The Role of Inhibitory Processes in Part-List Cuing

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Providing a subset of studied items as retrieval cues can have detrimental effects on recall of the remaining items. In 2 experiments, the authors examined such part-list cuing impairment in a repeated-testing situation. Participants studied exemplars from several semantic categories and were given 2 successive cued-recall tests separated by a distractor task of several minutes. Part-list cues were provided in the 1st test but not the 2nd. Noncue item recall was tested with the studied category cues (*same probes*) in the 1st test, but novel, unstudied retrieval cues (*independent probes*) in the 2nd test. The authors found detrimental effects of part-list cues in both the 1st (same-probe) test and the 2nd (independent-probe) test. These results show that part-list cuing impairment can be lasting and is not eliminated with independent probes. The findings support the view that the impairment was caused by retrieval inhibition.

Keywords: retrieval, part-list cuing, inhibition, independent-probe method

An intriguing finding in episodic memory research is part-list cuing impairment. Part-list cuing impairment refers to the observation that the presentation of a subset of previously learned items as retrieval cues often does not enhance but rather impairs recall of the remaining noncue items (Roediger, 1973; Slamecka, 1968). Given the vast literature on the beneficial effects of retrieval cues (e.g., Tulving, 1974), at first glance, this finding may come as a surprise. However, part-list cuing impairment has been found to be a very robust effect and to occur in a variety of experimental settings. Detrimental effects of part-list cues have been found to emerge in episodic as well as semantic memory (Brown, 1968). They have been demonstrated in different types of memory tests (Oswald, Serra, & Krishna, 2006; Serra & Nairne, 2000; Todres & Watkins, 1981), across different age groups (Marsh, Dolan, Balota, & Roediger, 2004; Zellner & Bäuml, 2005), with intralist and extralist cues (Watkins, 1975), and even in false memory settings (Bäuml & Kuhbandner, 2003; Kimball & Bjork, 2002; Reysen & Nairne, 2002).

Over the years, a number of explanations of part-list cuing impairment have been suggested (for reviews, see Nickerson, 1984, or Roediger & Neely, 1982). For instance, it has been proposed that the presentation of part-list cues introduces a competition bias for the noncue items and thus lowers these items' chances for being recalled (Roediger, 1973; Rundus, 1973) or that providing part-list cues disrupts some personal retrieval strategies and thus makes retrieval of the noncues less efficient (Basden & Basden, 1995). Although these explanations differ in the specific mechanisms assumed to underlie part-list cuing impairment, they share the view that, despite the recall impairment, the noncue items' memory representation remains unaffected.

These (noninhibitory) accounts of part-list cuing impairment contrast with a more recent account of the effect in terms of retrieval inhibition (Bäuml & Aslan, 2004, 2006; see also Anderson, Bjork, & Bjork, 1994). The inhibition account attributes the forgetting to long-term changes in the noncue items' representation itself. Specifically, it is assumed that, by providing part-list cues, the activation level of the noncue items is reduced so that the items are less likely to be recovered. At the heart of this explanation is the proposal that the presentation of part-list cues leads to early covert retrieval of the cue items and that this covert retrieval is similar in nature to overt retrieval of the same items, which, in studies on retrieval-induced forgetting, has been shown to inhibit nonretrieved items (for reviews of retrieval-induced forgetting, see Anderson, 2003, or Levy & Anderson, 2002). Part-list cuing impairment and retrieval-induced forgetting, therefore, should be functionally equivalent.[1]

That part-list cuing impairment is due to the covert retrieval of cue items rather than the mere strengthening of these items is indicated by a recent study by Bäuml and Aslan (2004). In their experiment, participants studied a list of items. After a distractor phase, a subset of the items was reexposed to the participants before a final memory test in which the not-reexposed items had to be recalled. Reexposure occurred in two groups of participants. The one group was told to study the items further (relearning), the other group was told to use the items as retrieval cues to recall the remaining items (part-list cuing). In the relearning condition, reexposure improved recall of the reexposed items but did not cause

