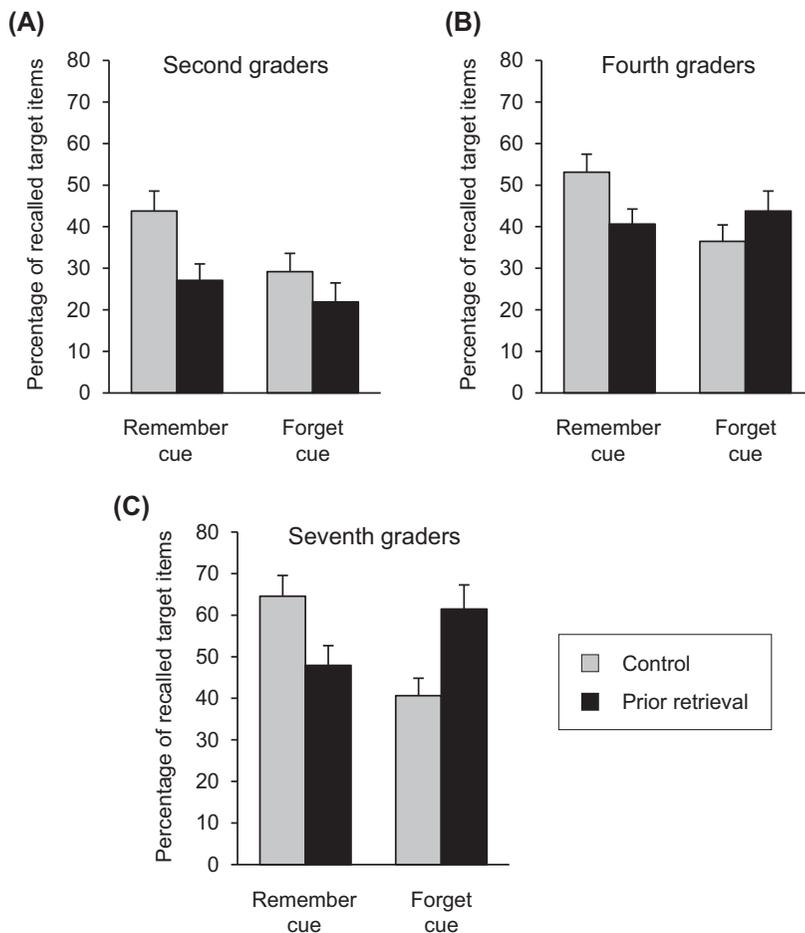
## 4.2 Developmental Trajectory of the Beneficial Effect

Does the beneficial effect of selective retrieval also depend on individuals' age? And, if so, is the developmental trajectory of the beneficial effect similar to that of the detrimental effect? Previous work with young adults suggests that the beneficial effect may vary with age and be reduced in young children and older adults. Indeed, [Dobler and Bäuml's \(2012\)](#) finding that an interpolated distractor activity between selective retrieval and test can reduce or eliminate the beneficial effect (see [Section 3.3](#)) suggests that, for the effect to emerge, the reactivated context information needs to be

maintained in working memory during target recall; disruption of such maintenance may reduce the reinstated context's activation level and thus its effectiveness in cuing the target information. Because the concurrent maintenance of context information and recall of target information should place relatively high demands on working memory, individuals may differ in their capability to capitalize on retrieval-induced context reactivation, and individuals with higher WMC may show a larger beneficial effect than individuals with lower WMC. Consistently, [Schlichting, Aslan, Holterman, and Bäuml \(2015\)](#) recently reported a positive relationship between the beneficial effect of selective retrieval and individuals' WMC, with high-WMC individuals, but not low-WMC individuals, benefiting from preceding selective retrieval. Given the inverted U-shaped relationship between age and WMC (e.g., [Case et al., 1982](#); [Craik & Salthouse, 2008](#); [Siegel, 1994](#)), the prediction may thus arise that children and older adults, whose WMC is generally reduced relative to young adults, should have difficulty capitalizing on retrieval-induced context reactivation and should show a reduced beneficial effect of selective retrieval, or no effect at all.

