

Part-List Cuing Can Impair, Improve, or Not Influence Recall Performance: The Critical Roles of Encoding and Access to Study Context at Test

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The results of four experiments are reported, in which we examined how the effects of part-list cuing - the presentation of a random selection of studied items as retrieval cues at test - on recall of the remaining target items depend on encoding and access to study context at test. Encoding was varied by inducing high and low degrees of interitem associations; access to study context at test was varied by inducing high and low degrees of contextual overlap between study and test. Results showed that the effects of part-list cuing depend critically on encoding and study context access. Depending on the combination of the two, part-list cuing impaired, improved, or did not influence recall of the target items. A multimechanisms account of part-list cuing is provided to explain how part-list cuing affects target recall in the different experimental conditions.

Keywords: episodic memory, part-list cuing, encoding, context

Part-list cuing impairment refers to the intriguing finding that if participants receive a random selection of studied items as retrieval cues at test and are asked to recall the remaining (target) items, such part-list cuing often reduces target recall compared with a condition in which such cues are absent (e.g., Roediger, 1973; Slamecka, 1968). Although initially dismissed as a procedural artifact (Slamecka, 1968, p. 510), part-list cuing impairment has proven to be a very robust effect that emerges in a variety of experimental settings. It has been found in episodic as well as semantic memory (Brown, 1968), with intralist and extralist cues (Watkins, 1975), in intentional and incidental memory tasks (Peynircioglu & Moro, 1995), and in veridical and false memory settings (Kimball & Bjork, 2002).

Although research on part-list cuing has attracted the attention of memory researchers in the first decades after Slamecka's (1968) discovery of the impairment effect (see Nickerson, 1984), in more recent years research on the issue has been relatively sparse. Still, several findings have emerged during these more recent years that have influenced researchers' thinking about part-list cuing. One of these findings is the demonstration that encoding can affect part-list cuing impairment, and, depending on whether items are encoded in a low or high associative manner, can lead to the involvement of quite different mechanisms that vary in how and under which circumstances they cause recall impairment (Aslan & Bäuml, 2007; Bäuml & Aslan, 2006). Another finding is that, at least with low associative encoding, part-list cuing cannot only be

detrimental but can also be beneficial for other memories, depending on the extent to which contexts during study and test overlap. The finding revealed part-list cuing impairment when study and test contexts matched, but showed part-list cuing improvement when the contexts differed (Bäuml & Samenieh, 2012; Goernert & Larson, 1994). The research reported in this study is based on both of these lines of findings, examining how the effects of part-list cuing depend on encoding and access to study context at test. Above all, it is examined whether encoding can influence the effects of part-list cuing not only when study and test contexts overlap but also when study and test contexts differ. The findings will provide new insights into the mechanisms mediating the effects of part-list cuing in different experimental conditions.

Accounts of Part-List Cuing Impairment and the Role of Encoding

Over the years, a number of accounts have been suggested to explain the detrimental effects of part-list cuing on recall performance. For instance, the blocking and inhibition accounts of part-list cuing explain the recall impairment by assuming that part-list cuing induces covert retrieval processes, which, similar to how overt retrieval does in output interference and retrieval-induced forgetting (Anderson, Bjork, & Bjork, 1994; Tulving & Arbuckle, 1963), impair target recall. The blocking account proposes that the reexposure of items as part-list cues strengthens these items' representations, resulting in a competition bias that favors the repeated covert retrieval of the strengthened items and blocks recall of the remaining (target) items (Roediger, 1973; Rundus, 1973). The inhibition account suggests that the instruction to use the presented items as retrieval cues causes the covert retrieval of the cues at test, which, like in retrieval-induced forgetting, triggers inhibitory processes on the target items (Anderson et al., 1994; Bäuml & Aslan, 2004). Results from many studies in the literature support this view, like studies showing parallel for-

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getting in part-list cuing impairment and retrieval-induced forgetting (Bäuml & Kuhbandner, 2003; Bäuml & Schlichting, 2014) and studies reporting part-list cuing impairment in item recognition (Todres & Watkins, 1981) and in the presence of item-specific probes for the target items (Aslan, Bäuml, & Grundgeiger, 2007).

A different account of part-list cuing impairment is strategy disruption (Basden & Basden, 1995; Basden, Basden, & Galloway, 1977). According to this account, subjects try to develop individual retrieval plans during encoding based on their subjective organization of the list items. When in the part-list cuing condition a randomly selected subset of items is presented at test, these retrieval cues disrupt the preferred recall order and the participants switch to a less effective order, thus reducing recall performance. Results from a number of studies support this view, like the finding that part-list cuing impairment as observed on a first recall test when part-list cues are present can be eliminated on a later second test when the cues are removed on that test. In fact, after the removal of the cues, the participants should be able to return quickly to their initial retrieval plans and the negative effects of part-list cuing should disappear (Basden & Basden, 1995; Basden et al., 1977).

Reconciling the different theoretical views, Bäuml and Aslan (2006) more recently suggested that both inhibition/blocking and strategy disruption contribute to part-list cuing impairment, though in different encoding conditions. They emphasized the distinction between so-called low associative and high associative encoding conditions. For instance, encoding information within a single study trial, in which no instruction for associative encoding is provided, may create low associative encoding. It may result in little interitem associations and a high degree of interitem interference, so that part-list cuing can trigger blocking and inhibitory processes at test. In contrast, providing repeated study-test cycles or an instruction to encode the study items in their serial order or in terms of a common story may create high associative encoding between the single items. It may lead to chainlike interitem associations and the formation of an elaborated retrieval plan. Part-list cuing may then disrupt the original retrieval strategy and thus impair recall performance. Bäuml and Aslan (2006) and Aslan and Bäuml (2007) reported results that are consistent with this two-factor explanation, for instance, by showing that, with high associative encoding, part-list cuing impairment is no longer present on a later test when the cues are removed on that test, whereas, with low associative encoding, the impairment can still be observed on the later test (see also Aslan et al., 2007). Together with other results from the literature (see Bäuml & Aslan, 2006, for a discussion), the findings support the view that primarily inhibition and blocking mediate part-list cuing impairment with a low degree of interitem associations, whereas strategy disruption mediates the impairment with a high degree of interitem associations.

Evidence for Beneficial Effects of Part-List Cuing with Low Associative Encoding

The numerous demonstrations of detrimental effects of part-list cuing suggest that part-list cuing typically impairs recall performance. However, using low associative encoding situations, three studies in the literature have provided evidence that part-list cuing can have two faces and may not only impair but may also improve recall performance. In a largely overlooked study, Goernert and

Larson (1994) were the first to demonstrate such a pattern of beneficial and detrimental effects of part-list cuing using the listwise directed forgetting task (e.g., Bjork, 1970). In this task, participants study a list of items and then, after study, receive the instruction either to continue remembering or to forget the list. After subsequent study of another list, a recall test is conducted in which participants are asked to recall the first-list items, irrespective of original cuing. Typically, recall performance is lower in the forget than in the remember condition, reflecting directed forgetting of first-list items. Goernert and Larson (1994) employed this 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; in the other condition, participants were provided four or eight of the first-list items as part-list cues for recall of the list's remaining (target) items. Whereas part-list cuing impaired target recall in the remember condition, it improved target recall in the forget condition. Both effects were larger with eight than with four part-list cues.

Bäuml and Samenieh (2012) replicated Goernert and Larson's (1994) basic finding and extended it to memories that were subject to context-dependent forgetting. Employing a diversion paradigm, in which participants change, or do not change, their internal context after study by means of an imagination task (see Sahakyan & Kelley, 2002), they found part-list cuing to impair target recall when subjects did not engage in imagination, but found part-list cuing to improve target recall when the imagination task was conducted. Part-list cuing improvement was also demonstrated for memories that were subject to time-dependent forgetting (Bäuml & Schlichting, 2014). In this study, participants learned a list of unrelated words and were tested either after a short distractor task of a few minutes or after a prolonged retention interval of 48 hours. At test, participants performed a free-recall task or were provided with some randomly selected list items as retrieval cues, which the subjects should use to recall the remaining target items. Whereas part-list cuing impaired target recall when testing occurred after a few minutes, it enhanced target recall when the retention interval was increased.

The finding of two faces of part-list cuing in list-method directed forgetting, context-dependent forgetting, and time-dependent forgetting suggests that the degree of overlap between study and test contexts can influence the effects of part-list cuing. Indeed, prolonged retention intervals and context-change tasks induce contextual drift after study and thus, at test, create a mismatch between study and test contexts (e.g., Bower, 1972; Estes, 1955; Mensink & Raaijmakers, 1988), which impairs study context access. Similarly, a forget cue after study may also change context (Sahakyan & Kelley, 2002), or alternatively inhibit access to the whole study episode (Geiselman, Bjork, & Fishman, 1983), thus again reducing study context access. On the basis of these views, the above results suggest that part-list cuing may induce detrimental effects on target recall when the test context is similar to the study context - like after a short retention interval in which no context-change task is employed and no forget cue is provided -, but can induce beneficial effects when study and test contexts differ - like after a forget instruction, a context-change task, or a prolonged retention interval.

These beneficial effects of part-list cuing on target recall have been attributed to context reactivation processes (Bäuml & Samenieh, 2012; Bäuml & Schlichting, 2014). According to this view, part-list cuing in low associative encoding situations may trigger

not only inhibition and blocking of interfering target memories, but may also reactivate the original study context. Indeed, similar to how retrieval or restudy of single items have been suggested to do (e.g., Greene, 1989; Howard & Kahana, 2002; Raaijmakers & Shiffrin, 1981; Wallner & Bäuml, 2017), part-list cuing may induce reactivation of the study context when access to the study context at test is impaired. The reactivated context may then serve as an additional retrieval cue for the remaining memories, increase target recall, and thus induce a beneficial effect of part-list cuing.

