

# Influences of Part-List Cuing on Different Forms of Episodic Forgetting

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Across 3 experiments, we examined the interplay of part-list cuing and forgetting, employing 3 different methods to induce episodic forgetting—list-method directed forgetting, context-dependent forgetting, and proactive interference. For each form of forgetting, participants were asked at test to recall the target items of a previously studied list in the presence or the absence of the list's remaining items serving as retrieval cues. We found such part-list cuing to amplify the forgetting in proactive interference but to diminish the forgetting in list-method directed forgetting and context-dependent forgetting. These results show that the effects of part-list cuing on forgotten memories depend critically on the circumstances surrounding the forgetting. If the forgetting reflects impaired access to the original encoding context, as has been suggested in list-method directed forgetting and context-dependent forgetting (but not in proactive interference), part-list cues improve access to forgotten memories; if the forgetting does not reflect such a contextual effect, no such beneficial effects emerge, and access to forgotten memories may even be impaired.

*Keywords:* cuing, forgetting, directed forgetting, context-dependent forgetting, proactive interference

There is much more information stored in an individual's memory than the individual can remember at a particular point in time. Tulving and Pearlstone (1966) emphasized this core feature of human memory by distinguishing between single memories' availability and their accessibility. Numerous factors determine whether an available memory can be accessed during a retrieval attempt (for an overview, see Baddeley, Eysenck, & Anderson, 2009). A particularly crucial factor is the presence of adequate retrieval cues. Tulving and colleagues demonstrated this point by showing that recall of a categorized list can be enhanced and interference effects be reduced, or even be eliminated, if the items' category names are provided as retrieval cues at test (Tulving & Pearlstone, 1966; Tulving & Psotka, 1971). Similarly, recall may benefit from more general, contextual retrieval cues, such as when an individual's environment or mood during test matches the individual's environment or mood during study (e.g., Godden & Baddeley, 1975; Teasdale & Fogarty, 1979).

However, retrieval cues are not always beneficial for memory performance and, under certain conditions, can even be detrimental. Indeed, when people are asked to recall items from a previously studied list and are given a subset of the items on that list as retrieval cues, they often do more poorly at recalling the remaining items on the list than do people asked to recall the items in the

absence of such retrieval cues (Slamecka, 1968; for reviews, see Nickerson, 1984; Roediger & Neely, 1982). Although initially dismissed as a procedural artifact (Slamecka, 1968, p. 510), in the meantime, such part-list cuing impairment has proven to be a very robust effect and to emerge in a variety of experimental settings. The detrimental effect of part-list cuing has been found to emerge in episodic as well as semantic memory (Brown, 1968); the effect has been observed in recall, recognition, and reconstruction tasks (Oswald, Serra, & Krishna, 2006; Serra & Nairne, 2000; Todres & Watkins, 1981), in veridical and false memory settings (Kimball & Bjork, 2002; Reysen & Nairne, 2002), with intralist and extralist cues (Roediger, Stellan, & Tulving, 1977; Watkins, 1975), and in different encoding situations (Bäuml & Aslan, 2006; Peynircioğlu & Moro, 1995). As a rough rule, these findings suggest that cues can be beneficial for recall if higher order information, such as category information or contextual cues, is provided as retrieval cues but that they may be detrimental if a subset of the originally encoded information is provided as retrieval cue (for details, see Nickerson, 1984; Roediger & Neely, 1982).

## Part-List Cuing and Forgetting

Not much is yet known about the interplay of part-list cuing and forgetting. Prior work on part-list cuing mostly focused on experiments in which participants studied a list of words and, after a short distractor task, were presented some of the studied words as cues for recall of the remaining words (e.g., Nickerson, 1984). While the finding of detrimental effects of part-list cuing in this type of situation is important, demonstrating that part-list cuing can make principally recallable memories inaccessible, it is unclear whether part-list cuing also affects memories that are subject to forgetting. Indeed, if an individual's memory for previously studied information is impaired—be it because of interference during retrieval, an intermittent context change, or some other reason—do part-list cues amplify the impairment, or can they diminish the forgetting?

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To date, only a few studies have examined the interplay of part-list cuing and forgetting. Basden (1973), for instance, examined the effects of part-list cuing in retroactive interference. Participants ran several study–test cycles on an original list of items to criterion, then ran seven study–test cycles on a second, interpolated list, and subsequently were tested on the original list. At test, half of the participants were cued with list members taken from alternate positions of their own final recall of the original list during learning. More original list items were recalled in the presence than the absence of the part-list cues, at first glance suggesting that the typical detrimental effect of part-list cuing may reverse in retroactive interference. However, caution is warranted about this interpretation because no no-interference baseline condition was included in the experiment. Indeed, when participants create elaborated retrieval plans—as occurs when they are put through repeated study–test cycles (e.g., Basden & Basden, 1995; Bäuml & Aslan, 2006; see also the General Discussion, below)—and the part-list cues are taken from alternate positions of participants' own prior recall report, part-list cues typically improve recall of the remaining items, thus providing an exception to the rule that part-list cuing is detrimental (see Nickerson, 1984). The results by Basden, therefore, indicate that this exception generalizes to retroactive interference, rather than suggesting that the typical detrimental effect of part-list cuing reverses in retroactive interference.