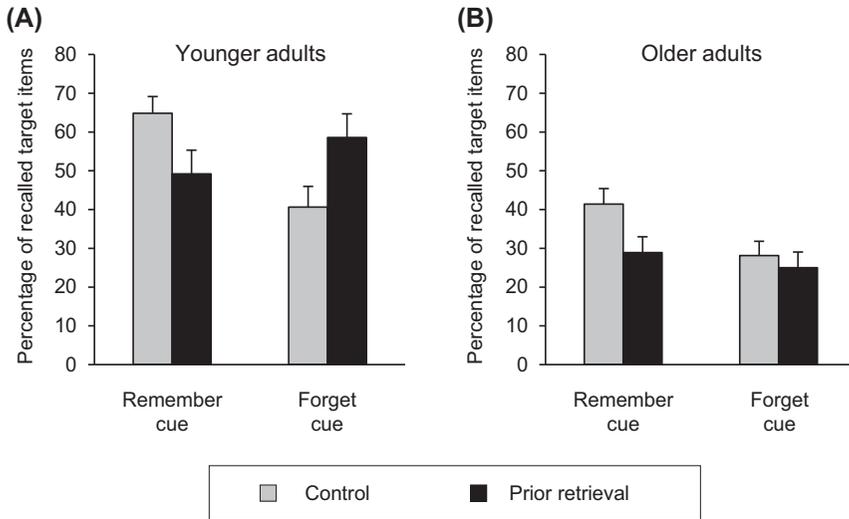
[Aslan and Bäuml \(2014\)](#) tested this prediction in second, fourth and seventh grade children. Following previous work with adults (e.g., [Bäuml & Samenieh, 2010, 2012a, 2012b](#)), study context access was manipulated using the listwise directed forgetting task. Children studied a list of unrelated items and, after study, received a cue to either forget or continue remembering the list. Following study of a second list, memory for predefined target items of the original list was assessed using the output-order task, that is, either with or without preceding selective retrieval of the list's remaining (nontarget) items. Preceding selective retrieval impaired recall of to-be-remembered target items, regardless of age, thus replicating the typical finding of intact retrieval-induced forgetting in school-aged children (e.g., [Aslan & Bäuml, 2010](#); [Zellner & Bäuml, 2005](#)). In contrast, preceding selective retrieval improved recall of to-be-forgotten target items in seventh graders, but not in fourth and second graders, indicating that elementary school children can or do not yet capitalize on retrieval-induced context reactivation (see [Fig. 8](#)).

Regarding older adults' memory, [Aslan, Schlichting, John, and Bäuml \(2015\)](#) examined in two experiments whether older adults, who typically show the detrimental effect of selective retrieval, also show the beneficial effect. Both experiments employed the output-order task. In Experiment 1, younger participants (20–35 years) as well as older participants (above 60 years) were examined, and, like in [Aslan and Bäuml's \(2014\)](#) children



**Figure 8** Effects of selective retrieval in children. (A) In second graders, prior nontarget retrieval impaired recall for to-be-remembered targets, but left recall for to-be-forgotten targets unaffected. (B) In fourth graders, prior nontarget retrieval impaired recall for to-be-remembered targets, but left recall for to-be-forgotten targets unaffected. (C) In seventh graders, prior nontarget retrieval impaired recall for to-be-remembered targets, but improved recall for to-be-forgotten targets. Error bars represent standard errors. *From Aslan, A., Bäuml, K.-H. T. (2014). Later maturation of the beneficial than the detrimental effect of selective memory retrieval. Psychological Science, 25, 1025–1030.*

work, study context access was manipulated using the listwise directed forgetting task. Results revealed that whereas both age groups showed a detrimental effect of selective retrieval on to-be-remembered target items, only younger, but not older, adults showed a beneficial effect of selective