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[1] There is some variation in the literature on when exactly a mechanism is called inhibitory. Some researchers speak of inhibition whenever a mechanism reduces accessibility of competing material, be it directly or indirectly. Others speak of inhibition only if a mechanism affects the competing material directly. In the present study, the latter view is taken and inhibition is assumed to affect the representation of other material directly. In this way, we follow the use of this term in the retrieval-induced forgetting literature (see Anderson, 2003).

impairment for the not-reexposed items, which replicates prior work (Anderson, Bjork, & Bjork, 2000; Ciranni & Shimamura, 1999). In contrast, in the part-list cuing condition, reexposure did cause forgetting of the not-reexposed items. This finding indicates that part-list cuing impairment reflects an instructional effect, with reexposure inducing forgetting only if participants are oriented to use the reexposed items as retrieval cues. Bäuml and Aslan argued that such orientation leads to covert retrieval of the cue items, which then inhibits the noncue items.

The assumption that part-list cuing induces covert retrieval of cue items is not a new one and is also part of previous noninhibitory accounts of the effect (Roediger, 1973; Rundus, 1973). Why should people covertly retrieve cue items that are already provided? In the Bäuml and Aslan (2004) study, part-list cues were provided before test and were removed before participants had to recall the noncues. Thus, to comply with the instruction and use the provided items as retrieval cues, participants had to (covertly) retrieve the cue items from memory (for similar demonstrations, see Oswald et al., 2006, or Roediger, Stellon, & Tulving, 1977). However, covert retrieval of cue items may also be involved if the part-list cues are provided at test and are present on the recall sheet. Indeed, participants do not always look on the cue items and, for instance, look on the stems for the noncue items as well. To follow the experimenter's instruction, the cue items then may periodically be reinstated from memory, which may be accomplished by covert retrieval.

To date, support for the inhibitory account of part-list cuing impairment comes mainly from studies that, within a single experiment, compared part-list cuing impairment and retrieval-induced forgetting directly and found neither qualitative nor quantitative differences between the two forms of forgetting. These studies include comparisons in veridical and false recall (Bäuml & Kuhbandner, 2003), the role of a delay between cuing/retrieval and the recall test (Bäuml & Aslan, 2004), and children's episodic memory (Zellner & Bäuml, 2005). The finding that both part-list cuing impairment and retrieval-induced forgetting occur across a wide range of memory tests, including recall, word completion, and item recognition (Anderson et al., 1994; Bäuml & Aslan, 2004; Hicks & Starns, 2004; Neely, Schmidt, & Roediger, 1983; Oswald et al., 2006; Peynircioğlu, 1989; Todres & Watkins, 1981), is also consistent with the inhibitory view.

The aim of the present study was to examine the inhibition account of part-list cuing impairment more directly than did previous studies by testing a crucial prediction of the account. As mentioned above, an important theoretical feature of inhibition is that it attributes the forgetting to long-term suppression of an item's representation itself rather than to changes in the item's associative structure (Anderson & Spellman, 1995; Bäuml, Zellner, & Vilimek, 2005; Hicks & Starns, 2004; Veling & van Knippenberg, 2004). In consequence, access to an inhibited item should be impaired irrespective of which retrieval cue is actually used to probe the item. For instance, retrieval practice of or cuing with the item *Curtain* should cause forgetting of the related item *Robe* not only when *Robe* is tested with the same retrieval cue as was used at study (e. g., COTTON) but also when it is tested with a novel, independent cue (e.g., CLOTHING). The property of cue independence distinguishes inhibition from alternative (noninhibitory) mechanisms of forgetting and is often considered a *sine qua non* for inhibition (Anderson, 2003). However, although this cru-

cial property has repeatedly been demonstrated in retrieval-induced forgetting (Anderson, Green, & McCulloch, 2000; Anderson & Spellman, 1995; Aslan, Bäuml, & Pastötter, in press; Saunders & MacLeod, 2006; Veling & van Knippenberg, 2004), it has not yet been investigated in part-list cuing impairment.