Goernert (1992) and Goernert and Larson (1994) examined the effect of part-list cuing in list-method directed forgetting. List-method directed forgetting is the demonstration that people can intentionally forget previously studied material if, after study, a forget instruction is provided and new material is learned (e.g., R. A. Bjork, 1970). In this paradigm, participants study a list of items and, after study of the list, receive the instruction either to forget or to continue remembering this list. After subsequent study of another list, a recall test is conducted in which participants are asked to recall the List 1 items, regardless of whether the participants were originally cued to remember or to forget the items. Compared with remember-cued participants, forget-cued participants typically show impaired recall of List 1 items<sup>1</sup> (for reviews, see E. L. Bjork, Bjork, & Anderson, 1998; MacLeod, 1998).

Both Goernert (1992) and Goernert and Larson (1994) varied testing conditions in list-method directed forgetting. In the free-recall condition, participants were asked to recall the List 1 items in the absence of any retrieval cues; in the part-list cuing condition, participants were provided some of the List 1 items as retrieval cues for recall of the list's remaining (target) items. The effects of part-list cuing on target recall varied with the interlist instruction. Employing four part-list cues, Goernert reported typical part-list cuing impairment in the remember condition but no reliable effect of part-list cuing in the forget condition. Increasing the cue set to eight part-list cues, Goernert and Larson replicated part-list cuing impairment in the remember condition but found reliable part-list cuing improvement in the forget condition, that is, target recall increased in the presence of the part-list cues.

The finding by Goernert and Larson (1994) demonstrates that the effects of part-list cuing can differ for to-be-remembered and to-be-forgotten memories. In particular, if a sufficiently large number of part-list cues are provided, the cues can enhance recall of forgotten memories, thus diminishing, rather than amplifying, the memory failure. To conclude from this that, in general, for-

gotten memories may benefit from part-list cues would be premature, however, because quite different circumstances can surround the forgetting, and the effects of part-list cues may depend on these circumstances. To draw strong conclusions on the interplay of part-list cuing and forgetting, experiments are required in which the effects of part-list cuing are examined in several forms of forgetting. This study examines the role of part-list cuing in three forms of episodic forgetting.

### The Impaired Context Access Hypothesis

A number of accounts of list-method directed forgetting have been suggested in the literature (see E. L. Bjork et al., 1998; MacLeod, 1998). For instance, list-method directed forgetting has been attributed to selective rehearsal processes, assuming that, during List 2 encoding, participants in the remember condition rehearse both List 2 and List 1 items, whereas, in the forget condition, they selectively rehearse the List 2 items, thus improving later recall of List 2 at the expense of List 1 (R. A. Bjork, 1970); the retrieval-inhibition account assumes that forget-cued participants engage in active inhibitory processes that reduce access to the List 1 context and thus induce List 1 forgetting (Geiselman, Bjork, & Fishman, 1983); the context-change account claims that the forget cue induces a change in participants' internal context, which then impairs List 1 recall due to a mismatch between the context at encoding and the context at retrieval (Sahakyan & Kelley, 2002).

Although retrieval inhibition and the context-change account differ in detail in attributing directed forgetting to an inhibitory or noninhibitory mechanism, in contrast to selective rehearsal, they both emphasize impaired context access as the source of the forgetting, a proposal supported by the results of many previous studies (e.g., Bäuml, Hanslmayr, Pastötter, & Klimesch, 2008; E. L. Bjork & Bjork, 1996; Geiselman et al., 1983; Kimball & Bjork, 2002; Sahakyan & Kelley, 2002). Following such context views on list-method directed forgetting and the previous finding of beneficial effects of part-list cues in this form of forgetting (Goernert & Larson, 1994), here we examine the hypothesis that beneficial effects of part-list cuing may arise for all those forms of forgetting that reflect impaired access to the original encoding context but that no such beneficial effects may arise for other forms of forgetting and in the absence of any induced memory impairment. We examine the hypothesis in forgetting that includes impaired context access as the major source of the memory failure and in forgetting that is due to other factors.

### Overview of Experiments

To study possible beneficial effects of part-list cues when access to the original encoding context is impaired, we used the listwise directed forgetting task (Experiment 1) to replicate Goernert and Larson (1994), and we used a variant of Sahakyan and Kelley's

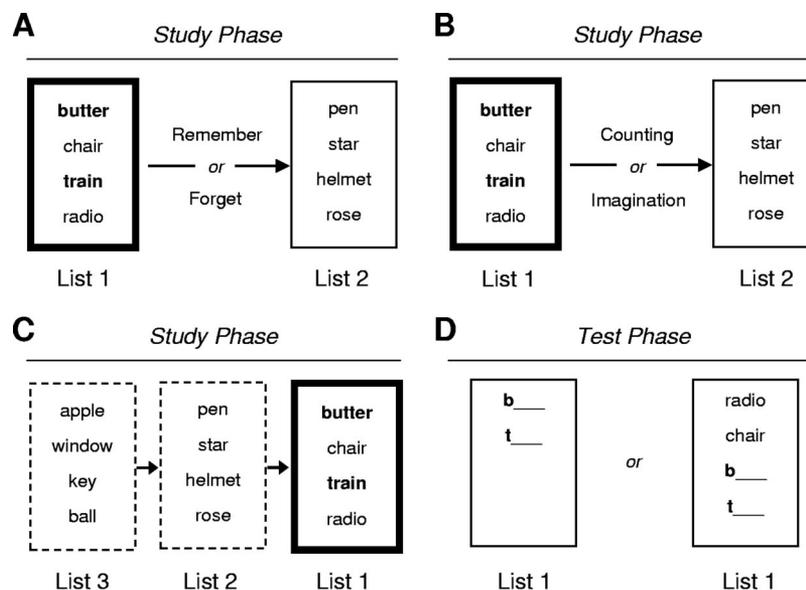
<sup>1</sup> Typically, the forget cue induces two effects in list-method directed forgetting: It impairs recall of List 1 items, and it improves recall of List 2 items (e.g., R. A. Bjork, 1989). However, because, like Goernert and Larson (1994), the present study focuses on List 1 recall, possible effects of part-list cuing on List 2 recall are ignored (see the Method section of Experiment 1).