Do the Beneficial Effects of Part-List Cuing Generalize from Low Associative to High Associative Encoding?

To date, no study has yet examined whether the observation of beneficial effects of part-list cuing in list-method directed forgetting, context-dependent forgetting, and time-dependent forgetting generalizes from low associative to high associative encoding situations. As described above, high associative encoding situations, like repeated study-test cycles or study phases with explicit instructions to encode the presented items in terms of a common story, are supposed to enhance the formation of chainlike interitem associations and elaborated retrieval plans, leading to preferred recall orders. Likely, a forget cue, a context-change manipulation, or a prolonged retention interval can cause forgetting of a list also after high associative encoding and thus reduce accessibility of the original retrieval plan; and likely, part-list cuing will also be able to reactivate the study context in this encoding situation. Still, it is unclear whether part-list cuing will also improve target recall with high associative encoding when study and test contexts differ. Indeed, expectations depend on when during the recall period the original retrieval plan is supposed to get reactivated.

Goernert and Larson (1994) found that the beneficial effect of part-list cuing increases with the number of provided part-list cues (see above). On the basis of the assumption that part-list cuing reactivates the study context when study and test contexts differ (e.g., Bäuml & Samenieh, 2012), this finding indicates that the amount of context reactivation increases with the number of provided part-list cues, suggesting that part-list cuing reactivates the study context gradually (for a similar result in selective retrieval, see Bäuml & Samenieh, 2010). If this result generalizes to high associative encoding situations and reconstruction of the original retrieval plan requires a high amount of context reactivation, then reconstruction of the retrieval plan may occur relatively late in the recall period, when quite a number of target items have already been reactivated and recalled. Context reactivation processes may then operate over most part of the recall period and facilitate recall of the target items, whereas the originally encoded retrieval plan may influence recall only late in the recall period and thus affect recall of only few items at best. In such case, part-list cuing may improve recall and lead to results similar to those found for low associative encoding, that is, beneficial effects of part-list cuing.

Alternatively, even if part-list cuing reactivated the study context gradually, the original retrieval plan may get reconstructed already early in the recall period. Because in high associative encoding conditions, chaining strategies create strong associations between single items, strategy reconstruction may require the reactivation of only few items, with many of the remaining items being filled in quickly to reinstate the original retrieval plan (see Murdock, 1983; Raaijmakers & Shiffrin, 1981). If so, the poten-

tially beneficial effect of context reactivation as caused by the part-list cues may quickly be masked by the detrimental effect of strategy disruption caused by the same part-list cues. In fact, although the reactivated retrieval plan would allow subjects to recall many of the target items, the presence of the part-list cues may disrupt this plan, keeping recall performance at a level that is similar to the recall level observed in the absence of any part-list cues. In such case, part-list cuing would not improve recall in high associative encoding and part-list cuing facilitation would be restricted to low associative encoding situations. The present study addresses the issue.

The Present Study

The results of four experiments are reported designed to examine whether the effects of part-list cuing vary with encoding when study and test contexts differ. In each of the experiments, subjects studied a list of items and recalled the list items on a later memory test, in either the presence or the absence of some of the items serving as retrieval cues. Following previous studies, we manipulated access to study context at test by employing a remember or a forget instruction after study (Experiments 1 and 3; Bäuml & Samenieh, 2012; Goernert & Larson, 1994) and by varying the length of the retention interval between study and test (Experiments 2 and 4; Bäuml & Schlichting, 2014). We varied encoding by inducing either low or high associative encoding situations. To induce high associative encoding, we employed a story building task (Experiments 1 and 3) or repeated study-test cycles (Experiments 2 and 4); to induce low associative encoding, we employed single study learning without any explicit instruction to encode the items strategically (Experiments 1 and 2; Aslan & Bäuml, 2007; Bäuml & Aslan, 2006).

We expected for low associative encoding that, due to blocking and inhibition processes, part-list cuing impairs recall when study and test contexts overlap - that is, after the remember instruction and the short retention interval - but that, due to context reactivation processes, part-list cuing improves recall when study and test contexts differ - that is, after the forget instruction and the prolonged retention interval (Bäuml & Samenieh, 2012; Bäuml & Schlichting, 2014; Goernert & Larson, 1994). We expected for high associative encoding that, due to strategy disruption processes, part-list cuing again impairs recall when study and test contexts overlap (Basden & Basden, 1995; Basden et al., 1977). Expectations on the effects of part-list cuing when study and test contexts differ depend on when during the recall period retrieval strategies are supposed to get reconstructed. If strategy reconstruction occurs only late in the recall period, then part-list cuing may improve target recall and show a pattern similar to the one expected for low associative encoding. In contrast, if strategy reconstruction occurs already early in the recall period, then part-list cuing may not improve recall and lead to a recall level similar to the one found when part-list cues are absent. The results of the experiments will provide detailed information on the roles of encoding and study context access for the effects of part-list cuing.

Experiment 1

The first goal of Experiment 1 was to replicate the results of Goernert and Larson (1994) and Bäuml and Samenieh (2012) by

showing that with single study learning and in the absence of an instruction to encode the items strategically, that is, low associative encoding, part-list cuing can both improve and impair recall of the other items, depending on whether a forget or a remember instruction is provided after study. The second goal of the experiment was to examine whether the results for low associative encoding generalize to high associative encoding situations. Following prior part-list cuing work, we employed a story building task to induce high associative encoding (Aslan & Bäuml, 2007; Bäuml & Aslan, 2006).

Subjects studied a word list, consisting of predefined target and nontarget (cue) items, and subsequently received the instruction to either forget the items or remember the items for an upcoming memory test (Bjork, 1970). Subjects in the low associative encoding condition were asked to encode the presented items in a single study cycle without any specific encoding instruction, whereas subjects in the high associative encoding condition were asked to formulate a meaningful sentence with each presented word and to interrelate the sentences to a common story (see Bower & Clark, 1969; Sahakyan & Delaney, 2003). Following presentation of a second list, memory for the first-list items was tested. We either provided the nontarget items as retrieval cues for recall of the remaining target items or required participants to remember both target and nontarget items in a free-recall task.

On the basis of the results of Goernert and Larson (1994) and Bäuml and Samenieh (2012), we expected for the single study condition that part-list cuing would impair recall in the remember condition but improve recall in the forget condition. For the story building condition, we also expected part-list cuing to impair recall in the remember condition (Aslan & Bäuml, 2007; Bäuml & Aslan, 2006). Two different expectations arise in the forget condition: If, in the presence of part-list cues, strategy reconstruction occurred late in the recall period, then mainly context reactivation processes should influence recall and part-list cuing improve recall performance. If strategy reconstruction occurred early in the recall period, however, then the presence of part-list cues should disrupt retrieval strategies and thus mask the beneficial effect of context reactivation. The effects of part-list cuing would then be different in the story than in the single study condition, indicating an effect of encoding on part-list cuing when study and test contexts differ.

Method

Participants. A total of 96 students at Regensburg University took part in the experiment ($M = 21.70$ years, range = 18–30 years, 79.2% female). They were equally distributed across the four between-subjects conditions, resulting in $n = 24$ participants in each condition. Sample size was based on prior part-list cuing work (e.g., Bäuml & Samenieh, 2012; Bäuml & Schlichting, 2014). All participants spoke German as native language. They were tested individually and received monetary reward or course credit for participation.

Materials. Item material contained four lists (A–D), each consisting of 20 unrelated concrete German nouns. List A and List B were taken from Aslan and Bäuml (2007) and were designated to be used as List 1. List C and List D consisted of items employed in Bäuml and Samenieh (2010) and were designated to be used as List 2. For both List A and List B, 10 randomly selected items were defined as target items and the remaining 10 items as non-

target (cue) items. The distinction was unknown to the participants. Within each list, no two items had the same initial letter.

Design. The experiment had a $2 \times 2 \times 2$ mixed factorial design. Instruction (remember, forget) was varied within participants, whereas encoding (1-study, story) and cuing (no-part-list cuing, part-list cuing) were manipulated between participants. In the remember condition, List 1 was followed by the instruction to remember the list for a later recall test. In the forget condition, List 1 was followed by the instruction to forget the list. Participants were told that a wrong list had been presented and that they could forget the preceding items, because they would not be tested later. Half of the participants learned the items within a single study cycle without any specific encoding instruction (1-study condition), whereas the other half were asked to build up a story that included the to-be-studied items (story condition). At test, half of the participants in each encoding condition were asked to recall the previously studied items in a free-recall task (no-part-list cuing condition). The other half was provided with the nontarget items as retrieval cues and were asked to recall the remaining target items (part-list cuing condition; see Figure 1A).

Procedure. In the study phase, the items of each list were exposed successively and in random order on a computer screen for 5 s each. In the 1-study condition, participants were asked to encode the items of each list for an upcoming memory test without any additional encoding instruction; in the story condition, participants were also asked to encode the items for an upcoming memory test, but they were additionally asked to form a meaningful sentence with each presented word and to interconnect these sentences to a coherent story. They were instructed to say the sentences aloud so that the experimenter was able to control whether the subject had understood the instruction and was compliant (e.g., Sahakyan & Delaney, 2003). After study of List 1, an instruction to continue remembering the preceding items and to additionally encode the items of List 2 was provided in the remember condition. In the forget condition, a software crash was simulated to make the cover story more plausible that a wrong list had been presented (e.g., Abel & Bäuml, 2017; Barnier et al., 2007). Subjects were asked to forget the first list and to focus on the list coming up next instead. Subsequently, items of List 2 were presented. The study phase in both encoding conditions was followed by a 1-min backward counting task as a recency control.