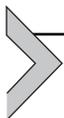


**Figure 9** Effects of selective retrieval in younger and older adults. (A) In younger adults, prior nontarget retrieval impaired recall for to-be-remembered targets, but improved recall for to-be-forgotten targets. (B) In older adults, prior nontarget retrieval impaired recall for to-be-remembered targets, but left recall for to-be-forgotten targets unaffected. Error bars represent standard errors. *From Aslan, A., Schlichting, A., John, T., Bäuml, K.-H. T. (2015). The two faces of selective memory retrieval: Earlier decline of the beneficial than the detrimental effect with older age. Psychology and Aging, 30, 824–834.*

retrieval on to-be-forgotten target items (see Fig. 9). In Experiment 2, a large sample of participants from a relatively wide age range (40–85 years) was examined, and study context access was manipulated by varying the retention interval between study and selective retrieval. Overall, a detrimental effect of selective retrieval arose when the retention interval was relatively short, but a beneficial effect arose when the retention interval was prolonged. More important, the size of the beneficial effect decreased gradually with age and this age-related decline was mediated by individuals' WMC. These results indicate that older adults, like younger children, have difficulty to capitalize on retrieval-induced context reactivation.

Together, the results from the developmental studies on the two faces of selective retrieval thus suggest an age-related dissociation in retrieval dynamics, indicating later maturation and earlier decline of the beneficial than the detrimental effect of selective retrieval. Indeed, while the (inhibitory) mechanisms underlying the detrimental effect develop around the time of school entry, remain stable for most part of the lifespan, and become inefficient again not until very old age (i.e., in old-old adults),

the (context-reactivation) mechanisms underlying the beneficial effect of selective retrieval develop sometime between fourth and seventh grade, and begin to decline at an age at which the detrimental effect is still intact (i.e., in young-old adults).



## 5. THE TWO FACES OF SELECTIVE RETRIEVAL IN SOCIAL SETTINGS

Most experimental memory research analyzes individual memory performance of single subjects who are trying to remember previously studied information in isolation. Naturally, such a focus on individual remembering neglects aspects that may influence recall and pervade memory in our daily lives. For instance, humans as social beings engage in conversations with others all the time, and, during such conversations, constantly reminisce about the past, which provides a social dimension to remembering (for reviews, see [Hirst & Echterhoff, 2012](#); [Rajaram & Pereira-Pasarin, 2010](#)). In particular, conversational remembering often occurs in a very selective manner, with people emphasizing some but leaving out other aspects of a remembered and discussed episode. Such conversational silences may arise for different reasons; sometimes what is left out does not fit with conversational goals, other times speakers may try to avoid stressful details or there may simply not be enough time for a complete retelling (e.g., [Tversky & Marsh, 2000](#); [Zerubavel, 2006](#)). The question is whether selective remembering in conversations has mnemonic consequences that arise not only for the speaker but may additionally be transmitted to a listener. And, if so, do such consequences depend on whether the listener's access to the original encoding context is intact or impaired during the selective retrieval of the speaker?

### 5.1 Detrimental Effects of Selective Retrieval in Social Groups

[Cuc et al. \(2007\)](#) addressed the issue of whether the selective retrieval of a speaker influences the recall of a listener by using the speaker-listener paradigm. In this paradigm, pairs of subjects were asked to engage in a memory task together. After individual study of a list of items, only one member of each pair (the “speaker”) was asked to engage in selective retrieval and to recall some of the studied items, while the other member of the pair (the “listener”) monitored the speaker's responses with regard to accuracy. Selective retrieval followed shortly after study, so that

participants' access to the study context during selective retrieval was largely maintained. On the final test, both subjects were asked to recall the previously studied items. The results showed that the selective retrieval of the speaker can induce forgetting of the remaining information in both the speaker and the listener, indicating that the effects of selective retrieval can be transmitted to a listener.

Such socially shared retrieval-induced forgetting in listeners seems to be a robust finding that generalizes across different types of materials and different types of selective retrieval. It was not only observed for recall of word lists, but also when coherent stories were used as study material and when selective retrieval was not controlled by the experimenter, but instead implemented in the form of free-flowing conversations (see Cuc et al., 2007). Such forgetting is not automatic, however, but it is under the (intentional or unintentional) control of the listener and depends on whether the listener retrieves the mentioned contents along with the speaker. Consistently, the forgetting was found to be present when the listener was asked to monitor the speaker's recollections for accuracy, but it was absent when the listener was instead asked to attend to more superficial features of the speaker's responses, like the speaker's fluidity or smoothness of recall (Cuc et al., 2007; see also Koppel, Wohl, Meksin, & Hirst, 2014).