(2002) diversion paradigm (Experiment 2) to study context-dependent forgetting. In this task, participants study two item lists and, between study of the two lists, count backwards or perform 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 List 1 items (e.g., Pastötter & Bäuml, 2007; Sahakyan & Kelley, 2002).

To study the effects of part-list cuing in the absence of impaired context access, we employed the proactive interference task (Experiment 3). Proactive interference refers to the finding that the preceding study of other lists reduces recall of a subsequently studied critical list, compared to a condition in which no such preceding study occurs (e.g., Underwood, 1957). According to the most widely accepted account, 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). Results from a number of studies support this impaired retrieval view (e.g., Szpunar, McDermott, & Roediger, 2008; Wixted & Rohrer, 1993), although impaired encoding may contribute to the effect as well (e.g., Pastötter, Schicker, Niedernhuber, & Bäuml, 2011). In contrast to listwise directed forgetting and context-dependent forgetting, proactive interference thus should not be caused by impaired access to the critical list context.

If the beneficial effect of part-list cues was tied to forgetting that results from impaired access to the previous encoding context, then the beneficial effect should emerge in listwise directed forgetting (Experiment 1) and context-dependent forgetting (Experiment 2) but should not arise in proactive interference (Experiment 3). Alternatively, if the beneficial effect of part-list cuing was restricted to listwise directed forgetting, it should be absent in context-dependent forgetting (Experiment 2) and proactive interference (Experiment 3); if the beneficial effect generalized to all forms of episodic forgetting, it should emerge in each of the three forms of forgetting.

As is shown in Figure 1 and explained in more detail below, Experiments 1–3 differed largely in how exactly forgetting was induced. Importantly, however, we controlled for other differences between the single experiments, such as differences in material, design, or procedural details. For instance, in all three experiments, participants studied unrelated item lists, with the lists including the same cue items and the same target items across experiments; in all three experiments, the forgetting induction was a within-participants factor and the part-list cuing manipulation a between-participants factor; at test, in all three experiments, participants were asked to recall (the same) predefined target items in the presence or absence of (the same) cue items serving as retrieval cues; in all three experiments, the target items were tested using their unique initial letters as retrieval cues, which was done to control output order of the target items in the absence of part-list cues (e.g., Bäuml & Aslan, 2004, 2006). Thus, if the effects of part-list cuing on forgotten memories varied across the three



*Figure 1.* Study and test phases of the three experiments. A: Study phase of Experiment 1. Participants studied two lists of items and, after study of List 1, were instructed either to forget or to continue remembering the list. B: Study phase of Experiment 2. Participants studied two lists of items and, after study of List 1, counted backwards from a three-digit number or performed a mental imagination task (e.g., imagining being back in one's childhood home). C: Study phase of Experiment 3. Participants studied a critical final list (List 1), preceded by either zero or two interfering lists (List 2 and List 3). D: Test phase of the three experiments. In all three experiments, participants were asked to recall predefined target items from List 1 (e.g., *butter*, *train*). The target items were tested in the presence or absence of the list's remaining (nontarget) items serving as retrieval cues (e.g., *chair*, *radio*).

experiments, the variation should have been caused by the differences in how exactly the forgetting was induced.

### Experiment 1: List-Method Directed Forgetting

Goernert and Larson (1994) examined the role of part-list cuing in list-method directed forgetting, providing evidence that, in this paradigm, part-list cues can enhance recall of forgotten memories. The goal of Experiment 1 was to replicate this basic finding and use the finding as a clue that contextual effects may moderate the effects of part-list cuing. Participants studied a first list of items and then, after study, received the instruction either to forget or to continue remembering the list (e.g., R. A. Bjork, 1970; see Figure 1A). After subsequent study of a second list, participants were asked to recall predefined target items from the first list; target items were determined by the experimenter but were unknown to the participant. Target items were tested either in the presence or the absence of the list's remaining items serving as part-list cues (see Figure 1D).

### Method

**Participants.** Seventy-two undergraduates of Regensburg University (Regensburg, Germany) participated (mean age = 22.5 years, range 19–29 years). They took part on a voluntary basis and were tested individually. They received monetary reward for participation (€7, about \$5.00 U.S.).

**Materials.** Four study sets (A–D) were constructed, each containing 15 unrelated concrete German nouns (e.g., Bäuml & Samenieh, 2010). Set A and Set B were designated to be used as List 1; Set C and Set D were designated to be used as List 2. Set A and Set B consisted of five target and 10 cue items each. Among all items of the four sets, each target item had a unique initial letter; the remaining items began with a unique word stem.

**Design.** The experiment had a  $2 \times 2$  mixed factorial design. Instruction (remember vs. forget) was manipulated within participants, and part-list cuing (absent vs. present) was varied between participants. In the remember condition, List 1 was followed by a cue to remember the list for an upcoming test, whereas, in the forget condition, List 1 was followed by a cue to forget the list; participants were told that the preceding items could be forgotten because they would not be tested later. Order of instruction conditions and assignment of lists to instruction conditions were counterbalanced (e.g., Bäuml & Samenieh, 2010). Results from recent work indicate that list-method directed forgetting experiments lead to the same results irrespective of whether each participant accomplishes both the remember and the forget conditions or accomplishes just one of the two conditions (e.g., Bäuml et al., 2008; Bäuml & Kuhbandner, 2009; Zellner & Bäuml, 2006; see also Barnier et al., 2007; Conway & Fthenaki, 2003). Cuing conditions differed in whether participants were asked to retrieve the five target items of List 1 in the presence or the absence of the list's remaining items serving as part-list cues.