In the present study, we addressed the issue by using a variant of the independent-probe method. A methodological problem specific to the part-list cuing paradigm is that instructing participants to use some of the studied items as retrieval cues and simultaneously providing an independent probe within the same test would run counter to the logic of independent-probe testing. To circumvent the problem, we used a repeated-testing procedure with part-list cuing occurring in a first, same-probe test, but not in a second, independent-probe test. By using a similar repeated-testing procedure, though without independent-probe testing, researchers have recently shown that the detrimental effect of part-list cues can persist beyond the test in which the cues are provided and be observable in a subsequent second test in which the cues are removed (Bäuml & Aslan, 2006). On the basis of this recent finding, we examined in two repeated-testing experiments whether part-list cuing impairment reflects cue-independent forgetting.

Experiment 1

In Experiment 1, participants studied exemplars from several semantic categories and were then given a category cued-recall test in which half of a category's exemplars were provided as part-list cues for recall of the remaining (target) items. After a delay, a second recall test was conducted in which no part-list cues were provided. In this second test, target items were probed with novel, independent cues and the items' initial letters. We expected that the presentation of part-list cues in the first, same-probe test produced the standard detrimental effect on recall of noncue items. Of primary interest, however, was the outcome of the second, independent-probe test. If part-list cuing impairment was the result of an inhibitory mechanism, the induced forgetting should not only be lasting but also be cue independent. As a result, part-list cuing impairment not only should be present in the first, same-probe test but should be present in the second, independent-probe test as well. Alternatively, if part-list cuing impairment was the result of a noninhibitory mechanism, the forgetting should be restricted to the first, same-probe test and should be absent in the second, independent-probe test.

Method

Participants

Thirty-two students at Regensburg University participated in the experiment. They were tested individually.

Materials

The study material consisted of 48 items, 6 items from each of eight semantic categories. Six of the eight categories (COTTON, SOUP, SHARP, RED, LOUD, and FLYING) were drawn from Anderson and Spellman (1995, Appendices A and B); the remaining two categories (WOOD and SPORTS) were drawn from German category norms (Mannhaupt, 1983; Scheithe & Bäuml, 1995). The items of a category were divided into a set of three targets and a set of three

nontargets. The target items of a category were selected such that they were (implicitly) related to another, independent cue. For instance, the category COTTON consisted of the 6 items *Curtain, Napkin, Sheet, Pajamas, Robe*, and *Slacks*, 3 of which (the targets) were also related to the independent cue CLOTHING; the category SPORTS consisted of the 6 items *Swimming, Jogging, Dancing, Boxing, Karate*, and *Wrestling*, 3 of which (the targets) were also related to the independent cue FIGHT. The independent cue was not presented during study or during the same-probe test. Within a category, no 2 items began with the same letter.[2] Another 6 buffer items from three filler categories were included into the study list to control for primacy and recency effects.

Design

The experiment consisted of three main phases: An initial study phase followed by two successive test phases. In both test phases, only the target items were to be recalled. In the first, same-probe test, the category names were provided and the target items were tested either in the absence (*control condition*) or presence (*part-list cuing condition*) of the three nontarget items as retrieval cues. Half of the categories were assigned to the control condition, half to the part-list cuing condition. In the subsequent independent-probe test, memory for the target items was assessed in the absence of any part-list cues. This held regardless of whether part-list cues had been presented in the first test. Participants were provided with the independent cue and the unique first letter of the to-be-remembered target item.

Procedure

Study phase. The 54 items of the study list (8 × 6 experimental items plus 6 buffer items) were presented successively at a 5-s rate on a computer screen, each item together with its category name (e.g., COTTON–*Curtain*, COTTON–*Robe*). The order of presentation was randomized within six blocks. Each block consisted of one randomly selected exemplar from each of the eight categories with the restriction that a block's last item never belonged to the same category as the next block's first item. The resulting sequence was presented to one half of the participants. The other half was given the same sequence but in reversed order. At the beginning and the end of the list, 1 item from each of the three filler categories was presented as a primacy and recency control. Following the last item, participants engaged in a backward counting task for 1 min.