At test, participants were asked to remember List-1 items first, regardless of the original instruction. In the no-part-list cuing condition, participants performed a free-recall task and wrote down previously learned items in any order they wished; in the part-list cuing condition, participants were provided with half of the studied items in two randomly ordered columns of five items on top of the test sheet and were instructed to read these items aloud and use them as retrieval cues for recall of the remaining items. Participants wrote down recalled target items below the columns with the nontarget items, which remained present during target recall. In both cuing conditions, List-2 items were tested subsequently in a free-recall test. Participants were given 2 min to remember each list.

After a break of 5 min, participants underwent a second experimental block, in which the instruction provided after study of List 1 was changed within participants. Participants, who had been told to remember List-1 items in the first block, received now the instruction to forget List-1 items. In contrast, participants, who had

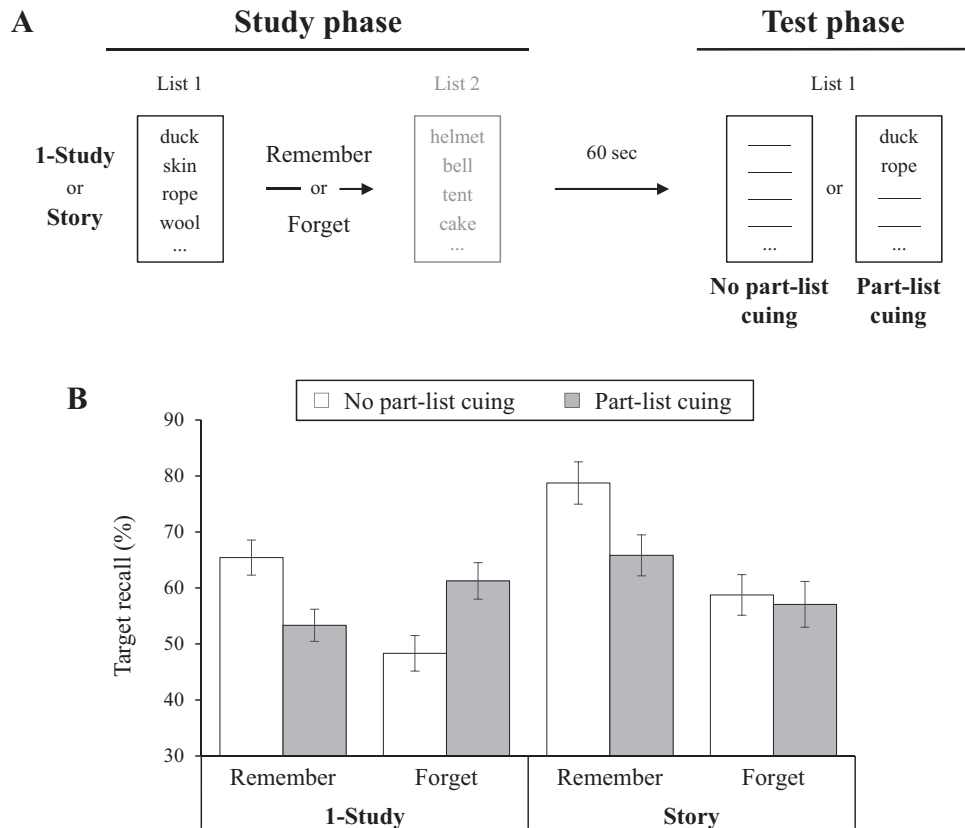


Figure 1. Experimental conditions and results of Experiment 1. Panel A: Illustration of experimental conditions. Subjects studied two lists of items and, after study of the first list, were instructed either to forget or to continue remembering that list. Encoding conditions differed in whether subjects studied each list in a single study cycle or were instructed to formulate a meaningful sentence with each presented word and to interrelate the sentences to a common story. In the test phase, participants recalled as many first-list items as possible in a free-recall task or were provided with half of the items serving as part-list cues for recall of the remaining (target) items. Panel B: Results. Target recall is shown as a function of instruction (remember, forget) and part-list cuing condition (no-part-list cuing, part-list cuing), separately for the two encoding conditions (1-study, story). Error bars represent standard errors.

been told to forget List-1 items in the first block, were now instructed to continue remembering List-1 items (see also Bäuml & Samenieh, 2012, or Zellner & Bäuml, 2006). Order of instruction conditions and assignment of study lists to conditions were counterbalanced.

Results

Following prior part-list cuing work, we restricted analysis of first-list items to target items.¹ Figure 1B shows mean recall rates for the target items as a function of instruction and cuing conditions, separately for the two encoding conditions.

1-study condition. A 2×2 analysis of variance (ANOVA) with the within-participants factor of instruction (remember, forget) and the between-participants factor of cuing (no part-list cuing, part-list cuing) yielded a significant main effect of instruction, $F(1, 46) = 4.79$, $MSE = 105.34$, $p = .034$, $\eta^2 = 0.09$, with higher recall in the remember than the forget condition (59.38% vs. 54.79%), and a significant interaction between instruction and cuing, $F(1, 46) = 35.60$, $MSE = 105.34$, $p < .001$, $\eta^2 = 0.44$,

indicating that cuing affected recall differently in the two instruction conditions. There was no main effect of cuing, $F(1, 46) < 1$. Follow-up pairwise comparisons revealed that whereas in the remember condition part-list cuing attenuated target recall (65.42% vs. 53.33%), $t(46) = 2.85$, $p = .007$, $d = 0.82$, part-list cuing enhanced target recall in the forget condition (48.33% vs. 61.25%), $t(46) = 2.84$, $p = .007$, $d = 0.82$. Target recall in the no-part-list cuing condition was significantly higher in the remember than the forget condition (65.42% vs. 48.33%), $t(23) = 5.86$, $p < .001$, $d = 1.20$, demonstrating typical directed forgetting of first-list items.

Story condition. A 2×2 ANOVA with the within-participants factor of instruction (remember, forget) and the between-participants

¹ In the no-part-list cuing conditions, subjects recalled both the target and the nontarget items. Had we included the nontarget items into the analysis, results would not have changed, however. Indeed, in no single condition of this experiment was there any difference between target and nontarget recall, all $r_s(23) < 1$. An analogous picture arose for Experiments 2–4 to be reported below.

factor of cuing (no part-list cuing, part-list cuing) revealed a significant main effect of instruction, $F(1, 46) = 28.76$, $MSE = 172.42$, $p < .001$, $\eta^2 = 0.39$, with higher recall in the remember than the forget condition (72.29% vs. 57.92%), and a significant interaction between instruction and cuing, $F(1, 46) = 4.40$, $MSE = 172.42$, $p = .041$, $\eta^2 = 0.09$, indicating that the effects of part-list cuing differed between instruction conditions. No main effect of cuing emerged, $F(1, 46) = 2.46$, $MSE = 518.98$, $p = .124$, $\eta^2 = 0.05$. Follow-up pairwise comparisons showed that target recall in the remember condition was significantly lower when part-list cues were present than when they were absent (78.75% vs. 65.83%), $t(46) = 2.46$, $p = .018$, $d = 0.71$, but that target recall was unaffected by the part-list cues in the forget condition (58.75% vs. 57.08%), $t(46) < 1$. When part-list cues were absent, participants recalled significantly more target items in the remember condition than in the forget condition (78.75% vs. 58.75%), $t(23) = 4.75$, $p < .001$, $d = 0.97$, indicating that the directed forgetting manipulation was successful.

Overall analysis. Analysis of recall performance in the two encoding conditions suggests that type of encoding influenced the effects of part-list cuing on target recall, at least when a forget instruction was provided. Whereas detrimental effects of part-list cuing arose in both encoding conditions when a remember instruction was presented, part-list cuing affected target recall differently after a forget instruction, creating a beneficial effect in the 1-study condition but no effect in the story condition. This suggestion is bolstered by the results of a $2 \times 2 \times 2$ ANOVA with the factors of instruction, cuing, and encoding (1-study, story), which revealed a significant three-way interaction between the single factors, $F(1, 92) = 4.08$, $MSE = 138.88$, $p = .046$, $\eta^2 = 0.04$.

Further analysis. Whereas type of encoding and part-list cuing were varied between participants in this experiment, interlist instructions were manipulated within participants. Order of instruction conditions, however, did not affect target recall. There was no main effect of order and no interaction effect of order with any of the other variables, all $ps > .122$.

We also analyzed recall of second-list items. A $2 \times 2 \times 2$ ANOVA with the factors of instruction, cuing, and encoding showed a significant main effect of encoding, $F(1, 92) = 32.80$, $MSE = 478.05$, $p < .001$, $\eta^2 = 0.26$, with higher recall in the story than the 1-study condition (69.84% vs. 51.77%), but there were no main effects of instruction, $F(1, 92) < 1$, or cuing, $F(1, 92) = 1.37$, $MSE = 478.05$, $p = .244$, $\eta^2 = 0.02$, and no interaction effects, all $ps > .174$. These results are consistent with prior work, showing that preceding recall of List-1 items often affects recall results for List-2 items and eliminates possible beneficial effects of the forget cue on List-2 items (e.g., Golding & Gottlob, 2005; Pastötter, Kliegl, & Bäuml, 2012).