Hirst and colleagues also investigated the influence of selective retrieval on autobiographical and flashbulb memories (Coman, Manier, & Hirst, 2009; Stone, Barnier, Sutton, & Hirst, 2013). Coman et al. (2009) examined how selective retellings of the September 11 terrorist attacks affected later memory for unmentioned details in both speaker and listener. Stone et al. (2013) investigated the consequences of selective discussions of only some aspects of prior autobiographical experiences, some of them emotionally toned; the issue was examined in both romantic couples who had experienced the respective events together and in strangers who did not have common memories. Both studies reported detrimental effects of selective retrieval in both speakers and listeners, suggesting that selective retrieval is also detrimental for autobiographical and flashbulb memories.

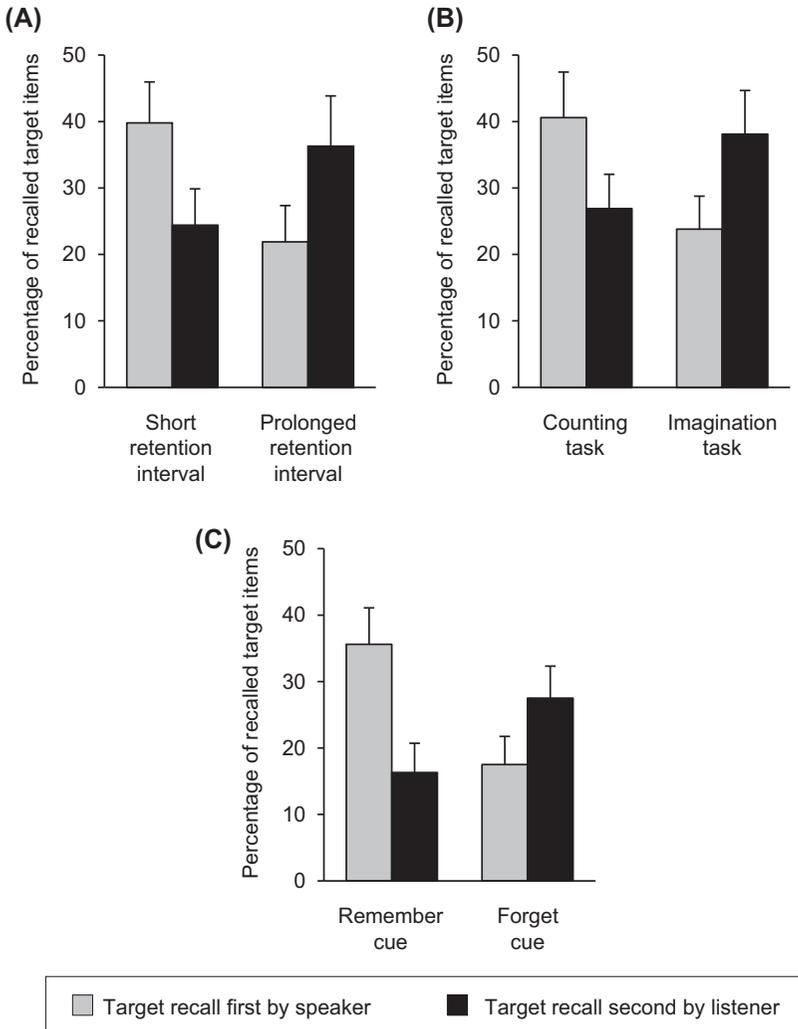
On the basis of the two-factor account of selective retrieval entertained earlier (see Section 3.1), the findings by Coman et al. (2009) and Stone et al. (2013) appear challenging, because they suggest that selective retrieval can be detrimental even when the to-be-remembered memories are encoded long time before selective retrieval starts, that is, even when individuals' access to the encoding context should definitively be impaired. Yet, in