Same-probe test. Following the distractor task, the same-probe test was carried out. In the control condition, a category's three target items were tested successively by providing the category name and the unique first letter of the to-be-remembered item. Participants were asked to recall a studied word that fit the category-plus-first-letter cue within 5 s. The verbal responses were noted by the experimenter. The part-list cuing condition differed only in that a category's three nontarget items were provided in addition to the category name and the unique first letter of the to-be-remembered item. Participants were asked to read these items aloud and use them as retrieval cues for recall of the to-be-remembered (target) items of that category. The order of the part-list cuing and the control condition was counterbalanced across participants, as was the assignment of categories to the two

conditions. Following the last category, participants engaged in a 12-min distractor task in which they rated the attractiveness of faces.

Independent-probe test. After the second distractor task, the independent-probe test was carried out. Again, only a category's 3 target items were to be recalled. Items were tested successively with the independent probe and the unique first letter of the item as retrieval cues (e.g., CLOTHING-*R*____, given that *Robe* was studied under the category COTTON). Participants were instructed to try to remember a studied word that fit the cue within 3 s each. The items were tested in a block-randomized order. One testing sequence consisting of three blocks was constructed such that each block contained 1 randomly selected target item from each of the eight categories, with the only restriction that no 2 items from the same category were tested adjacently. The resulting random sequence of the 24 target items was presented to one half of the participants. The other half was given the same sequence but in reversed order.

Results and Discussion

The results are depicted in the upper row of Table 1. A 2 × 2 analysis of variance with the within-participants factors of testing (same-probe vs. independent-probe) and cuing (part-list cuing vs. control) showed a significant main effect of testing, $F(1, 31) = 34.0$, $MSE = 0.025$, $p < .001$, partial $\eta^2 = .52$, and a significant main effect of cuing, $F(1, 31) = 8.9$, $MSE = 0.054$, $p < .01$, partial $\eta^2 = .22$. These main effects reflect the higher overall recall in the same-probe test and the detrimental effects of part-list cuing. The interaction between the two factors was not significant, $F(1, 31) < 1$, indicating that the amount of forgetting did not differ across the two tests. Single comparisons revealed that the forgetting was present in both the same-probe test, $t(31) = 3.2$, $p < .01$, $d = .56$ (two-tailed), and the independent-probe test, $t(31) = 2.1$, $p < .05$, $d = .37$ (two-tailed).

The inhibitory account of part-list cuing impairment predicts that the detrimental effect of part-list cues should not only be present in same-probe tests but generalize to independent-probe tests. Indeed, if part-list cuing reduced the noncue items' representation, recall of the noncues should be impaired irrespective of which retrieval cue was actually used to probe the item. By using a repeated-testing procedure, the results of Experiment 1 support the inhibition view by indicating that part-list cuing impairment is not only present in same-probe tests but occurs with independent probes as well. The present findings also show that the effect of part-list cuing impairment can be lasting and persist for at least 12 min after the removal of the part-list cues. This finding replicates recent results showing the same pattern in a same-probe setting (Bäuml & Aslan, 2006) and extends it to the independent-probe procedure.

In Experiment 1, each target item was tested both on the first, same-probe test and on the second, independent-probe test. Because on the same-probe test more targets were recalled in the control condition than in the part-list cuing condition and because recall of an item can enhance its recall on a subsequent test (Hogan

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[2] English translations of the items from both experiments, which were originally in German, are available on request via e-mail.

