The Detrimental Effects of Part-Set Cueing on False Recall in a Random List Design

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The part-set cueing effect refers to the phenomenon that giving a subset of the list items as recall cues inhibits recall of the remaining items. We investigated whether part-set cueing reduced false recall in a random list design in which words from five semantically related sub-lists were intermixed. All participants memorized a list of 75 words. One group of participants was given five part-cue words from each sub-list and asked to recall all remaining words of the sub-list. Another group recalled the memorized list without cues. Both groups were given an unexpected subsequent free recall test. Results indicated detrimental part-cue effects in both list and critical non-presented word recall in the first recall test. In the final free recall test, these detrimental effects were long lasting when we employed a random list. The respective roles of retrieval-strategy disruption and retrieval inhibition in mediating the detrimental effects of part-set cues are discussed.

Over the past two decades, there has been considerable interest in false memories or memories for events that a person has never seen or experienced. Roediger and McDermott (1995) pioneered a new paradigm for false memory research based on earlier research by Deese (1959) that is now known as the Deese-Roediger-McDermott (DRM) paradigm. In the DRM paradigm, participants were asked to learn list words (e.g., *bed, rest*, etc.) that were all semantically associated with a critical non-presented word (e.g., *sleep*). Experiments using the DRM paradigm have revealed remarkable levels of both false recall and false recognition of critical non-presented words, and numerous studies have focused on boundary conditions for producing false memories (for reviews, see Gallo, 2006, 2010; Nabeta & Kusumi, 2010; Takahashi, 2002a, b, 2003).

The goal of the present research is to investigate the detrimental effects of part-set cueing on false recall in the DRM paradigm. Part-set cueing refers to the presentation of a subset of learned items as retrieval cues in the recall test. It is well known that such part-set cueing has detrimental effects on the recall of list words in contrast to no cue situations. Previous DRM research has demonstrated detrimental effects of part-set cueing for the critical non-presented words, as well as for the presented list words (Bäuml & Kuhbandner, 2003; Kimball & Bjork, 2002; Kimball, Bjork, Bjork, & Smith, 2008; Reysen & Nairne, 2002). Recently, Takahashi and Kawaguchi (2010a, b) manipulated part-set cueing using between-participants design (Basden, Basden, & Galloway, 1977; Slamecka, 1968, 1969; Sloman, Bower, & Rohrer, 1991) and tested whether or not part-set cueing would inhibit false recall. As a result, they replicated the previous findings (Bäuml & Kuhbandner, 2003; Kimball & Bjork, 2002; Kimball et al., 2008; Reysen & Nairne, 2002) and extended them by using between-participants manipulation of cueing.

Although several accounts have been provided for the part-set cueing effect (for reviews, see Nickerson, 1984; Roediger & Neely, 1982), there are at least two classes of accounts for detrimental effects of part-set cueing on recall. One account focuses on inhibition factors, whereas the other stresses strategy factors. One early inhibition account of the detrimental effects of part-set cueing relies upon retrieval competition (Rundus, 1973). This view suggests that the extra exposure given to cue words strengthens their memory traces relative to non-cue words. Because these strong memory traces are presumably more retrievable, they should effectively block retrieval of the weaker non-cued traces. Although the retrieval competition account is regarded by some researchers as an adequate account of the detrimental effects of part-set cueing (Kimball & Bjork, 2002; Kimball et al., 2008), the more popular inhibition account involves retrieval inhibition (Anderson, Bjork, & Bjork, 1994), which can be conceived as a direct manifestation of the retrieval competition.

Indeed, some recent research (e.g., Bäuml, 2002; Bäuml & Aslan, 2004) has suggested that part-set cueing and retrieval-induced forgetting are mediated by a similar mechanism, that is, retrieval inhibition. In a typical experiment focusing on retrieval-induced forgetting, participants are presented a categorized list, namely a list containing several word items from each of a number of different categories. A retrieval practice phase usually followed in which participants were asked to retrieve half of the items from each category, which were cued by partial word stems of these items. Not surprisingly, this sort of retrieval practice selectively facilitates later recall of the practiced items. At the same time, however, it appears to impair recall of those word items in the same list that received no practice (i.e., non-practiced items), relative to a control condition in which there is no retrieval practice (Anderson et al., 1994; for a review, see Levy & Anderson, 2002). Impairment of non-practiced items is explained by inhibition during the retrieval practice phase. That is, as practiced items receive retrieval practice, activation of competing non-practiced items is suppressed to reduce interference with retrieval of target-items; in turn, this causes a reduction in accessibility of non-practiced items on subsequent recall tests (Anderson, Bjork, & Bjork, 2000; Bäuml, 2002; Ciranni & Shimamura, 1999). It seems reasonable to assume that part-set cueing causes participants to retrieve cued items before the recall of non-cued items. Furthermore, retrieval of cued items, either overtly or covertly, may impair the recall of non-cued items by causing retrieval inhibition (Bäuml, 2002; Bäuml & Aslan, 2004). This explanation characterizes a retrieval inhibition account in that it attributes recall impairment of non-cued items to effects of part-set cueing that are associated with activation levels of stored memory traces.