both studies, the respective memories were reactivated before selective retrieval was initiated. In Coman et al., a questionnaire probed participants' memories of the September 11 attack before subjects engaged in selective retrieval; in Stone et al., participants first underwent an elicitation phase and generated the autobiographical memories, before, one day later, they studied each generated memory again right before selective retrieval began. Such reactivations prior to selective retrieval may have improved access to the encoding context and retrieval may thus have triggered inhibition and blocking processes that reduced recall performance (see Section 3.4 aforementioned).

## 5.2 Beneficial Effects of Selective Retrieval in Social Groups

Abel and Bäuml (2015) addressed the issue and investigated whether selective retrieval can induce beneficial effects in listeners when access to the study context is experimentally impaired and the memories are not reactivated before selective retrieval starts. The study included three experiments, in each of which access to the study context was manipulated and it was examined whether the effects of selective retrieval by a speaker on memory for unmentioned information in a listener depend on study context access. In one of these experiments, time-dependent forgetting was employed to vary study context access and subjects were asked to recall a previously studied list of words either after a short retention interval of 3 min (*maintained context access condition*) or a prolonged retention interval of 24 h (*impaired context access condition*). A version of the speaker-listener paradigm was used, and, at test, one of the subjects was asked to act as the speaker and to selectively retrieve some of the studied items. The second subject acted as the listener, and recalled the remaining items after listening to the speaker's previous recall. The results showed that, after the short retention interval, the selective retrieval of the speaker impaired recall of the remaining items by the listener; in contrast, after the prolonged retention interval, the selective retrieval of the speaker improved recall of the remaining items by the listener (see Fig. 10A). These findings provide evidence that the two faces of selective retrieval can also exist in social groups.

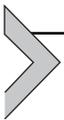
Abel and Bäuml's (2015) study contained two further experiments, demonstrating that the pattern observed for time-dependent forgetting generalizes to context-dependent forgetting and listwise directed forgetting. In the experiment on context-dependent forgetting, subjects studied two lists of items and between study of the two lists were either asked to engage in an imagination task to change internal context or to complete a simple



**Figure 10** Effects of selective retrieval in a social setting, examined with time-dependent forgetting (A), context-dependent forgetting (B) and list-method directed forgetting (C). Prior nontarget retrieval by a speaker impaired recall of targets by a listener after short retention interval, with an intermittent counting task, and after a remember cue. In contrast, listening to the speaker's prior nontarget retrieval improved subsequent target recall by the listener after prolonged retention interval, with an intermittent imagination task, and after a forget cue. Error bars represent standard errors. *From Abel, M., Bäuml, K.-H. T. (2015). Selective memory retrieval in social groups: When silence is golden and when it is not. Cognition, 140, 40–48.*

counting task that leaves context unaffected. In the counting task condition, the selective retrieval of the speaker impaired recall of the remaining items by the listener, whereas in the imagination condition, the selective retrieval of the speaker improved recall of the remaining items by the listener (see Fig. 10B). Analogous results arose with the listwise directed forgetting task (see Fig. 10C). All of these results suggest that, also in social groups, selective retrieval can improve recall of other memories, at least when study context access is impaired and the memories are not reactivated before selective retrieval starts.

Abel and Bäuml's (2015) findings suggest a generalization of the two-factor account of selective retrieval to social groups. The proposal is that selective retrieval by a speaker can induce inhibition and blocking as well as context reactivation processes in the listener. Which of the two types of processes is more dominant in a particular situation depends on the degree to which the listener's access to the encoding context during selective retrieval is impaired. If access to her encoding context is largely maintained, inhibition and blocking processes are more dominant and detrimental effects of selective retrieval arise. Yet, if access to her encoding context is impaired, context reactivation processes are more dominant, such that beneficial effects of selective retrieval arise (see Section 2.2). Thus, depending on circumstances, preceding selective retrieval of some detail by a speaker can both impair and improve recall of other details by the listener.