**Procedure.** For each of the two instruction conditions, the items of the two lists were exposed individually and in random order for 4 s each. After study of the two lists, there was a 30-s backward-counting task as a recency control. At test, participants were specifically asked to recall List 1 items, regardless of whether they were originally instructed to remember or to forget the items.

The five target items were recalled in the presence or the absence of the cue items. If cue items were provided, all 10 cue items were presented simultaneously. They were shown in two columns of five items on the screen. Their order was random. Participants were asked to read the items aloud and to use them as retrieval cues for recall of the remaining items. Then, the initial letters of the five targets appeared successively, in random order and for 6 s each. The letters were shown below the two columns containing the cue items. The cue items remained present on the screen during target recall. Responses were given orally. List 2 items were tested subsequently, but the results are not reported.<sup>2</sup> Participants completed the two instruction conditions successively, with a 10-min break between conditions.

### Results and Discussion

A  $2 \times 2 \times 2$  analysis of variance with the within-participants factor of instruction (remember vs. forget), the within-participants factor of study order (remember first vs. forget first), and the between-participants factor of part-list cuing (absent vs. present) showed a significant main effect of instruction,  $F(1, 68) = 9.57$ ,  $MSE = 0.026$ ,  $p < .005$ , and a significant interaction between instruction and part-list cuing,  $F(1, 68) = 24.51$ ,  $MSE = 0.026$ ,  $p < .001$ . There were no main effects of part-list cuing,  $F(1, 68) = 1.02$ ,  $MSE = 0.053$ ,  $p > .30$ , and study order,  $F(1, 68) < 1$ , and no further interactions,  $ps > .15$ .

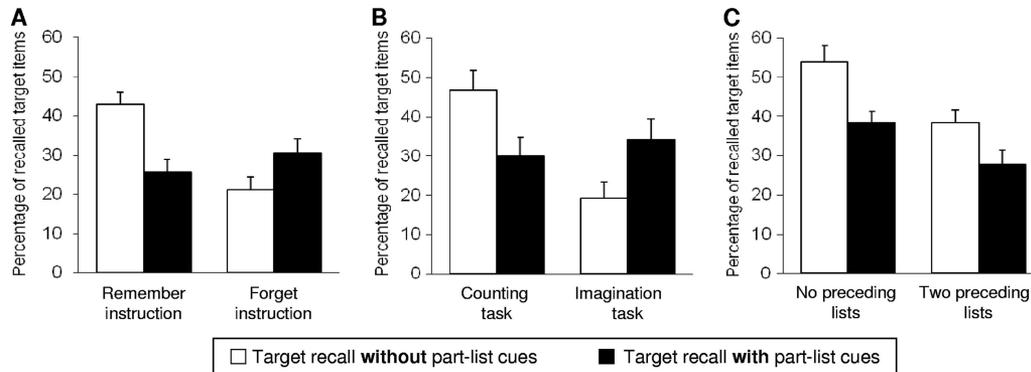
Collapsing across study order conditions, follow-up pairwise comparisons revealed that, in the absence of the part-list cues, target recall was higher in the remember condition than in the forget condition (42.8% vs. 21.1%),  $t(35) = 6.34$ ,  $p < .001$ , thus showing the standard directed forgetting effect for List 1 items. Part-list cuing also affected recall rates, though with opposing effects in the two instruction conditions. In the remember condition, part-list cues impaired recall of the target items (42.8% vs. 25.6%),  $t(70) = 3.72$ ,  $p < .001$ , thus showing the standard part-list cuing impairment effect, whereas, in the forget condition, part-list cues improved recall of the target items (21.1% vs. 30.6%),  $t(70) = 1.99$ ,  $p < .05$  (see Figure 2A).

The results show that part-list cuing can both impair and improve recall of the list's remaining items. Which effect part-list cuing reveals depends on the memory status of the encoded items. When to-be-remembered memories were tested, cuing attenuated recall of the target items; when to-be-forgotten memories were tested, cuing aided recall of the target information. These results replicate the basic Goernert and Larson (1994) finding. They indicate that part-list cues can enhance memory for forgotten items, at least in list-method directed forgetting.

### Experiment 2: Context-Dependent Forgetting

The results of Experiment 1, together with the Goernert and Larson (1994) finding, raise the question of whether the observed

<sup>2</sup> Recent work has indicated that List 2 recall results can be affected by prior List 1 recall (Aslan, Zellner, & Bäuml, 2010), which is consistent with a previous study pointing to possible output order effects in list-method directed forgetting (Golding & Gottlob, 2005). Because the focus of the present study is on the effects of part-list cuing on List 1 recall, we follow Goernert and Larson (1994) and report List 1 recall results only.