Table 1

Percentage of Target Item Recall as a Function of Cuing Condition and Test Type

	Same-probe test				Independent-probe test			
	Part-list cuing		Control		Part-list cuing		Control	
Experiment	%	% SE	%	% SE	%	% SE	%	% SE
Experiment 1	56.8	3.3	70.8	3.5	42.2	3.4	52.6	4.0
Experiment 2	54.2	2.5	64.3	2.4	45.8	2.4	52.3	2.6

Note. In Experiment 1, recall performance in the two tests was based on the same target items. In Experiment 2, recall performance in the two tests was based on two separate sets of target items.

& Kintsch, 1971; Roediger & Karpicke, 2006), one might like to argue that the recall difference found in the independent-probe test was caused by the recall difference in the same-probe test. In this case, the results of Experiment 1 would be consistent with both inhibitory and noninhibitory accounts of part-list cuing impairment. Results from recent repeated-testing experiments let this case appear unlikely, however. They have shown that there is no simple relationship between the detrimental effect of part-list cues in the first test and the existence of the effect in a subsequent second test (Bäuml & Aslan, 2006; see also Basden & Basden, 1995, or Basden, Basden, & Galloway, 1977), which indicates that the results in the subsequent test do not just reflect strengthening effects as they may occur during the first test. Experiment 2 examines the issue directly.

Experiment 2

The goal of Experiment 2 was to replicate the results of Experiment 1 with different material and under conditions that exclude the possibility that the prior recall of items in the same-probe test causes the pattern of results in the independent-probe test. To reach this goal, only half of the targets were tested in the first, same-probe test, and the remaining half were tested in the second, independent-probe test. If part-list cuing induces long-term inhibition of the noncue items, forgetting should arise not only for those targets tested in the same-probe test but also for the targets tested in the independent-probe test. Because the targets in the independent-probe test had not been tested before, Experiment 2 has eliminated any confounding between the forgetting in this test and in prior testing. Thus, if forgetting arises in the second, independent-probe test, the effect is directly attributable to the presentation of the part-list cues in the first, same-probe test.

Method

Participants

Forty-eight students at Regensburg University participated in the experiment. They were tested individually.

Materials

The study material consisted of 56 items, 7 items from each of eight semantic categories. The items were drawn from the same

item pool as was used in Experiment 1. Three of the eight categories (LEATHER, GREEN, LOUD) were taken from Anderson and Spellman (1995; Appendix B); the remaining five categories (DISHES, INSECTS, TOOLS, TOYS, and MAMMALS) were taken from German category norms (Mannhaupt, 1983; Scheithe & Bäuml, 1995). In contrast to Experiment 1, however, 7 rather than 6 items were drawn from each of the eight categories. In this way, the number of target items per category was increased from 3 to 4. For instance, the category DISHES consisted of the 7 items *Tureen, Plate, Frypan, Spoon, Saucer, Pot*, and *Sugar Bowl*, 4 of which (the targets) were also related to the independent cue COFFEE; the category MAMMALS consisted of the 7 items *Pig, Rat, Deer, Elephant, Zebra, Lion*, and *Giraffe*, 4 of which (the targets) were also related to the independent cue AFRICA.

Design

Except for the procedural changes mentioned below, the design was identical to that of Experiment 1.

Procedure

The study phase and the subsequent distractor task were identical to Experiment 1. Like in Experiment 1, only the ($8 \times 4 = 32$) target items were tested, half of them in the same-probe test, the other half in the independent-probe test. Indeed, in both the control and the part-list cuing condition, only two of a category's four targets were tested in the same-probe test; the category's other two targets were tested in the independent-probe test. Between the two tests, a 10-min distractor task was carried out in which participants rated the attractiveness of faces. The assignment of a category's four target items to the same-probe test and the independent-probe test was counterbalanced across participants.