Discussion

In agreement with the results of previous studies (Bäuml & Samenieh, 2012; Goernert & Larson, 1994), we found two faces of part-list cuing in the 1-study condition. When a remember instruction was provided after study, the presence of part-list cues reduced recall of the target items; in contrast, when a forget instruction was provided, the presentation of part-list cues improved target recall. Going beyond the prior work, we found part-list cuing in the story condition to impair target recall in the remember condition but to leave target recall unaffected in the forget condi-

tion. These results provide first evidence that the beneficial effect of part-list cuing as observed with low associative encoding may not generalize to high associative encoding. Before drawing more firm conclusions on the issue, however, it was the goal of Experiment 2 to replicate this pattern of results using a different method to create a mismatch between study and test contexts and a different method to induce high associative encoding.

Experiment 2

Experiment 2 followed previous work by Bäuml and Schlichting (2014) and induced a mismatch between study and test contexts by varying the length of the retention interval between study and test (e.g., Estes, 1955; Mensink & Raaijmakers, 1988). Following other previous work (Aslan & Bäuml, 2007; Bäuml & Aslan, 2006), we induced high associative encoding by employing study-test cycles during learning. Subjects studied a word list, consisting of predefined target and nontarget (cue) items, which was followed by a delay of 1 min or a prolonged retention interval of 30 min. In the low associative encoding condition, participants received a single study cycle to encode the provided items, whereas in the high associative encoding condition, the word list was presented twice with a free-recall test on the list after each list presentation. At test, participants were asked to recall the target items in the presence of the nontarget items serving as retrieval cues, or to perform a free-recall task and recall all of the previously studied items. On the basis of the results of Bäuml and Schlichting (2014), we expected part-list cuing in the single study condition to impair target recall after the short retention interval but to improve target recall after the prolonged retention interval. In contrast, on the basis of the results of Experiment 1, we expected part-list cuing in the study-test cycles condition to impair target recall after the short retention interval but to leave recall of target items unaffected after the prolonged retention interval.

Method

Participants. A total of 96 students took part in the experiment ($M = 22.5$ years, range = 18–30 years, 86.5% female). They were equally distributed across the four between-subjects conditions, resulting in $n = 24$ participants in each condition. Sample size followed Experiment 1. None of the participants had been tested in Experiment 1. Again, all of the participants spoke German as native language, were tested individually, and received monetary reward or course credit for participation.

Materials. Materials were identical to List A and List B in Experiment 1. Each list consisted of the same 10 target and 10 nontarget items as employed in Experiment 1.

Design. The experiment had a $2 \times 2 \times 2$ mixed factorial design. Retention interval (short, long) was varied within participants, whereas encoding (1-study, 2-study-test) and cuing (no-part-list cuing, part-list cuing) were manipulated between participants. In the short retention interval condition, testing occurred 1 min after study, in the long retention interval condition, it occurred after a delay of 30 min. Half of the participants learned the items within a single study cycle without any specific encoding instruction (1-study condition), whereas the other half completed two successive study-test cycles (2-study-test condition). At test, half of the participants in each encoding condition were asked to

recall all of the previously studied items in a free-recall task (no-part-list cuing condition); the other half was provided with the nontarget items as retrieval cues and were asked to recall the remaining target items (part-list cuing condition; see also Figure 2A).

Procedure. Like in Experiment 1, items were presented successively and in a random order on a computer screen at a 5-s rate. Again, participants received one study cycle to encode the items in the 1-study condition. In the 2-study-test condition, participants completed two study-test cycles. After the first study cycle, they counted backward from a three-digit number for 30 s and were then told to write down as many of the previously studied items as possible in any order they wished. Immediately thereafter, a second study-test cycle was ran in exactly the same way. Presentation order of items during study was the same as in the first study cycle. The study phase in both encoding conditions was followed by a 1-min backward counting task.

In the prolonged retention interval condition, another retention interval of 29 min followed, in which participants were engaged in several distractor tasks, which included counting backward from a

three-digit number, resolving decision tasks, and doing three different imagination tasks (last trip abroad; a study trip at school; where will you be and what will you do in five years; see Delaney, Sahakyan, Kelley, & Zimmerman, 2010). The imagination tasks lasted 3 min each and were included to enhance contextual drift between study and test phases (for a similar procedure, see Wallner & Bäuml, 2017). Testing was identical to testing of List 1 in Experiment 1. In the no-part-list cuing condition, subjects were asked to recall and write down the previously studied items by means of a free-recall task; in the part-list cuing condition, half of the items were presented in two randomly ordered columns of five items on top of the test sheet and subjects were asked to use the items as retrieval cues for recall of the remaining items. Participants wrote down recalled target items below the columns with the nontarget items, which remained present during target recall. Recall time in both cuing conditions was 2 min.

After a break of 5 min, participants underwent a second experimental block, in which the retention interval after the study phase was changed within participants. Participants, who were tested after 1 min in the first block, now completed the memory Test

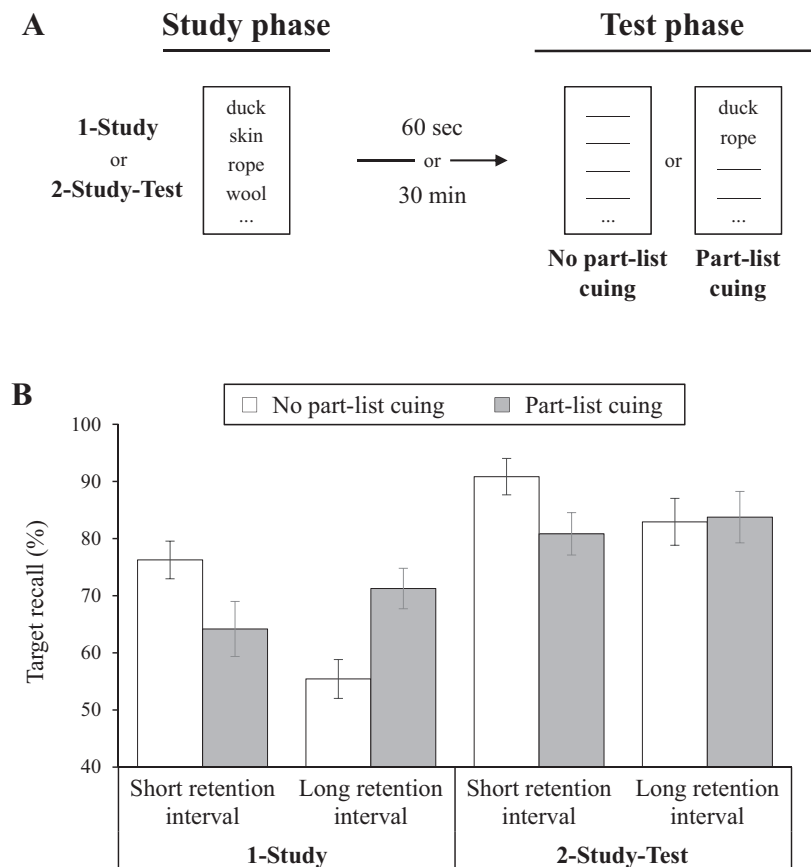


Figure 2. Experimental conditions and results of Experiment 2. Panel A: Illustration of experimental conditions. Subjects studied a list of items by means of a single study cycle or two successive study-test cycles. After a retention interval of either 60 s or 30 min, participants recalled as many items of the list as possible in a free-recall task or were provided with half of the items serving as part-list cues for recall of the remaining (target) items. Panel B: Results. Target recall is shown as a function of retention interval (short, long) and part-list cuing condition (no-part-list cuing, part-list cuing), separately for the two encoding conditions (1-study, 2-study-test). Error bars represent standard errors.

30 min after study. In contrast, participants, who were tested after 30 min in the first block, now completed the memory test 1 min after study. Order of retention interval conditions and assignment of study lists to conditions were counterbalanced.

Results

Like in Experiment 1, we restricted analysis to target items. Figure 2B shows mean recall rates for the target items as a function of instruction and cuing conditions, separately for the two encoding conditions.

1-study condition. A 2×2 ANOVA with the within-participants factor of retention interval (short, long) and the between-participants factor of cuing (no part-list cuing, part-list cuing) revealed a significant main effect of retention interval, $F(1, 46) = 6.26$, $MSE = 181.30$, $p = .016$, $\eta^2 = 0.12$, with higher recall in the short than the long retention interval condition (70.21% vs. 63.33%), and a significant interaction between retention interval and cuing, $F(1, 46) = 25.79$, $MSE = 181.30$, $p < .001$, $\eta^2 = 0.36$, indicating that cuing affected recall differently in the two retention interval conditions. No main effect of cuing arose, $F(1, 46) < 1$. Follow-up pairwise comparisons showed that whereas part-list cuing impaired target recall after the short retention interval (76.25% vs. 64.17%), $t(46) = 2.07$, $p = .044$, $d = 0.60$, it improved target recall after the long retention interval (55.42% vs. 71.25%), $t(46) = 3.23$, $p = .002$, $d = 0.93$. Target recall in the no-part-list cuing condition was significantly higher after the short retention interval than after the long retention interval (76.25% vs. 55.42%), $t(23) = 6.67$, $p < .001$, $d = 1.37$, demonstrating typical time-dependent forgetting.

2-study-test condition. In the study phase, target recall increased from 69.38% in the first test to 89.79% in the second test, $F(1, 46) = 100.89$, $MSE = 198.32$, $p < .001$, $\eta^2 = 0.69$, indicating successful learning. Recall levels were unaffected by retention interval condition, $F(1, 46) < 1$, and cuing condition, $F(1, 46) < 1$, which was expected given that both manipulations were conducted after the study phase (see Table 1).