*Figure 2.* Results of the three experiments. A: Results of Experiment 1. Part-list cuing impaired memory for to-be-remembered targets but improved memory for to-be-forgotten targets. B: Results of Experiment 2. Part-list cuing impaired memory for targets with the intermittent counting task but improved memory for targets with the intermittent imagination task. C: Results of Experiment 3. Both with and without study of the two preceding lists, part-list cuing impaired recall of the target items. Error bars indicate standard errors.

beneficial effect of part-list cues on forgotten material is unique to list-method directed forgetting or generalizes to other forms of forgetting. On the basis of the impaired context access hypothesis, beneficial effects of part-list cues may not be restricted to list-method directed forgetting but may occur for all forms of forgetting that include impaired context access as a source of the forgetting. Experiment 2 addressed the issue and examined the influence of part-list cuing in context-dependent forgetting, using a variant of Sahakyan and Kelley's (2002) diversion paradigm. Participants studied two lists of items and, between study of the two lists, counted backwards from a three-digit number or performed a mental imagination task (e.g., imagining being back in one's childhood home; see Figure 1B). After study of the second list, participants were asked to recall predefined target items from the first list. Target items were tested either in the presence or the absence of the list's remaining items serving as part-list cues (see Figure 1D).

## Method

**Participants.** Forty-eight undergraduates of Regensburg University participated (mean age = 22.7 years, range 19–30 years). Again, they took part on a voluntary basis, were tested individually, and received monetary reward for their participation (€7, about \$5.00 U.S.).

**Materials.** The same two pairs of word lists were used as in Experiment 1. Consequently, List 1 of each list pair contained five target and 10 cue items.

**Design.** The experiment had a  $2 \times 2$  mixed factorial design. Task (counting task vs. imagination task) was manipulated within participants, and part-list cuing (absent vs. present) was varied between participants. In the counting task, participants counted backwards aloud from a three-digit number for 60 s, whereas, in the imagination task, for the same time interval, participants were asked to imagine their parents' house, to mentally walk through it, and to tell what they imagined to the experimenter (e.g., Pastötter & Bäuml, 2007; Sahakyan & Kelley, 2002). Order of task conditions and assignment of lists to task conditions were counterbalanced. Again, cuing conditions differed in whether participants

were asked to retrieve the five target items of List 1 in the presence or the absence of the list's cue items serving as part-list cues.

**Procedure.** With the only difference being that, between study of the two lists, task was varied (counting vs. imagination) rather than instruction (remember vs. forget), the procedure was identical to Experiment 1.

## Results and Discussion

A  $2 \times 2 \times 2$  analysis of variance with the within-participants factor of task (counting task vs. imagination task), the within-participants factor of study order (counting task first vs. imagination task first), and the between-participants factor of part-list cuing (absent vs. present) showed a significant main effect of task,  $F(1, 44) = 6.75$ ,  $MSE = 0.048$ ,  $p < .05$ , and a significant interaction between task and part-list cuing,  $F(1, 44) = 12.43$ ,  $MSE = 0.048$ ,  $p < .001$ . There were no main effects of part-list cuing,  $F(1, 44) < 1$ , and study order,  $F(1, 44) = 1.66$ ,  $MSE = 0.064$ ,  $p > .20$ , and no further interactions,  $ps > .25$ .

Collapsing across testing order conditions, follow-up pairwise comparisons revealed that, in the absence of the part-list cues, target recall was higher with the counting task than with the imagination task (46.7% vs. 19.2%),  $t(23) = 6.38$ ,  $p < .001$ , thus showing standard context-dependent forgetting in the diversion paradigm. Part-list cuing also affected recall rates, with opposing effects for the two intermittent tasks. With the counting task, part-list cues impaired recall of the target items (46.7% vs. 30.0%),  $t(46) = 2.24$ ,  $p < .05$ , thus showing the standard part-list cuing impairment effect, whereas, with the imagination task, part-list cues improved recall of the target items (19.2% vs. 34.2%),  $t(46) = 2.39$ ,  $p < .05$  (see Figure 2B).

Part-list cuing impaired recall when no internal context change occurred between study and test (counting task) but improved recall when a context change occurred (imagination task). This finding mimics the results for list-method directed forgetting, as shown in Experiment 1 and originally reported by Goernert and Larson (1994). It indicates that beneficial effects of part-list cues on forgotten memories are not restricted to list-method directed forgetting but may show up in other forms of forgetting as well. In

particular, the finding suggests that beneficial effects of part-list cues may arise if impaired context access underlies the forgetting—be it caused by an explicit forget instruction, as in list-method directed forgetting, or an internal context change, as in context-dependent forgetting.

### Experiment 3: Proactive Interference

On the basis of the impaired context access hypothesis, beneficial effects of part-list cues should arise in those forms of forgetting in which impaired access to the original encoding context is the major source of the forgetting and should not arise in other forms of forgetting. The results of Experiments 1 and 2 support the first part of the hypothesis by demonstrating beneficial effects of part-list cues when access to the original encoding context is impaired. The goal of Experiment 3 was to examine the second part of the hypothesis by investigating the role of part-list cues in proactive interference, a form of forgetting in which impaired context access is unlikely to play a role (e.g., Wixted & Rohrer, 1993) and part-list cuing therefore should not be beneficial. Participants were asked to study a critical final list, preceded by either zero or two interfering lists (see Figure 1C). At test, the target items of the critical list should be recalled in the presence or the absence of the list's cue items serving as part-list cues.

### Method

**Participants.** Seventy-two Regensburg University undergraduates participated (mean age = 22.4 years, range 19–38 years). They took part on a voluntary basis, were tested individually, and received monetary reward for their participation (€7, about \$5.00 U.S.).

**Materials.** Materials were identical to Experiment 1. Set A and Set B were designated to be used as List 1, whereas Set C and Set D were designated to be used as Lists 2 and 3 (see Figure 1C).

