Context Retrieval as a Critical Component in Selective Memory Retrieval

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Abstract

Selective retrieval often impairs recall of nonretrieved items, a finding referred to as retrieval-induced forgetting. In this article, I review recent research showing that selective retrieval can also improve recall of other items. This research points to a critical role of context retrieval in selective memory retrieval. Context retrieval, which has played a prominent role in other lines of memory research, suggests that selective retrieval can reactivate the retrieved items’ temporal context during study, facilitating recall of other items with similar context at study. Such facilitatory effects on recall can arise both when selective item repetition occurs via retrieval and when it occurs via restudy, which suggests a link to the reminding literature. The findings offer new perspectives for investigating and understanding the effects of selective memory retrieval.

Keywords

episodic memory; retrieval; context
Selective Memory Retrieval

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Selective retrieval of some studied items can induce forgetting of the nonretrieved items, a finding referred to as retrieval-induced forgetting (RIF). Evidence for RIF has been provided in the older output-interference and the more recent retrieval-practice task. In the output-interference task, it has been shown that recall performance for a studied item declines with its output position in the test sequence, indicating that selective retrieval of earlier-tested items impairs recall of later-tested items (Tulving & Arbuckle, 1966). In the retrieval-practice task, it has been shown that selective retrieval on some studied items during an intermediate practice phase can impair recall of related nonretrieved items later at test (Anderson, Bjork, & Bjork, 1994). RIF has often been attributed to blocking and inhibition processes. According to blocking, selective retrieval strengthens the retrieved material, so that, during later attempts to recall the nonretrieved items, the stronger retrieved items are continually brought to mind, blocking access to the weaker nonretrieved items (Roediger & Neely, 1982). According to inhibition, the not-to-be-practiced items interfere during selective retrieval and are inhibited to reduce the interference, which impairs the memory representation of these items and reduces their accessibility on a later memory test (Anderson, 2003). Results from recent years suggest that both processes can contribute to RIF (for a recent review, see Bäuml & Kliegl, 2017).

Retrieval Can Reactivate Study Context

The finding that selective retrieval can induce RIF and blocking and inhibition operate in response to selective retrieval may not tell the entire story of how selective retrieval influences recall performance. Rather, context retrieval may contribute to the effects of selective retrieval. Temporal context - the current pattern of activity in an individual’s mind that, among others, can be influenced by both environmental and internal factors - changes gradually over time and it is assumed that each studied item is associated
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with the temporal context in which it is shown (Bower, 1972; Estes, 1955). As a result, temporal context during later retrieval will often be different from context during study and thus not be the optimal cue for studied items. However, as emphasized by Kahana and colleagues (Howard & Kahana, 2002; Polyn & Kahana, 2008), context during recall is not a static entity but changes in response to recall attempts: recall of an item results in a partial reactivation of the context that was present when that item was studied, and this retrieved context then serves as a retrieval cue for other items with a similar context at study, facilitating recall of these items.

Context retrieval did not play a role in prior work on the effects of selective retrieval, which typically employed experimental settings that minimize the contextual change between study and selective retrieval. Indeed, in most studies, short delays between study and selective retrieval were employed without any major contextual change between the two experimental phases (see Bäuml & Kliegl, 2017). Possible effects of context retrieval therefore may have been small in these studies and be masked by inhibition and blocking. In order to investigate whether context retrieval can contribute to the effects of selective retrieval and influence RIF, recent work from our lab examined the effects of selective retrieval when the contextual overlap between study and selective retrieval was reduced. Such reduction in overlap should enhance the role of context retrieval for the effects of selective retrieval, which may then attenuate the typical detrimental effect, eliminate it, or even reverse it into a beneficial effect.

Selective Retrieval Improves Recall When Study and Retrieval Contexts Differ

Changes in temporal context typically increase when the delay between study and retrieval is increased, which reduces the overlap between study and retrieval contexts (Estes, 1955; Howard & Kahana, 2002; Mensink & Raaijmakers, 1988). Bäuml and Schlichting (2014) examined in two experiments how delay between study and retrieval influences
the effects of selective retrieval. In Experiment 1 of their study, subjects studied a list of unrelated items and, after a delay of 5 min or 48 hours, were asked to recall predefined target items from the list first or after prior selective retrieval of the remaining (nontarget) items; both target and nontarget retrieval were guided by providing the items’ unique initial-letters as retrieval cues. Selective retrieval induced RIF after short delay, which was expected, but it improved recall after prolonged delay (see Fig. 1). Experiment 2 of the study replicated this pattern of results using coherent prose material for study (for further conceptual replications, see Abel & Bäuml, 2015; Aslan, Schlichting, John, & Bäuml, 2015).