A 2×2 ANOVA with the within-participants factor of retention interval (short, long) and the between-participants factor of cuing (no part-list cuing, part-list cuing) revealed neither a main effect of retention interval, $F(1, 46) < 1$, nor a main effect of cuing, $F(1, 46) < 1$. There was a significant interaction between retention interval and cuing, $F(1, 46) = 4.66$, $MSE = 151.00$, $p = .036$, $\eta^2 = 0.09$, however, indicating that the effects of part-list cuing differed between delay conditions. Follow-up pairwise comparisons demonstrated that, after the short retention interval, target recall was lower when part-list cues were present than when they were absent (90.83% vs. 80.83%), $t(46) = 2.05$, $p = .046$, $d = 0.59$, whereas after the long retention interval, recall was unaffected by cuing condition (82.92% vs. 83.75%), $t(46) < 1$. In the absence of part-list cues, participants recalled more target items after the short retention interval than after the long retention interval (90.83% vs. 82.92%), $t(23) = 2.40$, $p = .025$, $d = 0.49$, reflecting typical time-dependent forgetting.

Overall analysis. The above results indicate that the effects of part-list cuing varied with encoding condition, at least after the long retention interval. Whereas part-list cuing impairment arose in both encoding conditions after the short retention interval, part-list cuing affected target recall differently after the long retention interval, showing a beneficial effect in the 1-study condi-

Table 1

Percentage of Recalled Target Items for Each of the Two Study-Test Cycles of Experiment 2 as a Function of Retention Interval (Short, Long) and Part-List Cuing Condition at Test (No-Part-List Cuing, Part-List Cuing)

| Study-test cycles | Short | | Long | |
|-------------------|------------|------------|------------|------------|
| | No-PLC | PLC | No-PLC | PLC |
| Cycle 1 | 70.4 (4.3) | 66.3 (4.6) | 71.3 (5.3) | 69.6 (5.0) |
| Cycle 2 | 90.8 (3.4) | 89.2 (2.8) | 90.4 (3.2) | 88.8 (4.1) |

Note. PLC = part-list cuing. Standard errors are shown in parentheses.

tion but no such effect in the 2-study-test condition. This suggestion is supported by the results of a $2 \times 2 \times 2$ ANOVA with the factors of retention interval, cuing, and encoding (1-study, 2-study-test), which revealed a significant three-way interaction, $F(1, 92) = 5.27$, $MSE = 166.15$, $p = .024$, $\eta^2 = 0.05$.

Further analysis. Whereas type of encoding and part-list cuing were varied between participants in this experiment, retention interval was manipulated within participants. However, order of retention interval conditions did not affect the results. There was no main effect of order and no interaction effect of order with any of the other variables, all $ps > .114$.

Discussion

Consistent with the results of previous work (Bäuml & Schlichting, 2014), we found two faces of part-list cuing in the 1-study condition. After the short retention interval, the presence of the part-list cues reduced recall of the target items, whereas after the prolonged retention interval, it improved target recall. Going beyond the prior work, we found part-list cuing in the 2-study-test condition to impair target recall after the short retention interval but to leave target recall unaffected after the prolonged retention interval. These results are consistent with the results of Experiment 1, which used a different method to create a mismatch between study and test contexts and a different method to induce high associative encoding, indicating that the beneficial effect of part-list cuing as observed with low associative encoding may not generalize to high associative encoding.

The results of Experiments 1 and 2 are in line with the view that, when study and test contexts differ - like after a forget cue or a prolonged retention interval -, part-list cuing in high associative encoding situations induces reactivation of the study context, and, fairly early in the recall period, reconstruction of the original retrieval plan. Although such context reactivation can potentially improve target recall, allowing subjects to recall many of the target items, the proposal has been that the beneficial effect may be masked by the detrimental effect of strategy disruption caused by the same part-list cues, thus keeping recall at a level similar to the one observed in the absence of any part-list cues.

Although this theoretical view can explain the null effects of part-list cuing reported in Experiments 1 and 2 with high associative encoding and impaired study context access, the view must remain speculative because no separate evidence for the beneficial effect of context reactivation and the detrimental effect of strategy disruption was provided. The goal of Experiment 3 was therefore to isolate the putative beneficial effect of context reactivation from

the detrimental effect of strategy disruption, showing that part-list cuing can improve recall also with high associative encoding, though only if strategy disruption processes are eliminated. To achieve this, we employed Basden et al.'s (1977) two-stage recall test to unpack the processes mediating part-list cuing with high associative encoding and impaired study context access.

Experiment 3

Basden et al. (1977) employed a two-stage recall test to study the effects of part-list cuing. After inducing high associative encoding of study items, subjects in their study participated in two successive recall tests, which were separated by a short retention interval. In the first (critical) test, subjects in the part-list cuing condition received half of the list items as retrieval cues and were asked to recall the remaining (target) items; subjects in the control condition were asked to recall all of the previously learned items. In the subsequent (final) test, the part-list cues were removed in the part-list cuing condition and subjects in both cuing conditions were asked to recall as many list items as possible. The finding was that the typical detrimental effect of part-list cues was present in the critical test but was largely eliminated on the final test when the cues were removed. On the basis of this finding, Basden and Basden suggested that strategy disruption occurred in the presence of part-list cues but did no longer operate in their absence (for similar results, see Basden & Basden, 1995).²

Experiment 3 applied such two-stage recall testing with the goal to isolate the beneficial effect of context reactivation from the detrimental effect of strategy disruption when subjects employ high associative encoding and study and test contexts differ. Under such conditions, the putative common action of context reactivation and strategy disruption should again create the previously observed null effect of part-list cuing on target recall on the first, critical test (Experiments 1 and 2), but the beneficial effect of context reactivation may no longer be masked by the detrimental effect of strategy disruption on the second, final test. Indeed, on this final test, strategy disruption may no longer operate because, after the removal of the cues, participants may return to their initial retrieval plans, and subjects may thus be able to recall items that were reactivated by context reactivation during the critical test but due to strategy disruption processes were not recallable on that test. If so, a null effect of part-list cuing on target recall may arise on the critical test, but a beneficial effect of part-list cuing show up on the final test.

Like in Experiment 1, we employed (a) the listwise directed forgetting task to manipulate the overlap of study and test contexts and (b) a story building task to induce high associative encoding. No single study condition was included in this experiment. In particular, a two-stage recall test with the critical test as the first and the final test as the second recall test was employed. Part-list cues were present on the critical test but were removed on the final test. We expected to replicate the results for the high associative encoding condition of Experiment 1 in the critical test, with a detrimental effect of part-list cuing in the remember condition but no effect of part-list cuing in the forget condition. However, following the reasoning above, we expected a different result on the final test. On the final test, strategy disruption processes should be largely eliminated and therefore recall levels in the part-list cuing conditions be increased, in both the remember and the forget

conditions. If so, the detrimental effect of part-list cuing in the remember condition should be reduced and a beneficial effect of part-list cuing in the forget condition arise.

Method

Participants. Sixty-four students participated in the experiment ($M = 21.4$ years, range = 18–29 years, 76.6% female). They were equally distributed across the two between-subjects conditions, resulting in $n = 32$ participants in each condition. Sample size followed prior part-list cuing work employing two-stage recall testing (e.g., Aslan et al., 2007; Bäuml & Aslan, 2006). None of the participants had taken part in Experiment 1 or Experiment 2. All participants spoke German as native language, were tested individually, and received monetary reward or course credit for participation.

Materials. The same four study lists were used as in Experiment 1. Again, List A and List B were presented as List 1, whereas List C and List D were presented as List 2. Lists A and B consisted of the same 10 target and the same 10 nontarget (cue) items as in Experiment 1.

Design and procedure. The experiment had a $2 \times 2 \times 2$ mixed factorial design. Instruction (remember, forget) and testing (critical, final) were varied within participants, whereas cuing (no-part-list cuing, part-list cuing) was manipulated between participants. Design and procedure were largely identical to Experiment 1 with the following two exceptions. First, in the study phase, we omitted the single study condition, so all participants were therefore asked to encode the items in terms of a common story. Second, in the test phase, we provided an additional final free-recall test after the first (critical) test. On the final test, no part-list cues were present, and the test was therefore identical for the two cuing conditions (see Figure 3A). Critical and final tests were separated by a 30-s backward counting task. In both tests, participants had 2 min to recall and write down previously studied first-list items. List-2 items were tested after the final test.

Results

Again, we restricted analysis of first-list recall to target items. Figure 3B shows mean recall rates for the target items as a function of instruction and cuing conditions, separately for the critical and the final test.

Critical test. A 2×2 ANOVA with the within-participants factor of instruction (remember, forget) and the between-participants factor of cuing (no part-list cuing, part-list cuing) replicated the main results of Experiment 1, yielding a significant main effect of instruc-

² Presentation of the part-list cues on the first test provides another study opportunity for the cue items in the part-list cuing condition, thereby facilitating the recall of these items on the final test. If this facilitatory effect somehow improved overall recall performance on the second test through a set of mechanisms different than release from strategy disruption, then this facilitatory effect may underlie the observed elimination of the detrimental effect rather than release from strategy disruption. There is evidence, however, that the facilitatory effect for the cue items and the recall improvement for the target items are unrelated (e.g., Bäuml & Aslan, 2006), which supports the proposal that the elimination of the detrimental effect is mediated by release from strategy disruption.