**Design.** The experiment had a  $2 \times 2$  mixed factorial design. Study condition (no preceding lists vs. two preceding lists) was manipulated within participants, and part-list cuing (absent vs. present) was varied between participants. In the two-preceding-lists condition, participants studied Lists 2 and 3 before studying List 1; in the no-preceding-list condition, participants solved decision problems as a distractor task that was equal in duration to study of Lists 2 and 3 before studying List 1. Order of the two study conditions and assignment of lists to study conditions were counterbalanced. As in Experiments 1 and 2, cuing conditions differed in whether participants were asked to retrieve the five target items of List 1 in the presence or the absence of the list's remaining items serving as part-list cues.

**Procedure.** Presentation of a list's items was identical to Experiment 1. After study of the final List 1, there was a 30-s backward-counting task. Both the cuing procedure and the procedural details for target recall were identical to Experiment 1. Again, participants were specifically asked to recall List 1 items. In the two-preceding-lists condition, items from Lists 2 and 3 were tested subsequent to testing List 1 items; the results, however, are not reported. Following Experiments 1 and 2, there was a 10-min break between the two study conditions.

### Results and Discussion

A  $2 \times 2 \times 2$  analysis of variance with the within-participants factor of study condition (no preceding lists vs. two preceding lists), the within-participants factor of study order (no-preceding-lists condition first vs. two-preceding-lists condition first), and the between-participants factor of part-list cuing (absent vs. present) showed significant main effects of study condition,  $F(1, 68) = 13.06$ ,  $MSE = 0.047$ ,  $p < .001$ , and of part-list cuing,  $F(1, 68) = 13.12$ ,  $MSE = 0.047$ ,  $p < .001$ ; there was no main effect of study order,  $F(1, 68) < 1$ , and there were no interactions between factors,  $ps > .25$ .

Collapsing across study order conditions, follow-up pairwise comparisons revealed that, in the absence of the part-list cues, target recall was higher when there was no study of preceding lists than when there was such additional study (53.9% vs. 38.3%),  $t(35) = 2.84$ ,  $p < .01$ , thus showing the standard proactive interference effect. Part-list cuing also affected recall rates: Part-list cues impaired target recall in the absence of preceding lists (53.9% vs. 38.3%),  $t(70) = 3.00$ ,  $p < .01$ , and they impaired target recall in their presence, (38.3% vs. 27.8%),  $t(70) = 2.13$ ,  $p < .05$  (see Figure 2C).

Part-list cuing impaired recall regardless of whether proactive interference was induced or not. This finding differs from the results with list-method directed forgetting (Experiment 1) and context-dependent forgetting (Experiment 2), in which beneficial effects of part-list cues on forgotten material were observed. The finding supports the hypothesis that beneficial effects of part-list cues on forgotten memories are tied to certain forms of contextual forgetting and do not arise if other sources underlie the forgetting.

### General Discussion

Research of the past 4 decades has demonstrated that the presentation of a subset of previously encoded items as retrieval cues typically impairs recall of the remaining items (e.g., Nickerson, 1984; Roediger & Neely, 1982). The present series of experiments supports this finding by replicating the standard detrimental effect of part-list cuing in each of the three experiments. In the remember condition of Experiment 1 (list-method directed forgetting), in the counting-task condition of Experiment 2 (context-dependent forgetting), and in the no-preceding-list condition of Experiment 3 (proactive interference), part-list cuing reduced recall of the target items. A different, and more mixed, picture of the effects of part-list cuing arose when forgetting was induced in the single experiments. While part-list cuing amplified the forgetting in proactive interference (Experiment 3), it improved access to forgotten memories in list-method directed forgetting (Experiment 1) and context-dependent forgetting (Experiment 2). These results indicate that forgotten memories can benefit from part-list cuing, although the effect seems to depend on the circumstances surrounding the forgetting.

### The Critical Role of Context Access in Part-List Cuing

On the basis of previous research suggesting that list-method directed forgetting and context-dependent forgetting reflect impaired context access (e.g., Bäuml et al., 2008; Geiselman et al.,

1983; Kimball & Bjork, 2002; Sahakyan & Kelley, 2002) and the many reported parallels between list-method directed forgetting and context-dependent forgetting (e.g., Pastötter & Bäuml, 2007; Sahakyan & Kelley, 2002), the present results indicate that whether part-list cuing is detrimental or incremental for recall of the remaining memories depends on whether access to the memories' original encoding context is impaired or not. Consistently, part-list cuing enhanced recall of the remaining memories if the memories were subject to impaired context access—as supposedly is the case in list-method directed forgetting and context-dependent forgetting—whereas part-list cuing impaired recall in the other cases, for example, when the forgetting was due to other factors—as supposedly is the case in proactive interference (e.g., Baddeley, 1990; Wixted & Rohrer, 1993)—and when no forgetting was induced at all.

Although both list-method directed forgetting and context-dependent forgetting have been attributed to impaired context access, the impairment may be mediated by different mechanisms in the two types of forgetting. Indeed, in listwise directed forgetting, the impaired context access has been suggested to be mediated by inhibition of the original list context (i.e., Geiselman et al., 1983; Kimball & Bjork, 2002); if so, the present results indicate that cuing participants with some memories of the original context can release inhibition of the context representation and thus improve recall of the remaining memories. In context-dependent forgetting, the impaired context access has been suggested to be mediated by mental travel creating a mismatch between the context at encoding and the context at retrieval (e.g., Sahakyan & Delaney, 2003; Sahakyan & Kelley, 2002); if so, the present results indicate that retrieval of some of the items of the original context can reinstate context, reduce the mismatch between the context at encoding and the context at test, and thus improve recall of the remaining memories.