## 6. CONCLUSIONS AND FUTURE DIRECTIONS

### 6.1 Conclusions

Research on retrieval-induced forgetting of the past decades has shown that selective retrieval of a subset of studied items can impair recall of other studied items. This effect turned out to be very robust and to hold over a wide range of settings and materials. Retrieval-induced forgetting has typically been investigated under conditions in which participants' context during selective retrieval was similar to their context at study. Results from more recent studies now indicate that this contextual similarity may be critical for the detrimental effect of selective retrieval to arise. Indeed, when access to the study context is impaired, selective retrieval often does no longer induce detrimental effects on recall of the other items but improves item recall. To date, this pattern was demonstrated in three different experimental tasks: in listwise directed forgetting when study

context access is impaired by a forget cue; in context-dependent forgetting when study context access is impaired by engagement in a diversion task; and in time-dependent forgetting when study context access is impaired by means of a prolonged retention interval (see [Table 1](#)). Together, these findings indicate that there are two faces of selective memory retrieval with the detrimental face arising when study context access is largely maintained during selective retrieval, and the beneficial face arising when study context access is impaired.

The two-factor account of the two faces of selective retrieval follows the prior work on retrieval-induced forgetting and attributes the detrimental effect of selective retrieval to inhibition and blocking; in addition, the account attributes the beneficial effect to context reactivation processes. Here the proposal is that, when study context access is impaired, selective retrieval of some of the studied items may reactivate the study context, which may serve as a retrieval cue for recall of the remaining items and thus improve their recall. At the core of this account is the assumption that, in general, selective retrieval triggers inhibition and blocking as well as context reactivation processes, but that the extent to which access to the study context during selective retrieval is maintained or impaired determines which of the two types of processes dominates in an experimental situation. When study context access is (largely) maintained, primarily inhibition and blocking are supposed to operate, whereas when study context access is impaired primarily context reactivation processes are triggered.

The basic finding of the two faces of selective memory retrieval is consistent with the two-factor account, as are the results from other recent lines of research. For instance, the finding that the detrimental face of selective retrieval is retrieval specific, whereas the beneficial effect shows up after both selective retrieval and selective restudy is well in line with the two-factor account. The finding that, after induced context change, mental context reinstatement immediately before test can turn the beneficial effect of selective retrieval into a detrimental one also supports this theoretical view. Finally, results from both developmental and social work are consistent with the two-factor account.

## 6.2 Future Directions

The results of the previous studies on the two faces of selective retrieval provide important insights into the effects of selective retrieval and the critical role of study context access for these effects. Naturally, this research

**Table 1** List of key findings on the two faces of selective memory retrieval

<b>Study</b>	<b>Experimental paradigm(s)</b>	<b>Selective retrieval task(s)</b>	<b>Key finding(s)</b>
Bäuml and Samenieh (2010)	List-method directed forgetting	Output-order task	Retrieval-induced forgetting arises after the remember cue, but retrieval-induced facilitation after the forget cue
Bäuml and Samenieh (2012b)	List-method directed forgetting (Exp. 1); context-dependent forgetting (Exp. 2); proactive interference (Exp. 3)	Output-order task	Retrieval-induced forgetting arises after the remember cue and in the absence of mental context change, but retrieval-induced facilitation after both the forget cue and mental context change; with proactive interference no facilitation effect of selective retrieval emerges
Bäuml and Schlichting (2014)	Time-dependent forgetting	Output-order task	Retrieval-induced forgetting arises after short retention interval, but retrieval-induced facilitation after prolonged retention interval
Bäuml & Dobler (2015)	List-method directed forgetting (Exp. 1); time-dependent forgetting (Exp. 2)	Retrieval-practice task (Exp. 1); output-order task (Exp. 2)	Retrieval-induced forgetting is specific to selective retrieval, but the facilitation effect can also arise after selective restudy
Dobler & Bäuml (2012)	List-method directed forgetting	Retrieval-practice task	Retrieval-induced forgetting persists in size for at least 10 min, but retrieval-induced facilitation reduces, or even disappears, with delay between selective retrieval and test
Wallner & Bäuml (2016)	Time-dependent forgetting	Output-order task	Mental reinstatement of the study context after prolonged retention interval and before the final test reverses retrieval dynamics and leads to retrieval-induced forgetting