Wallner and Bäuml (2017, Experiment 1) improved our understanding of the beneficial effect. Using lists of unrelated items for study, they compared the effects of selective retrieval after prolonged delay between two conditions that differed in whether, immediately before selective retrieval started, study context was mentally reinstated or not. 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 (Sahakyan
& Kelley, 2002), whereas in the no-context-reinstatement condition, participants solved arithmetic problems for the same duration of time. Mental context reinstatement should reduce the delay-induced mismatch between study and retrieval contexts and thus reduce the need for further (retrieval-induced) context retrieval. It should therefore attenuate the beneficial effect, eliminate it, or even reverse it - which might occur if the mental reinstatement was complete. As expected, mental reinstatement largely eliminated the delay-induced mismatch between study and retrieval contexts. More important, results showed the expected beneficial effect of selective retrieval when no preceding mental reinstatement had taken place, but showed a reversal of the effect into a detrimental effect when participants engaged in mental context reinstatement (see Fig. 2).

![Fig. 2: Effects of selective retrieval after prolonged delay in the presence and the absence of mental context reinstatement. In the presence of mental context reinstatement selective retrieval impairs target recall, in its absence it improves target recall. Adapted from Wallner, L. A., Bäuml, K.-H. T., 2017, Beneficial effects of selective item repetition on the recall of other items. Journal of Memory and Language, 95, Figure 1B, p. 163.](image)

The results of these studies are consistent with the view that selective retrieval generally triggers two types of processes: inhibition/blocking and context retrieval (Bäuml & Samenieh, 2012; Bäuml & Schlichting, 2014). The relative contribution of the two types of processes depends on the contextual overlap between study and selective retrieval. When
the contextual overlap is high - as may occur after short delay or after long delay when there is prior mental context reinstatement - interitem interference is high and mainly inhibition and blocking operate, while there is not much need for context retrieval. When the contextual overlap is low - as may occur after prolonged delay when there is no prior mental context reinstatement - mainly context retrieval operates, while blocking and inhibition may be reduced due to attenuated interitem interference. Differences in relative contributions of the two types of processes then create the pattern of detrimental and beneficial effects of selective memory retrieval.

**Selective Restudy Can Also Improve Recall**

Context retrieval is often assumed not to be restricted to retrieval but to also arise after restudy trials (Greene, 1989; Thios & D’Agostino, 1976), a proposal included in computational models (Howard & Kahana, 2002; Polyn, Norman, & Kahana, 2009). If so, the beneficial effect of selective retrieval, as observed in the delay experiments reported above, should generalize to selective restudy and both selective retrieval and selective restudy improve recall of other items. Bäuml and Dobler (2015) addressed the issue and compared the effects of selective retrieval and selective restudy after both short (5 min) and long delay (48 hours) between study and selective item repetition. Lists of unrelated items served as study material. Consistent with prior RIF work, results showed a detrimental effect after short delay that was retrieval specific, i.e., it arose in response to selective retrieval but not in response to selective restudy. In contrast, after prolonged delay, a beneficial effect emerged after both repetition formats, indicating that the detrimental effect but not the beneficial effect of selective retrieval is retrieval specific.

Wallner and Bäuml (2017) again compared the effects of selective retrieval and selective restudy and additionally examined the influence of difficulty of selective retrieval on the size of the beneficial effect. After study of a list of unrelated items (Experiments 2 and 3) or coherent prose material (Experiment 4) and a delay interval of at least 30 min, subjects
selectively retrieved some studied items in the presence of strong word-stem cues (*app* for *apple*; easy retrieval) or weak initial-letter cues (*a* for *apple*; difficult retrieval) or selectively restudied the same items, before they recalled the target items. Results showed beneficial effects after all three repetition formats, again indicating that the effect is not retrieval specific. The size of the effects, however, varied with repetition format: they were larger after difficult than easy selective retrieval, and they were larger after easy retrieval than selective restudy (see Fig. 3). This pattern of results mimics research on desirable difficulties in learning, which has shown that variables that pose challenges for learners and make initial learning feel more difficult can provide a beneficial effect on long-term retention (Bjork, 1994). Similarly, variables that pose challenges during (delayed) retrieval of some memory contents may be beneficial for the recall of related memory contents.

![Fig. 3: Beneficial effects of selective item repetition on target recall as a function of repetition format (control, restudy, easy retrieval, difficult retrieval). Beneficial effects are strongest after difficult retrieval and weakest after restudy. Adapted from Wallner, L. A., Bäuml, K.-H. T., 2017, Beneficial effects of selective item repetition on the recall of other items. *Journal of Memory and Language*, 95, Figure 3A, p. 167.](image-url)
Restudy and Reminding, Retrieval and Context Change

The finding of beneficial effects of selective restudy and the suggested role of context retrieval for the effect fits with the reminding literature. In fact, context retrieval plays a key role in stimulus repetition effects, in which the second presentation of an item is often assumed to be not only encoded in its own right but to remind the subject of the first presentation (Hintzman, 2004). Such reminding, for instance, has been suggested to underlie the spacing effect - the beneficial mnemonic effect of spaced over massed learning - and judgments of the frequency or recency of an item’s occurrence during study (for an overview, see Benjamin & Tullis, 2010). Recently, the concept has also been applied to explain possible beneficial effects of the encoding of new material on the recall of previously encoded memory contents (Jacoby, Wahlheim, & Kelley, 2015; Putnam, Sungkhasette, & Roediger, 2017). The restudy findings reviewed in this article add to this list of studies, indicating that (delayed) selective item repetition can serve as a reminder for the remaining, not repeated items.