The present finding that impaired context access can be reduced by part-list cues is consistent with a previous list-method directed forgetting study by E. L. Bjork and Bjork (1996). In this study, after the learning of two lists and the presentation of a forget or remember instruction in between, a subset of the List 1 items was reexposed as part of a List 2 recognition test, in which some of the List 2 items were tested. Subsequently, a recall test on the not-yet-tested List 2 items was conducted. The forget cue typically causes recall impairment of List 1 items and recall improvement of List 2 items (see E. L. Bjork et al., 1998; MacLeod, 1998), but part-list reexposure of List 1 items eliminated the improvement effect. On the basis of the view that List 1 forgetting and List 2 improvement are mediated by the same mechanism (e.g., E. L. Bjork & Bjork, 1996; R. A. Bjork, 1989; but see Pastötter & Bäuml, 2010; Sahakyan & Delaney, 2003), these results suggest that partial reexposure of List 1 items can eliminate directed forgetting effects and thus mimic the effects of part-list cuing (Goernert & Larson, 1994; present Experiment 1).

The present finding that impaired context access can be reduced by part-list cues is also consistent with prior work by Sahakyan and Kelley (2002). Using both list-method directed forgetting and the diversion paradigm, in which participants' mental context is changed between study of two lists (see present Experiment 2), Sahakyan and Kelley investigated the effects of context reinstatement at the time of recall. At test, participants were instructed to mentally recreate their original list learning environment and gen-

erate their own contextual cues from memory. Reinstatement of the context of List 1 encoding reduced List 1 forgetting both in the condition where mental context had been manipulated and in the standard forget condition. The results are consistent with the impaired context access interpretation of list-method directed forgetting and context-dependent forgetting and suggest that, in both paradigms, context can be reaccessed and forgotten items be reactivated if appropriate (contextual or item) cues are provided.

### A Three-Mechanism Account of Part-List Cuing

It has repeatedly been argued that the detrimental effect of part-list cuing is the result of covert retrieval processes induced by the cue items (e.g., Anderson, Bjork, & Bjork, 1994; Bäuml & Aslan, 2004; Roediger, 1973; Rundus, 1973). Such covert retrieval of the cue items has been proposed to impair recall of the remaining items, either by blocking access to the remaining items (Roediger, 1973; Rundus, 1973) or by actively inhibiting the remaining items (Anderson et al., 1994; Bäuml & Aslan, 2004). Alternatively, part-list cuing impairment has been attributed to strategy disruption processes. According to this view, participants build up interitem associations and elaborated retrieval plans during study, which at test may be disrupted by part-list cues, forcing a serial recall order that is inconsistent with the initial retrieval plan (e.g., Basden & Basden, 1995; Basden, Basden, & Galloway, 1977).

In contrast to these one-mechanism accounts of part-list cuing, a more recent two-mechanism account suggests that both inhibition and strategy disruption may play a role in part-list cuing impairment (Bäuml & Aslan, 2006; see also Aslan & Bäuml, 2007). According to this account, the detrimental effect of part-list cues is mediated by inhibition in situations in which participants do not encode items strategically and interitem associations play only a minor role—as seems to be the case when participants receive just a single study trial and no instruction to encode the items strategically is provided (e.g., Bäuml & Aslan, 2004, 2006; Neely, Schmidt, & Roediger, 1983; Oswald et al., 2006; present Experiments 1–3)—and the effect is mediated by strategy disruption in situations in which participants build up interitem associations and elaborated retrieval plans—as seems to be the case when participants are put through repeated study–test cycles or are instructed to encode items serially (e.g., Basden, 1973; Basden & Basden, 1995; Bäuml & Aslan, 2006; Serra & Nairne, 2000).

The results from the present study indicate that part-list cuing may even trigger a third process responsible for the beneficial effects of part-list cuing. Generalizing prior work indicating that item recall can result in partial reactivation of the context that was present when an item was studied (Howard & Kahana, 1999, 2002), we suggest that part-list cuing can trigger processes that reactivate the original encoding context of the cue items. Such context reactivation may lead to reactivation of the remaining list items and to recall improvement of the target material. Amount of context reactivation and induced recall improvement should vary with the extent to which access to the original study context is impaired: Reactivation should be high if the impairment is strong but should be low, if existent at all, if the impairment is weak.

Consistently, in the present series of experiments, we found beneficial effects of part-list cuing in list-method directed forgetting and context-dependent forgetting but not in proactive interference. Because impaired context access reduces activation of the

original study context and its associated items, in list-method directed forgetting and context-dependent forgetting, much room should be left for context reactivation, whereas not much room should be left for inhibition; as a net result, target recall should improve. In contrast, if access to the critical context is not impaired and the original study context and its associated items still show a high level of activation, as occurs in proactive interference and when no memory impairment is induced at all, not much room should be left for context reactivation, whereas inhibition may well arise, causing recall impairment. Thus, inhibition should dominate the effects of part-list cuing when access to the original context is maintained, whereas context reactivation should dominate the effects of part-list cuing when access to the context is impaired.<sup>3</sup> The present results are consistent with this view of part-list cuing.