*(Continued)*

**Table 1** List of key findings on the two faces of selective memory retrieval—cont'd

Study	Experimental paradigm(s)	Selective retrieval task(s)	Key finding(s)
Schlichting, Aslan, Holterman, & Bäuml (2015)	Context-dependent forgetting	Output-order task	Individuals with high working memory capacity show more retrieval-induced facilitation than individuals with low working memory capacity
Aslan & Bäuml (2014)	List-method directed forgetting	Output-order task	Retrieval-induced forgetting is present from at least second grade on, but retrieval-induced facilitation matures only after elementary school
Aslan et al. (2015)	List-method directed forgetting (Exp. 1); time-dependent forgetting (Exp. 2)	Output-order task	Younger adults show both retrieval-induced forgetting and retrieval-induced facilitation, but older adults show retrieval-induced forgetting only
Abel & Bäuml (2015)	List-method directed forgetting (Exp. 1); context-dependent forgetting (Exp. 2); time-dependent forgetting (Exp. 3)	Output-order task	Both retrieval-induced forgetting and retrieval-induced facilitation can be socially shared and arise not only for speakers (who engaged in selective retrieval themselves), but also for listeners

also raises a number of new questions that have not been examined in the prior work and that future work may address. One such question has to do with the possible role of experimental task for the effects of selective retrieval. To date, most studies on the two faces of selective retrieval employed the output-order task and only few used the retrieval-practice task. Indeed, although in listwise directed forgetting the two faces of selective retrieval were demonstrated with both the output-order task and the retrieval-practice task, in context-dependent forgetting and time-dependent forgetting the two faces were demonstrated with the output-order task only (see [Table 1](#)). Future work may thus like to complement the previous work by also using the retrieval-practice task to demonstrate the two faces of selective retrieval in context-dependent forgetting and time-dependent forgetting.

Another question that future work may address has to do with the possible role of study material for the beneficial effect of selective retrieval. In the previous studies, the presence of the beneficial effect has been examined for a relatively restricted set of study materials. Indeed, most studies employed lists of unrelated words as study material with the only exception of [Bäuml and Schlichting \(2014\)](#), which used more integrated prose material. Additional work is needed to examine the effects for a wider range of study materials. Although, on the basis of the [Bäuml and Schlichting](#) results, such work may be expected to find the two faces of selective retrieval over a wider range of study materials, it may also find that type of material can influence retrieval-induced context reactivation processes. For instance, while for lists of unrelated words retrieval-induced context reactivation has been found to occur fairly gradually ([Bäuml & Samenieh, 2010](#)), retrieval-induced context reactivation may be accelerated by the presence of semantic information during selective retrieval. In fact, if subjects learned semantically categorized material, selective retrieval of few items of a category may already be sufficient to reinstate the study context more or less completely. Similarly, the presence of a category label as a retrieval cue during selective retrieval may enhance context reactivation processes. In their context theory of retrieval-induced forgetting, [Jonker et al. \(2013\)](#) suggested that context may be more or less immediately reinstated for a single item when the item's category label together with its unique initial letter were provided as retrieval cues at test. However, whether this is really the case has not been examined to date and may be addressed in future work.

A further question regarding material is whether the beneficial face of selective retrieval also becomes evident in autobiographical remembering. In most experimental studies on the effects of selective retrieval for autobiographical remembering, the memories were initially captured in a so-called elicitation phase, with the next phases of the experiment following rather closely upon this reactivation. Consistent with the two-factor account of selective retrieval and the findings by Wallner and Bäuml (2016), such experiments typically revealed negative consequences of selective retrieval for other autobiographical memories (e.g., Barnier et al., 2004; Coman et al., 2009). Future work may examine the effects of selective retrieval for autobiographical remembering in the absence of elicitation-induced reactivation of the memories, or when a longer delay is introduced between elicitation and selective retrieval. Such delay may again induce impaired context access and thus create beneficial effects of selective retrieval for autobiographical memories. However, because autobiographical memories are generally assumed to be highly complex, cross-linked, emotional and relevant to our sense of self (e.g., Conway, 2005), delays of several days or even weeks may be necessary so as to again impair context access.