Results and Discussion

The results are depicted in the bottom row of Table 1. A 2×2 analysis of variance with the within-participants factors of testing (same-probe vs. independent-probe) and cuing (part-list vs. control) showed a significant main effect of testing, $F(1, 47) = 17.4$, $MSE = 0.029$, $p < .001$, partial $\eta^2 = .27$, and a significant main effect of cuing, $F(1, 47) = 15.6$, $MSE = 0.021$, $p < .001$, partial $\eta^2 = .25$. As in Experiment 1, these main effects reflect the higher overall recall in the same-probe test and the detrimental effects of part-list cuing. The interaction between the two factors was not significant, $F(1, 47) < 1$, indicating that the amount of part-list cuing impairment did not differ across the two tests. Again, single comparisons revealed that the forgetting was present in both the same-probe test, $t(47) = 3.3$, $p < .01$, $d = .48$ (two-tailed), and the independent-probe test, $t(47) = 2.2$, $p < .05$, $d = .32$ (two-tailed).

In Experiment 2, we attempted to eliminate possible effects of prior testing in the same-probe test on subsequent testing in the independent-probe test. This was accomplished by testing one half of the target items in the first, same-probe test, and the other half in the second, independent-probe test. The same pattern of results emerged as in Experiment 1, indicating that the results of Experiment 1 were not due to the repeated testing of the same target items. In particular, the detrimental effect of part-list cues observed in the same-probe test was still present when testing was

conducted with independent probes. This finding supports the view that the forgetting was caused by inhibition and, at the same time, challenges noninhibitory views of part-list cuing impairment, which predict that the forgetting should be restricted to same-probe testing. In addition, Experiment 2 provides another demonstration that part-list cuing impairment can be lasting and does not necessarily disappear if the part-list cues are removed (Bäuml & Aslan, 2006).

General Discussion

The goal of the present study was to examine the inhibition account of part-list cuing impairment by testing a crucial prediction of the account. According to inhibition, presenting part-list cues at test leads to covert retrieval of these items, causing long-term changes in the activation level of the remaining noncue items. Because inhibition is assumed to directly affect an item's representation, access to an inhibited item should be impaired irrespective of which retrieval cue is used to probe the item. This is exactly what we found in the present experiments. In both Experiment 1 and Experiment 2, the presentation of part-list cues caused forgetting of the remaining items regardless of whether these items were probed with the same retrieval cue as was used at study or with a novel, independent cue. As a further result, we replicated previous work by showing that the detrimental effect of part-list cuing can be lasting and does not disappear when the cues are removed in a subsequent memory test (Bäuml & Aslan, 2006).

These results are in line with related work on retrieval-induced forgetting. Indeed, by using several variants of the independent-probe procedure, a number of studies have consistently demonstrated that retrieval-induced forgetting is cue independent (Anderson, Green, & McCulloch, 2000; Anderson & Spellman, 1995; Aslan et al., in press; Saunders & MacLeod, 2006; Veling & van Knippenberg, 2004; but see Perfect et al., 2004, and Williams & Zacks, 2001, for failures to find the effect). Moreover, it has also been shown that the detrimental effects of overt retrieval practice on a subset of previously studied items can persist for at least 20 min (Anderson et al., 1994) and are not eliminated with repeated testing (Zellner & Bäuml, 2004). These parallels between part-list cuing impairment and retrieval-induced forgetting lend strong support to the view that part-list cuing impairment is mediated by the same mechanism as retrieval-induced forgetting, that is, retrieval inhibition.

The results of the present study cannot easily be explained by alternative accounts of part-list cuing impairment like retrieval competition (Rundus, 1973) or strategy disruption (Basden & Basden, 1995). Retrieval competition assumes that the presentation of part-list cues strengthens the cue items' representations, so that, during attempts to recall the noncues, the stronger cue items come to mind persistently and block access to the weaker noncue items. Such blocking from strengthened competitors should be circumvented, however, if the (weaker) noncue items were tested with independent probes that are not related to the (stronger) cue items. The present finding that part-list cuing impairment is not eliminated with independent probes thus seriously challenges the retrieval competition explanation of part-list cuing impairment (see Basden et al., 1977, or Bäuml & Aslan, 2004, for further evidence against retrieval competition).