The present series of experiments examined part-list cuing in situations in which participants received just a single study trial and no instruction to encode the items strategically was provided. The finding of both detrimental and incremental effects of part-list cuing in these encoding situations suggests that, in the absence of elaborated retrieval plans, part-list cues can trigger both inhibitory and context reactivation processes. Whether beneficial effects of part-list cuing arise also when, at study, participants build up interitem associations and elaborated retrieval plans is unclear. While it appears likely that part-list cues will trigger context reactivation processes also when interitem associations are built up, it is less obvious whether the part-list cues will reactivate the original retrieval plan as well and what the effect of the reactivated part-list cues on such reactivated strategies would be. Future work is needed to determine whether the beneficial effects of part-list cuing found in the absence of elaborated retrieval plans generalize to encoding situations in which such plans are present.

### The Possible Role of Part-List Cuing in Time-Dependent Forgetting

This study has examined the effects of part-list cuing on three prominent forms of forgetting, chosen to reflect impaired context access as well as another form of episodic forgetting. Of course, there are other prominent forms of forgetting that have not been addressed here, such as, for instance, time-dependent (normal) forgetting.

Time-dependent forgetting refers to the finding that recall typically declines when the retention interval between study and test is increased (e.g., Slamecka & McElree, 1983). Such forgetting can be due to a number of factors (see Baddeley et al., 2009), but two of the most important suggested factors are interference and changes in context between study and test. Indeed, as the retention interval increases, new material may be encoded, thus increasing retroactive interference at test; similarly, as the retention interval increases, the (internal and external) context between study and test may change, thus causing context-dependent forgetting.

The present results suggest that very different effects of part-list cuing may arise in time-dependent forgetting, depending on whether interference or impaired context access dominate the induced forgetting. If interference was the dominant factor of the forgetting, part-list cuing might be detrimental for recall, at least if findings from proactive interference generalized to retroactive interference;<sup>4</sup> in contrast, if impaired context access was the dominant factor of the forgetting, part-list cuing might be beneficial for

recall. Whether interference or impaired context access dominate the effects of part-list cuing may vary with situation. However, one can easily imagine that context reaccess is more important for remembering in people's everyday lives than it is in the laboratory, where context is relatively constant within single experimental sessions. Therefore, in people's everyday lives, context reaccess may play a particularly critical role for successful remembering, so that, quite often, beneficial, rather than detrimental, effects of part-list cuing may arise. It is a high priority for future research to determine the role of part-list cuing in time-dependent forgetting.

### Part-List Cuing "Versus" Part-List Retrieval

Like part-list cuing, part-list retrieval can also impair recall of other memories. Indeed, results from numerous studies have shown that when a subset of previously encoded material is retrieved, subsequent retrieval of the remaining material is typically impaired. Such impairment has been observed when the second retrieval task immediately followed the first retrieval task and when there was a longer delay between the two tasks. In the first case, the impairment has been termed output interference (e.g., Roediger, 1974; Smith, 1971), in the second case, retrieval-induced forgetting (e.g., Anderson et al., 1994; Anderson & Spellman, 1995).

In two recent studies, Bäuml and Samenieh (2010, in press) demonstrated that, like part-list cuing, part-list retrieval is not always detrimental but can improve recall of forgotten memories. Examining part-list retrieval in list-method directed forgetting, Bäuml and Samenieh (2010) found increasingly improved recall of forgotten first-list targets when more and more of the other first-list items were previously retrieved. Bäuml and Samenieh (in press) replicated the basic finding for list-method directed forgetting, extended the finding to context-dependent forgetting, but found detrimental effects of part-list retrieval in proactive interference. These findings mimic the results from the present experiments, pointing to similar effects of part-list cuing and part-list retrieval on forgotten material.

Prior work demonstrated a number of parallels between part-list cuing and part-list retrieval by showing detrimental effects of part-list cuing in situations in which part-list retrieval is detrimental as well (e.g., Bäuml & Kuhbandner, 2003; Roediger, 1973, 1974; Zellner & Bäuml, 2005). By generalizing this parallel to the

<sup>3</sup> The present view that context reactivation should dominate the effects of part-list cuing when access to the context is impaired does not exclude the possibility that inhibitory processes may operate in this situation once the context is reactivated. Possible detrimental effects of such late inhibition, however, should generally be small when compared to the beneficial effects arising from early context reactivation processes.

<sup>4</sup> At first glance, this assumption seems to be in conflict with the fact that Basden (1973) found beneficial effects of part-list cues in retroactive interference, whereas, in the present Experiment 3, we found detrimental effects of part-list cues in proactive interference. However, as already mentioned in the introduction, Basden employed study and cuing conditions that generally create beneficial effects of part-list cuing and thus provide an exception to the rule that part-list cues are detrimental. We expect that, when using study and cuing conditions as employed in the present study (and most other work in part-list cuing), part-list cues will amplify rather than diminish retroactive interference, thus mimicking the role of part-list cues in proactive interference.

incremental effects of part-list cuing and part-list retrieval, the present study goes beyond this prior work and thus strongly supports the proposal of the functional equivalence of part-list cuing and part-list retrieval (e.g., Bäuml & Aslan, 2004).

## Conclusions

The present results indicate that the effects of part-list cuing on forgotten memories depend critically on the circumstances surrounding the forgetting. If the forgetting reflects impaired access to the original encoding context—be it caused by an explicit forget cue, as occurs in list-method directed forgetting, or mental travel, as occurs in the diversion paradigm—part-list cues are beneficial for recall of forgotten memories. In contrast, if the forgetting does not reflect such a contextual effect, as occurs in proactive interference, or when no forgetting is induced at all, no such beneficial effects arise, and part-list cues can be detrimental. Thus, the interplay between part-list cues and forgetting does not take the same form in all cases but varies with the way the forgetting occurs.

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