Regarding generalizability of the previous results, it is also an important question of whether the findings on the two faces of selective retrieval in social recall generalize to more complex social settings. While the recent work provides first evidence that the two faces of selective retrieval can generalize from individuals to social groups (Abel & Bäuml, 2015), this demonstration was provided with the highly controlled speaker-listener paradigm. Whether the beneficial effect also occurs when more than two people engage in joint remembering is unclear. Research on collaborative remembering investigated group recall of three or more people and typically showed that being exposed to other subjects' responses at test reduces recall (for a review, see Rajaram & Pereira-Pasarin, 2010). Yet, most studies on collaborative remembering employed conditions under which access to the original study context was largely maintained before collaborative retrieval started. Thus, on the basis of the two-factor account of selective retrieval, there is room left to speculate that collaborating with several people at test could also be beneficial for recall when retrieval occurs under conditions that impair study context access and make contextual reactivation necessary.

A different line of future work may address specific predictions arising from the two-factor account. Although previous studies already started to examine such predictions (see Sections 3.2–3.4), there are further

predictions that deserve investigation. An intriguing prediction of the two-factor account, for instance, is that, after impaired study context access, retrieval dynamics may change during the selective retrieval period. In fact, when study context access is impaired, selective retrieval may initially trigger primarily context reactivation processes, which may cause beneficial effects of selective retrieval. But once a sufficiently large number of items are selectively retrieved, context reactivation may reach such a high level that interference between items is back again and further selective retrieval starts to trigger primarily inhibition and blocking, rather than context reactivation processes. In such case, selective retrieval may be self-propagating early in the selective retrieval period but become self-limiting later in the retrieval period. Future work may address this interesting prediction.

Finally, future work may also search for the neural mechanisms underlying the beneficial effect of selective retrieval. Previous studies on retrieval-induced forgetting already identified neural markers of the detrimental effect of selective retrieval. Such markers were reported both when employing functional magnetic resonance imaging (Kuhl, Dudukovic, Kahn, & Wagner, 2007; Wimber, Alink, Charest, Kriegeskorte, & Anderson, 2015; Wimber, Bäuml, Bergström, Markopoulos, Heinze, & Richardson-Klavehn, 2008) and when using electrophysiological measures of brain activity (Johansson, Aslan, Bäuml, Gäbel, & Mecklinger, 2007; Spitzer, Hanslmayr, Opitz, Mecklinger, & Bäuml, 2009; Staudigl, Hanslmayr, & Bäuml, 2010). These markers supported the view of a critical role of inhibition for the detrimental effect of selective retrieval and thus improved our knowledge on the mechanisms underlying the detrimental effect of selective retrieval. Future work may also search for neural markers of the beneficial effect of selective retrieval. Identifying neural markers of selective retrieval when study context access is impaired may lead to new insights into retrieval-induced context reactivation processes. In particular, together with the behavioral evidence and the results for the detrimental face of selective retrieval, such results may eventually lead to a neurocognitive model of the two faces of selective memory retrieval.



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## 7. TAKE HOME MESSAGE

Selective retrieval of a specific episode can affect memory for related episodes. It impairs recall of other episodes when access to study context during selective retrieval is maintained, but can improve recall of other episodes when study context access is impaired. This evidence for two faces

of selective memory retrieval reveals new insights into the cognitive mechanisms mediating the effects of selective retrieval. It is important for research on memory development, because it demonstrates age-related dissociations in retrieval dynamics between the two effects, and it builds a bridge from individual to social memory by showing that the two faces can generalize from individual to social recall. Last not least, by indicating that related memories can trigger each other through associative processes, it reconciles scientific work with people's—and particularly Aristotle's—intuition.

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