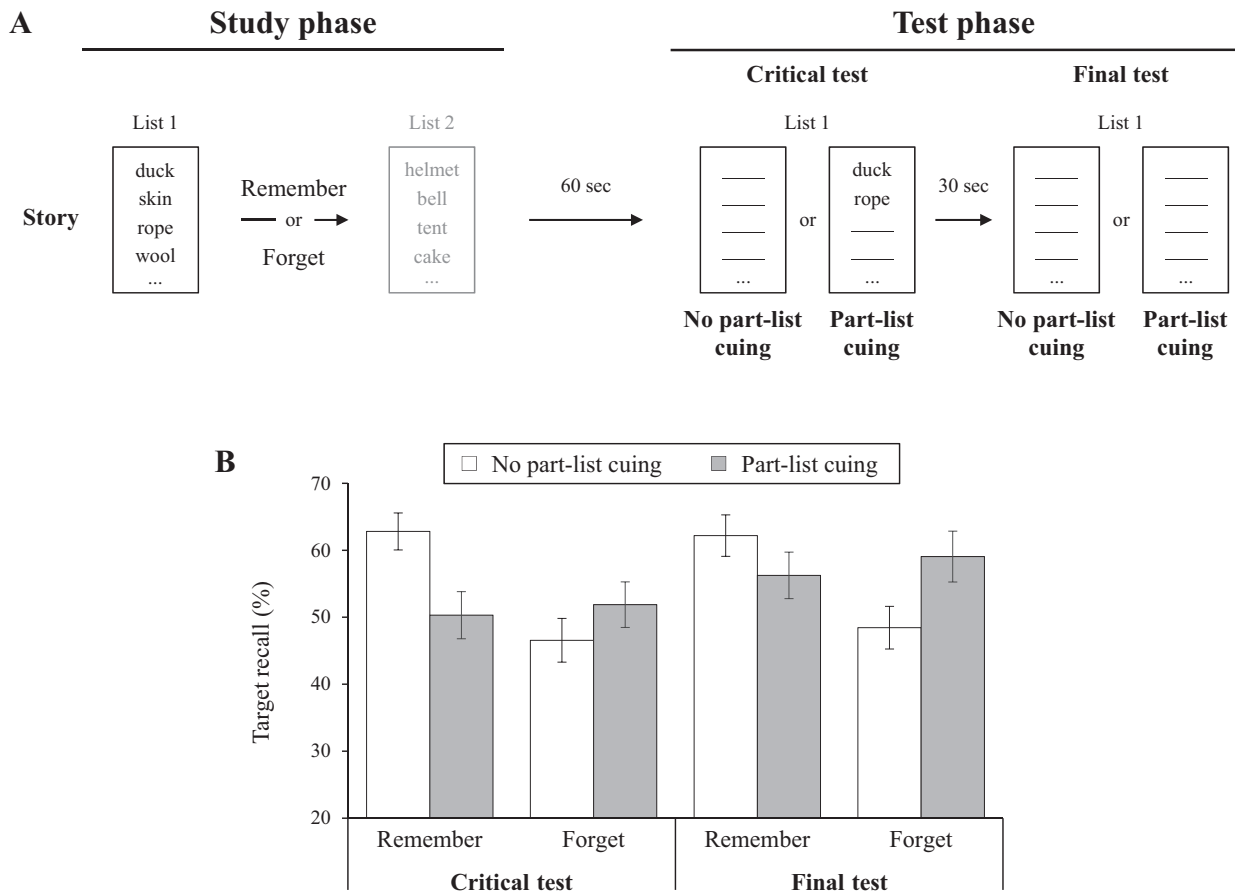


Figure 3. Experimental conditions and results of Experiment 3. Panel A: Illustration of experimental conditions. Subjects studied two lists of items and, after study of the first list, were instructed either to forget or to continue remembering that list. All participants were asked to formulate a meaningful sentence with each presented word and to interrelate the sentences to a common story. The test phase consisted of a two-stage recall test with a first critical test, in which part-list cues were provided or not, and a second final test, in which no part-list cues were provided at all. Panel B: Results. Target recall is shown as a function of instruction (remember, forget) and part-list cuing condition (no-part-list cuing, part-list cuing), separately for the two recall tests (critical test, final test). Error bars represent standard errors.

tion, $F(1, 62) = 6.82$, $MSE = 253.00$, $p = .011$, $\eta^2 = 0.10$, with higher recall in the remember than the forget condition (56.56% vs. 49.22%), and a significant interaction between instruction and cuing, $F(1, 62) = 10.03$, $MSE = 253.00$, $p = .002$, $\eta^2 = 0.14$, indicating different effects of part-list cuing in the remember and forget conditions. No main effect of cuing arose, $F(1, 62) < 1$. Follow-up pairwise comparisons showed that whereas part-list cuing impaired target recall in the remember condition (62.81% vs. 50.31%), $t(62) = 2.79$, $p = .007$, $d = 0.70$, there was no difference in recall levels in the forget condition (46.56% vs. 51.88%), $t(62) = 1.13$, $p = .264$, $d = 0.28$. In the absence of part-list cues, target recall in the remember condition exceeded target recall in the forget condition (62.81% vs. 46.56%), $t(31) = 4.80$, $p < .001$, $d = 0.85$, demonstrating typical directed forgetting of first-list items.

Final test. A 2×2 ANOVA with the within-participants factor of instruction (remember, forget) and the between-participants factor of cuing (no part-list cuing, part-list cuing) revealed a marginally significant main effect of instruction, $F(1, 62) = 3.93$, $MSE =$

243.52, $p = .052$, $\eta^2 = 0.06$, with numerically higher recall in the remember than the forget condition (59.22% vs. 53.75%), and a significant interaction between instruction and cuing, $F(1, 62) = 9.01$, $MSE = 243.52$, $p = .004$, $\eta^2 = 0.13$, indicating that part-list cuing on the critical test affected recall in the final test differently in the two instruction conditions. There was no main effect of cuing, $F(1, 62) < 1$. Follow-up pairwise comparisons showed that, in contrast to the critical test, recall levels did not differ between cuing conditions in the remember condition (62.19% vs. 56.25%), $t(62) = 1.28$, $p = .207$, $d = 0.32$, indicating that part-list cuing impairment diminished in the final test. In the forget condition, a different picture emerged: Target recall was higher in the part-list cuing than in the no-part-list cuing condition (59.06% vs. 48.44%), $t(62) = 2.15$, $p = .036$, $d = 0.54$, which suggests that providing part-list cues in the critical test improved recall on the final test. Like in the critical test, a directed forgetting effect arose in the no-part-list cuing condition, with participants recalling more target items in the remember than the forget condition (62.19% vs. 48.44%), $t(31) = 3.90$, $p < .001$, $d = 0.69$.

Overall analysis. The above results indicate that recall increased from the critical to the final test in the two part-list cuing conditions, but did not do so in the two no-part-list cuing conditions. A $2 \times 2 \times 2$ ANOVA with the factors of instruction, cuing, and testing (critical test, final test) confirmed this picture, revealing a significant main effect of testing, $F(1, 62) = 22.68$, $MSE = 36.44$, $p < .001$, $\eta^2 = 0.27$, with higher recall in the final than the critical test (56.48% vs. 52.89%), and a significant interaction between cuing and testing, $F(1, 62) = 15.48$, $MSE = 36.44$, $p < .001$, $\eta^2 = 0.20$. Pairwise comparisons in fact showed that, both in the remember and the forget conditions, target recall increased in the part-list cuing condition from the critical to the final test (remember: 50.31% vs. 56.25%, $t(31) = 3.05$, $p = .005$, $d = 0.55$; forget: 51.88% vs. 59.06%, $t(31) = 3.86$, $p = .001$, $d = 0.68$). In contrast, in both the remember and the forget conditions, target recall in the no-part-list cuing condition did not change across tests (remember: 62.81% vs. 62.19%, $t(31) < 1$; forget: 46.56% vs. 48.44%, $t(31) = 1.65$, $p = .110$, $d = 0.30$). There was no three-way interaction, $F(1, 62) < 1$, indicating that the increase in target recall when part-list cues were provided in the critical test was roughly the same in the two instruction conditions (5.94% vs. 7.19%), leading to a release of part-list cuing impairment in the remember condition and part-list cuing improvement in the forget condition.

Further analysis. In this experiment, part-list cuing was varied between participants, but interlist instructions were manipulated within participants. It is important to note that order of instruction conditions did not affect the results. There was no main effect of order and no interaction effect of order with any of the other variables, all $ps > .081$.

Like in Experiment 1, we also analyzed recall rates for List-2 items. A 2×2 ANOVA with the factors of instruction and cuing showed no main effect of instruction, $F(1, 62) = 1.15$, $MSE = 245.44$, $p = .288$, $\eta^2 = 0.02$, no main effect of cuing, $F(1, 62) < 1$, and no interaction between the two factors, $F(1, 62) < 1$. Like in Experiment 1, these results are not surprising, given that List 2 was recalled after List-1 items (see above).

Discussion

Results on the critical test replicate the results of Experiment 1, again demonstrating that, with high associative encoding, the presence of part-list cues impairs target recall after a remember instruction, but leaves target recall unaffected after a forget instruction. Results on the final test provide a different picture, however. They demonstrate an elimination of the recall impairment in the remember condition and recall improvement in the forget condition. The elimination of the recall impairment in the remember condition replicates prior work, indicating that strategy disruption, which may operate on the critical test when part-list cues are present, is attenuated once part-list cues are removed in the final test (Basden & Basden, 1995; Basden et al., 1977). The recall improvement in the forget condition extends this prior finding, suggesting that strategy disruption can also be attenuated in the forget condition when the part-list cues are removed.