Unlike retrieval competition, the strategy disruption hypothesis assumes that part-list cues lead to forgetting by forcing participants to use a serial recall order that is inconsistent with their personal retrieval strategy (Basden & Basden, 1995). Because strategy disruption attributes the forgetting to an ineffective retrieval process in the presence of part-list cues and not to long-term changes in the items' representations, the forgetting should disappear as soon as the cues are removed (Basden & Basden, 1995, p. 1657). The finding of significant forgetting in the second, independent-probe test, which occurred some time after the first test and in which no part-list cues were provided, thus challenges strategy disruption. Moreover, forcing participants to use experimenter-guided (random) retrieval "strategies"—as we did in both experiments when using the items' initial letters as item-specific cues—should disrupt participants' personal strategies more or less regardless of whether part-list cues are provided (Peynircioğlu, 1989). The finding of reliable part-list cuing impairment with such item-specific cues in the same-probe test of the two experiments therefore provides another challenge to strategy disruption (see Bäuml & Aslan, 2004, 2006, and Aslan & Bäuml, in press, for related results).

To rule out possible effects of prior testing on subsequent recall of the same items, in Experiment 2, we tested one half of the target items in the first, same-probe test and the other half in the second, independent-probe test. In doing so, some retrieval-induced forgetting may have occurred for the targets tested in the second test because of the prior retrieval of the other targets in the first test. If, for some reason, this effect was larger in the part-list cuing condition than in the control condition, then the forgetting in the independent-probe test might reflect retrieval-induced forgetting rather than "real" part-list cuing impairment. Possible retrieval-induced forgetting in the second, independent-probe test should have been influenced by the amount of retrieval practice and the degree of interference of the nonretrieved items in the first, same-probe test.

Indeed, prior work showed that retrieval-induced forgetting increases with the number of practiced items (Blaxton & Neely, 1983; Roediger & Schmidt, 1980; Rundus, 1973; Smith, 1971). Both in Experiment 1 and Experiment 2, more targets were recalled in the control condition than in the part-list cuing condition of the same-probe test. Because of this difference in amount of retrieval practice, more, rather than less, retrieval-induced forgetting should have arisen in the control than in the part-list cuing condition of the independent-probe test. Prior work also showed that retrieval-induced forgetting operates on an item-level basis so that not-to-be-retrieved items are inhibited depending on their individual interference potential (Anderson et al., 1994; Anderson, Green, & McCulloch, 2000; Bäuml, 1998; Bäuml & Hartinger, 2002). Accordingly, in the same-probe test, the not-to-be-retrieved targets should have induced the same degree of interference regardless of whether part-list cues were provided. Degree of interference, therefore, should not have led to differential retrieval-induced forgetting in the control and part-list cuing condition of the independent-probe test. In sum, if recall of targets in the same-probe test really induced retrieval-induced forgetting on targets tested in the independent-probe test, then, if anything, this effect should have reduced rather than increased the part-list cuing impairment.

In the present study, we used the independent-probe technique to examine the inhibition account of part-list cuing impairment as directly as possible. A concern regarding this technique might be that, during the independent-probe test, participants may have tried to use additional cue information beyond that provided by the independent probe. For instance, participants may have tried to reinstate the original category name and (covertly) use it as a cue rather than the novel, independent probe. Indeed, a participant may notice that the item *Robe*, tested with the independent probe CLOTHING, was originally studied under the category COTTON. This might lead the participant to associate the independent probe with the original category cue and, compromising the very logic of independent-probe testing, to use the original cue COTTON rather than the independent probe CLOTHING in following recall attempts (Perfect et al., 2004). Fortunately, however, there is evidence that the likelihood of such covert self-cuing strategies can be effectively reduced by taking some precautions in experimental design.