The suggested role of context retrieval for the beneficial effect of selective retrieval is consistent with the general view that retrieval can induce context change (Jang & Huber, 2008; Shiffrin, 1970). Indeed, the assumption that selective retrieval induces context retrieval implies that, after selective retrieval has taken place, context has changed: context is updated in response to selective retrieval and then includes a composite of study and retrieval contexts (Polyn & Kahana, 2008). Importantly, such updating makes context after selective retrieval more similar to study context than in the absence of selective retrieval, and it is this similarity that is supposed to underlie the beneficial effect of selective retrieval.

As an alternative to the blocking and inhibition accounts of RIF, Jonker, Seli, and MacLeod (2013) recently provided a context account of RIF. They argued that selective retrieval induces a distinct shift in context that makes context less, rather than more,
similar to study context, and, accordingly, induces a detrimental, rather than a beneficial, effect on the recall of the nonretrieved items. Although quite different, or even opposite, in character, the two context proposals may not be mutually exclusive. For instance, whereas context retrieval seems to influence recall mainly when the contextual overlap between study and retrieval is low (see above), context shift may influence recall mainly if the contextual overlap is high: when the contextual overlap is already low, retrieval-induced context shift may not reduce the overlap much further and have not much influence on recall performance. I encourage researchers to consider the two context proposals and their relation in future work on the effects of selective retrieval.

**Boundary Conditions**

The results reviewed in this article suggest that when the contextual overlap between study and selective retrieval is low, and recall relies largely on temporal context, then selective retrieval can improve recall performance due to context retrieval. This effect may not arise under all circumstances. As shown by Wallner and Bäuml (2017), the beneficial effect of selective retrieval can turn into RIF, if immediately preceding the retrieval phase, study context was mentally reinstated. Such preceding reinstatement of study context may not only arise through deliberate active reinstatement attempts, but may also occur unintentionally, for instance, if an encoded event included particularly salient, exceptional, or emotional features. Accordingly, once again seeing the pictures of the two passenger airliners crashing into the towers of the New York World Trade Center may immediately reinstate the context that one was into while becoming aware of the September 11 terrorist attacks, reducing the likelihood of further retrieval-induced context retrieval.

Conversely, when the contextual overlap between study and selective retrieval is high, selective retrieval may not always induce RIF. Employing prose material for study, a short delay between study and selective retrieval, and a long delay between selective retrieval
and recall of the nonretrieved items, Chan, McDermott, and Roediger (2006) indeed reported beneficial, rather than detrimental, effects of selective retrieval. These beneficial effects arose in response to selective retrieval, but not selective restudy, indicating that they were retrieval specific and thus mediated by other cognitive mechanisms than the beneficial effects reviewed here (see Chan, 2009, for suggestions for candidate mechanisms). Thus, not only contextual overlap between study and selective retrieval but also a few other factors can influence whether selective retrieval is beneficial or detrimental for other memory contents.

Conclusions

Accounts of the effects of selective retrieval that focus on RIF and the underlying operation of blocking, inhibition, or context shift processes are incomplete. Rather, context retrieval can critically contribute to the effects of selective retrieval and, when the contextual overlap between study and retrieval is reduced, turn the typical RIF effect into a beneficial effect of selective retrieval. In everyday life, retrieval is often selective and delayed, like when a teacher repeats some of the information from the last lecture or a person is interrogated by a police officer about a specific event that she witnessed a few days ago. The results reviewed in this article suggest that selective retrieval may not induce RIF in such situations, but retrieval of a particular memory rather aid and guide the retrieval of other memories. The findings therefore offer new perspectives for investigating and understanding the effects of selective retrieval.
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Declaration of Conflicting Interests

The author declares that he had no conflicts of interest with respect to his authorship or the publication of this article.
References


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Recommended Reading


Bäuml, K.-H. T., & Kliegl, O. (2017). (See References). A recent review of the RIF literature, which summarizes important empirical findings, introduces the most prominent accounts of RIF, and evaluates the accounts against the empirical findings.

Jonker, T. R., Seli, P., & MacLeod, C. M. (2015). Retrieval-induced forgetting and context. *Current Directions in Psychological Science, 24*, 273-278. Provides a context account of RIF, which is conceptually different from (and even opposite to) the ideas presented here and explains RIF through a distinct shift in context.