This latter finding is consistent with the theoretical view that, with high associative encoding and a difference in study and test contexts, both (beneficial) context reactivation processes and (detrimental) strategy disruption processes operate on the critical test

when part-list cues are present, whereas strategy disruption processes may no longer operate on the final test when the cues are absent, thus creating a null effect of part-list cuing in the critical test but a beneficial effect on the final test. Experiment 3 was thus successful in separating the beneficial effect of context reactivation from the possible detrimental effect of strategy disruption. The goal of Experiment 4 was to replicate this finding using different method to create a mismatch in study and test contexts, and different method to induce high associative encoding.

Experiment 4

Like Experiment 3, Experiment 4 examined the proposal that, with high associative encoding and a difference in study and test contexts, part-list cuing may leave recall unaffected on a critical test in which the part-list cues are provided, but improve recall on a final test when the cues are removed. Doing so, Experiment 4 employed the same two-stage recall test as was used in Experiment 3. Besides, Experiment 4 followed Experiment 2 by using study-test cycles to induce high associative encoding and by using a prolonged retention interval between study and test to create a mismatch in study and test contexts. Unlike Experiment 2, Experiment 4 did not include a short delay condition. Rather, four different part-list cuing conditions were employed, providing subjects on the critical test with 0, 4, 8, or 12 part-list cues. This was done to measure the effects of part-list cuing on the critical and final tests in a more fine-graded way.

Participants in this experiment studied a list of words in two successive study-test cycles and were asked to recall the list items after a prolonged retention interval of one week. Recall was tested in two successive recall tests. The critical test, in which 0, 4, 8, or 12 part-list cues were provided, was followed by a final test, in which no part-list cues were present. On the basis of the results of Experiments 1–3, we expected recall to be largely unaffected by part-list cuing condition in the critical test. However, on the basis of the results of Experiment 3, we expected enhanced target recall in the final relative to the critical test when part-list cues were provided on the critical test, but no such recall enhancement in the no-part-list cuing condition, thus creating a beneficial effect of part-list cuing on the final test. In addition, if amount of context reactivation increased with number of provided part-list cues (e.g., Bäuml & Schlichting, 2014; Goernert & Larson, 1994), then the beneficial effect of part-list cuing on target recall in the final test may be expected to increase with the number of part-list cues provided on the critical recall test.

Method

Participants. Ninety-six students participated in the experiment ($M = 22.7$ years, range = 18–30 years, 82.3% female). None of them had taken part in any of the previous experiments. They were equally distributed across the four between-subjects conditions, resulting in $n = 24$ participants in each condition. All participants spoke German as native language, were tested individually, and received monetary reward or course credit for participation.

Materials. Materials were identical to List A and List B used in Experiment 2, but to avoid ceiling effects (see Figure 2B), four additional items were included in each list, which were drawn from

published norms (Battig & Montague, 1969; Scheith & Bäuml, 1995). Half of the participants studied List A, the other half studied List B. For each list, 12 target and 12 nontarget (cue) items were determined by the experimenter. The same 10 target and 10 nontarget items as employed in Experiment 2 were chosen and 2 further target and nontargets items were randomly selected from a list's four additional items. Within each list, no two items had the same initial letter.

Design and procedure. The experiment had a 2×4 mixed factorial design. Testing (critical, final) was varied within participants, whereas cuing (0, 4, 8, 12 part-list cues) was manipulated between participants. Design and procedure resembled Experiment 2 with the following three exceptions. First, in the study phase, we omitted the single study condition; all participants were therefore asked to encode the items in two successive study-test cycles. Second, we removed the short retention interval condition and extended the long retention interval condition to one week; after studying the list, all participants engaged in a 5-min unrelated distractor task (d2 test of attention, Brickenkamp & Zillmer, 1998), left laboratory, and returned one week later to complete the ex-

periment. Third, the test phase consisted of a critical and a final recall test. In the critical test, cuing conditions differed in the number of presented cue items: participants were provided with 0, 4, 8, or 12 of the nontarget items as retrieval cues and were asked to recall the remaining items. For each subject, the nontargets serving as part-list cues were randomly selected from the set of 12 nontarget items. After solving simple arithmetical problems for 30 s, all participants had 2 min to freely recall all previously studied items in the final test. No part-list cues were present at this test (see Figure 4A).

Results

Again, we restricted analysis to target items. Figure 4B shows mean recall for the target items in the single part-list cuing conditions (0, 4, 8, 12 cues), separately for the critical and the final test.

Study phase. Target recall increased from 68.40% in the first test to 88.19% in the second test, $F(1, 92) = 161.87$, $MSE = 116.16$, $p < .001$, $\eta^2 = 0.64$, indicating successful learning. Recall

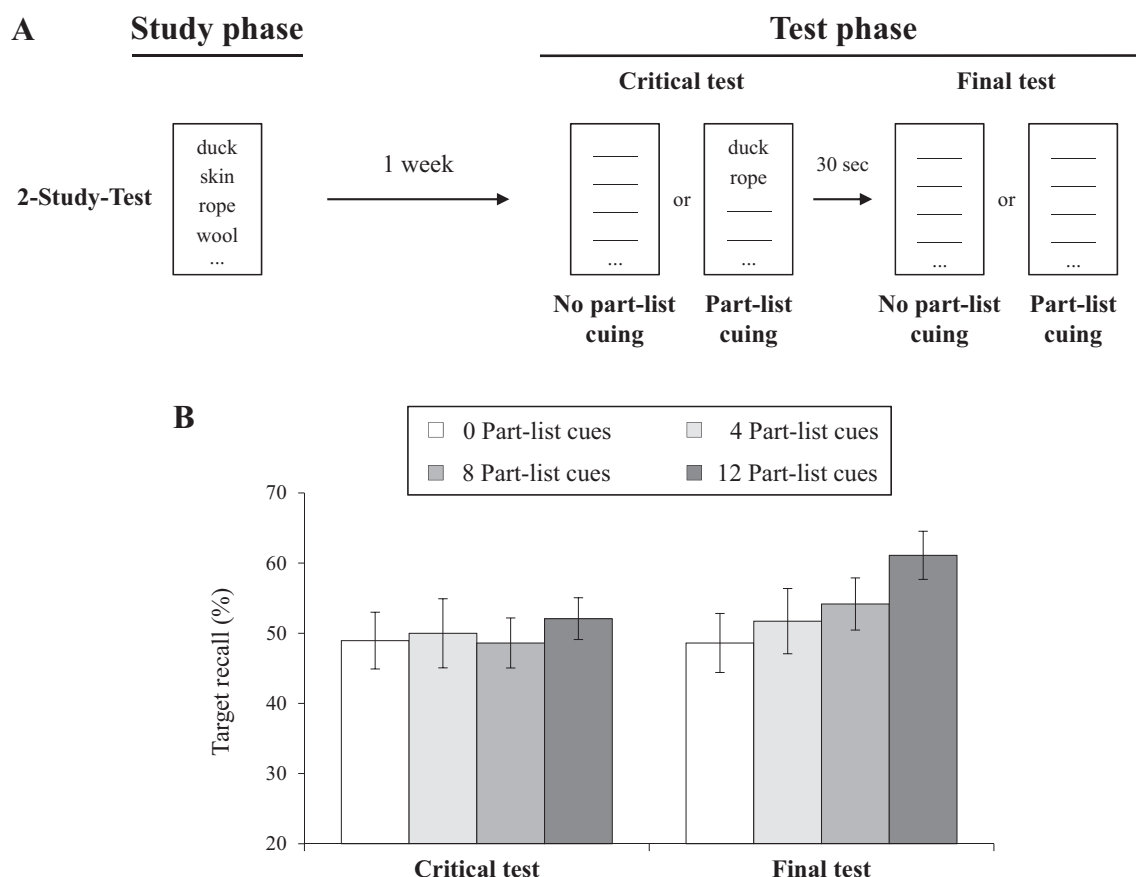


Figure 4. Experimental conditions and results of Experiment 4. Panel A: Illustration of experimental conditions. Subjects studied a list of items by means of two successive study-test cycles. After a retention interval of one week, a two-stage recall test was conducted with a first critical test, in which part-list cues were provided or not, and a second final test, in which no part-list cues were provided at all. Panel B: Results. Target recall is shown for the different part-list cuing conditions (0 or 4 or 8 or 12 part-list cues), separately for the two recall tests (critical test, final test). Error bars represent standard errors.

levels were unaffected by cuing condition, $F(3, 92) < 1$, which was expected given that part-list cues were provided after the study phase (see Table 2).

Test phase. A 2×2 ANOVA with the factors of cuing (0, 4, 8, 12 part-list cues) and testing (critical, final) yielded a significant main effect of testing, $F(1, 92) = 38.94$, $MSE = 19.66$, $p < .001$, $\eta^2 = 0.30$, with higher recall in the final than the critical test (53.90% vs. 49.91%), and a significant interaction between cuing and testing, $F(3, 92) = 10.53$, $MSE = 19.66$, $p < .001$, $\eta^2 = 0.26$, indicating that the single cuing conditions affected recall in the two tests differently. There was no main effect of cuing, $F(3, 92) < 1$. Pairwise comparisons showed that target recall increased from the critical test to the final test when 12 part-list cues were provided in the critical test (52.08% vs. 61.11%), $t(23) = 6.03$, $p < .001$, $d = 1.23$, and when 8 part-list cues were provided (48.61% vs. 54.17%), $t(23) = 4.29$, $p < .001$, $d = 0.88$. No significant difference between recall rates in the two tests emerged when 4 part-list cues were present in the critical test (49.99% vs. 51.72%), $t(23) = 1.31$, $p = .203$, $d = 0.27$, and when part-list cues were absent (48.96% vs. 48.61%), $t(23) < 1$. Consistent with these results, there were no differences in target recall between the control condition and the single cuing conditions in the critical test, all $t(46) < 1$, whereas target recall in the final test was higher when 12 part-list cues were provided on the critical test than when part-list cues were absent (61.11% vs. 48.61%), $t(46) = 2.30$, $p = .026$, $d = .66$.