The precautions taken in the present experiments were similar to those used in previous studies on retrieval-induced forgetting (for a discussion, see Anderson, 2003). First, and perhaps the most crucial factor in reducing covert-cuing strategies, participants were forced to give their response within 3 s after presentation of the independent probe. In fact, Anderson, Green, and McCulloch (2000) demonstrated that covert cuing can be significantly reduced with such restrictive test times, an observation that was supported in further experiments (e.g., Johnson & Anderson, 2004). Second, because the presence of item-specific cues was argued to prevent participants from looking for additional cue information (Anderson, 2003), the targets' unique first-letter cues were provided in the independent-probe test. Third, the targets in the independent-probe test were tested unblocked. That is, a category's target items were tested apart from one another, thus limiting the extent to which trial-by-trial priming of the category could lead participants to use category names to augment memory search.

Finally, there may be reason to believe that the likelihood of covert cuing increases somewhat with each presentation of an independent probe. Accordingly, covert cuing may be reduced if the number of items tested with the same independent probe is reduced. Whereas prior work often used independent probes with four targets associated to it (e.g., Anderson & Spellman, 1995), in the present study we tested three (Experiment 1) or just two (Experiment 2) targets with the same independent probe. In particular, analysis showed that, in both experiments, part-list cuing impairment was not different for targets tested first with a certain independent probe than for targets tested second or third with an independent probe.[3] The forgetting, therefore, did not build up with repeated presentation of the independent probe. This finding, together with the precautions taken, casts serious doubt on the possible role of covert cuing in the present experiments.

Accounts of part-list cuing impairment have typically been one-mechanism accounts, suggesting that the detrimental effect is caused by a single mechanism, like retrieval competition, strategy disruption, or retrieval inhibition. On the basis of these one-mechanism accounts, the present results speak strongly in favor of retrieval inhibition and challenge noninhibitory accounts. More recently, however, a two-mechanism account of part-list cuing impairment has been suggested (Bäuml & Aslan, 2006), arguing that part-list cuing impairment may be caused by different mechanisms in different encoding situations. Concretely, it was sug- gested that part-list cuing impairment is mediated by retrieval inhibition in case of low associative encoding, that is, when no elaborated retrieval plans are built up, and by strategy disruption in case of high associative encoding, that is, when interitem associations and serial retrieval plans are established. Manipulating the degree of associative encoding directly within single experiments, the results of three experiments turned out to be consistent with the two-mechanism account (for further evidence in favor of the two-mechanism account, see Aslan & Bäuml, in press).

The present two experiments used encoding situations that mimic the conditions called low associative encoding in the previous study. We presented items from different semantic categories for one single learning trial and with no instruction to encode the items strategically. Such encoding conditions differ from those called high associative encoding in the previous study, in which repeated study-test cycles were used or participants were asked to encode the single items in terms of a common story (Bäuml & Aslan, 2006, Experiments 1 and 3). The present findings, therefore, are consistent with the two-mechanism account. They support the view that, with low associative encoding, part-list cuing impairment is mediated by retrieval inhibition.[4]

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[3] In the independent-probe test of Experiment 1, part-list cuing impairment was 12.5% for targets tested first with a certain independent probe, and 6.3% and 12.5% for targets tested second and third with an independent probe, $F(2, 62) < 1$. In the independent-probe test of Experiment 2, part-list cuing impairment was 5.7% for tested-first targets and 7.3% for tested-second targets, $F(1, 47) < 1$. Thus, in both experiments, testing position did not influence the part-list cuing impairment.

[4] The two-mechanism account predicts that, with high associative encoding, strategy disruption mediates part-list cuing impairment. Because strategy disruption reflects a noninhibitory account and thus should be present in same-probe tests only, cue independence should not be found with high associative encoding. This prediction cannot easily be tested. The test of cue independence, as used in this study, relies on repeated-testing situations, in which part-list cues are provided in the first test and independent probes are provided in the second. However, because strategy disruption predicts that the detrimental effect of part-list cues is eliminated once the cues are removed (Basden & Basden, 1995), the forgetting in the second test should disappear regardless of whether same-probe or independent-probe tests are used.

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