Discussion

Results for the critical test replicate and extend those of Experiment 2 with high associative encoding and prolonged retention interval. There was no effect of part-list cuing when half of the items were provided as part-list cues (12 part-list cues) and this pattern generalized to the conditions in which a lower number of part-list cues were provided. Results on the final test differed from those on the critical test, showing a beneficial effect of part-list cuing when 12 part-list cues were present. This finding is consistent with the results of Experiment 3, providing another case for the proposal that, with high associative encoding and when study and test contexts differ, part-list cuing may leave recall on a critical test unaffected but may improve recall on a subsequent final test when the part-list cues are removed on that test. This pattern of results is in line with the view that, under the conditions examined, context reactivation and strategy disruption may operate on the critical test but context reactivation only influence recall on the final test.

Table 2

Percentage of Recalled Target Items for Each of the Two Study-Test Cycles of Experiment 4 as a Function of Part-List Cuing Condition at Test (0, 4, 8, 12 Part-List Cues)

| Study-test cycles | Number of part-list cues | | | |
|-------------------|--------------------------|------------|------------|------------|
| | 0 | 4 | 8 | 12 |
| Cycle 1 | 70.1 (3.0) | 64.6 (4.2) | 69.1 (4.2) | 69.8 (3.5) |
| Cycle 2 | 87.5 (1.9) | 87.2 (2.6) | 88.5 (2.6) | 89.6 (2.1) |

Note. Standard errors are shown in parentheses.

General Discussion

The results of Experiments 1 and 2 replicate prior work by showing that, with low associative encoding, part-list cuing induces detrimental effects on target recall when study and test contexts overlap but induces beneficial effects when study and test contexts differ (Bäuml & Samenieh, 2012; Bäuml & Schlichting, 2014; Goernert & Larson, 1994). Going beyond the prior work, the results demonstrate that, with high associative encoding, part-list cuing again induces detrimental effects on target recall when study and test contexts overlap, but it leaves target recall unaffected when study and test contexts differ. These findings indicate that encoding influences the effects of part-list cuing when study and test contexts differ, leading to improved recall of target items with low associative encoding only. The findings emerged both when a mismatch between study and test contexts was created by means of a forget cue and when it was created by a prolonged retention interval.

The results of Experiment 3 replicate prior work by showing that, with high associative encoding and when study and test contexts match, part-list cuing impairment can arise in a first, critical test when part-list cues are present, but be reduced, if not eliminated, in a second, final test when the cues are removed on that test (e.g., Basden & Basden, 1995; Basden et al., 1977). Indeed, in the remember condition of this experiment, target recall increased from the critical to the final test in the part-list cuing condition, whereas it was unaffected by test in the no-part-list cuing condition. As a result, the part-list cuing impairment observed in the critical test was reduced and statistically no longer present in the final test. It is important to note that the results of Experiments 3 (forget condition) and Experiment 4 (prolonged retention interval) generalize this finding by demonstrating that, also when study and test contexts differ, target recall can increase from the critical to the final test in the part-list cuing condition, but be unaffected by test in the no-part-list cuing conditions. The null effect of part-list cuing observed on the first, critical test therefore turned into a beneficial effect of part-list cuing on the second, final test. This finding demonstrates that, also with high associative encoding, part-list cuing can improve recall of target items when study and test contexts differ, though only on a second test when the cues are removed. Again, the findings arose when a mismatch between study and test contexts was created by means of a forget cue and when it was created by prolonged retention interval.

Mechanisms Underlying the Effects of Part-List Cuing with High Associative Encoding

The finding of Experiments 1–4 that, with high associative encoding (and on the first, critical test), part-list cuing impairs target recall when study and test contexts match, but leaves target recall unaffected when study and test contexts differ, is consistent with the view that the effects of part-list cuing in this type of encoding are mediated by two different mechanisms. The proposal is that, when study and test contexts overlap and access to study context at test is maintained, part-list cuing triggers strategy disruption processes, which cause part-list cuing impairment. Indeed, with high associative encoding, subjects may try to develop individual retrieval plans during encoding and the part-list cues may then disrupt the preferred recall orders (e.g., Basden & Basden,

1995; Basden et al., 1977). In contrast, when study and test contexts differ and access to study context at test is impaired, part-list cuing may trigger context reactivation and strategy disruption processes. Initially, part-list cuing may reactivate the study context and the reactivated context then serve as an additional retrieval cue for the remaining memories and facilitate target recall (e.g., Bäuml & Samenieh, 2012). However, already early in the recall period, such context reactivation may lead to reconstruction of the original retrieval plan. Although the reactivated retrieval plan would allow subjects to recall many of the target items, the presence of the part-list cues may disrupt this plan, so that the potentially beneficial effect of context reactivation as caused by the part-list cues is masked by the detrimental effect of strategy disruption caused by the same part-list cues. Part-list cuing may thus not much affect target recall, which is what the present results show.

This proposal is supported by the finding of Experiments 3 and 4 that, with high associative encoding and a difference in study and test contexts, no beneficial effect of part-list cuing may arise on a first, critical test when part-list cues are present but a beneficial effect emerge on a second, final test when the cues are removed on that test. Indeed, following the two-mechanism proposal above and the findings on the effects of part-list cuing in two-stage recall tests (e.g., Basden & Basden, 1995; Basden et al., 1977), the absence of the part-list cues in the final test should reduce, or even eliminate, strategy disruption processes and thus unmask the beneficial effect of context reactivation processes operating during the first, critical test. As a whole, the findings of Experiments 1–4 thus indicate that, with high associative encoding, strategy disruption mediates the effects of part-list cuing when study and test contexts match, but context reactivation *and* strategy disruption mediate the effects when study and test contexts differ. Both strategy disruption and context reactivation operate on the critical test when the part-list cues are present, but mainly the effects of context reactivation are present on the final test when the cues are removed.

A Multimechanisms Account of Part-List Cuing

Bäuml and Samenieh (2012) attributed the effects of part-list cuing in low associative encoding to inhibition/blocking and context reactivation processes. The proposal has been that, when study and test contexts overlap and access to study context at test is largely maintained, part-list cuing may trigger mainly inhibition and blocking processes with little need to reactivate the study context. As a result, part-list cuing impairment may arise. In contrast, when study and test contexts differ and study context access at test is impaired, the interference level of the items may

be low and blocking and inhibition may hardly operate. Rather, part-list cuing may trigger context reactivation processes, with the reactivated context serving as an additional retrieval cue for the remaining items, thus improving target recall.

When combining the theoretical views on part-list cuing for low and high associative encoding, a multimechanisms account arises. This account suggests that, when study and test contexts match, detrimental effects of part-list cuing emerge, with different mechanisms operating in different encoding situations. Inhibition and blocking are supposed to underlie the impairment in low associative encoding, whereas strategy disruption is supposed to underlie the impairment in high associative encoding (e.g., Aslan & Bäuml, 2007; Bäuml & Aslan, 2006). In addition, the account suggests that, when study and test contexts differ, beneficial or null effects of part-list cuing emerge, partly mediated by similar mechanisms. Although in low associative encoding, mainly context reactivation processes are supposed to operate, causing part-list cuing improvement, in high associative encoding, both context reactivation and strategy disruption may operate, which due to their opposing character may not much influence target recall (see Table 3). This multimechanisms account can explain the present set of experimental results as well as other findings in the part-list cuing literature (see Bäuml & Aslan, 2006; Bäuml & Samenieh, 2012).

Conclusions

In this series of experiments we showed that the effects of part-list cuing depend critically on encoding as well as the contextual overlap between study and test. Depending on the combination of encoding and study context access, part-list cuing can impair, improve, or not influence target recall. On the basis of these findings, a multimechanisms account of part-list cuing is suggested, which provides a rationale for how part-list cuing affects target recall in different experimental conditions.

Since Slamecka's (1968) original finding the term 'part-list cuing' has typically been associated with recall impairment, making this form of cuing appear an ineligible method to improve people's recall performance. The present findings reveal part-list cuing in a different light, indicating that it can also induce recall improvement. These findings are of practical relevance, for instance, with regard to eyewitness testimony, as, during interrogations, witnesses' access to the encoding context is often impaired and presenting known detail of an episode as retrieval cues may thus trigger witnesses' memory for critical information. Similarly, part-list cuing may be beneficial in educational or clinical settings and, under certain conditions, provide an effective way to support students' recall or enhance the recall of patients with memory

Table 3
Summary of Observed Effects of Part-List Cuing in the Different Encoding and Testing Conditions, Together With Suggestions on Underlying Mechanisms

| Encoding | Study and test contexts match | Study and test contexts differ |
|---------------------------|--|--|
| Low associative encoding | Part-list cuing <i>impairment</i> caused (mainly) by inhibition and blocking | Part-list cuing <i>improvement</i> caused (mainly) by context reactivation |
| High associative encoding | Part-list cuing <i>impairment</i> caused (mainly) by strategy disruption | <i>Null effect</i> of part-list cuing caused by opposing effects of context reactivation and strategy disruption |

problems. With these perspectives, the present study may motivate and guide future research on part-list cuing.

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