Another class of accounts does not invoke activation levels in memory; instead, part-set cueing effects are attributed to the disruption of some retrieval-strategy (Basden & Basden, 1995; Basden et al, 1977; Sloman et al., 1991). The retrieval-strategy disruption account assumes that chunking based on either inter-item associations or on hierarchical associations formed during learning may contribute to an individual's retrieval-strategy. Thus one's attempt to use the stored chunking for an optimal retrieval can be disrupted by part-set cues during recall. Accordingly, participants adopt a less optimal retrieval strategy, and thus recall fewer of the non-cued items than in the no cue condition.

Thus a core difference between the retrieval inhibition and the retrieval-strategy disruption account rests with their respective emphases on changes in the levels of activation of stored memory traces. According to the retrieval inhibition account, memory traces are stronger for cued words due to their extra exposure; in turn, this implies long-lasting changes in the relative strengths of memory traces of cued versus non-cued items. In fact, Anderson et al. (1994) suggest that forgetting due to retrieval inhibition can last for at least 20 minutes. By contrast, in the retrieval-strategy disruption account, the impairment effect of part-set cueing is a transitory retrieval phenomenon that does not depend upon an enduring storage property, such as activation level. Because the retrieval-strategy disruption account attributes impairment to an altered retrieval strategy in the presence of cues, the removal of those cues should readily eliminate the detrimental effects.

Basden and his colleagues (Basden & Basden, 1995; Basden et al., 1977) tested this prediction using a design with an additional free recall test in which a non-cued recall test followed the cued recall test. They found that the detrimental effects of part-set cueing disappeared in the second non-cued recall test, presumably because this allowed participants to return to their original retrieval strategy. According to Basden and Basden (1995), this result argues strongly against any interpretation of the part-set cueing effect as entailing changes in stored memory traces.

Recently, Takahashi and Kawaguchi (2010b) examined whether or not the impairment of false recall disappears in a subsequent free recall test in the DRM paradigm. Following the retrieval-strategy disruption hypothesis, they predicted that the part-set cueing effect on recall of list words, which would appear in the first test, should disappear in the subsequent free recall test. Furthermore, given previous findings that part-set cues impair recall of list and critical non-presented words in the same manner (Bäuml & Kuhbandner, 2003; Kimball & Bjork, 2002), they also predicted that the impairment of critical non-presented words, which should emerge in the cued recall test, would disappear in the subsequent free recall test. In contrast, the retrieval inhibition account would predict the detrimental effects of the critical non-presented words, as well as those of the list words, in the first cued test. However, it could also predict no recovery of the part-set effects in the subsequent free recall test because it assumes forgetting due to retrieval inhibition can last for at least 20 minutes (Anderson et al., 1994).

Takahashi and Kawaguchi (2010b) found that the detrimental effects of false memories disappeared when cues were absent on a subsequent test. That is, part-set cueing affects list words and critical non-presented words in exactly the same manner. Their results are consistent with predictions based on the retrieval-strategy disruption account, and are not in line with the retrieval inhibition account (Bäuml, 2002; Bäuml & Aslan, 2004). In their experiment, the first 5-minutes test was followed by a 30 seconds interpolated task and the subsequent 5-minutes free recall test. This falls within the range of 20 minutes for the retrieval inhibition noted by Anderson et al (1994). Thus, the retrieval inhibition explanation predicts that the inhibitory effects of both list and critical non-presented words should remain in the subsequent free recall test used in their experiment. This prediction was not supported by their results.

However, Bäuml and Aslan (2006) demonstrated that the detrimental effects of part-set cueing for list words disappear in subsequent free recall tests characterized by a high degree of inter-item associations (e.g., a categorized item list), but the effect was long-lasting with lists characterized by a low degree of inter-item associations (e.g., an unrelated words list).

Accordingly, they suggested that, with high associative encoding, the part-set cueing effect is mediated by retrieval-strategy disruption and, with low associative encoding, it is mediated by inhibition. Takahashi and Kawaguchi (2010b) used a blocked list design to present study words where all 15 items of a sub-list are presented together. Such a situation was to encourage high integration of items within each sub-list and thereby increase the likelihood that participants rely upon the chunking based on inter-item associations.

In the present research, we use a random list design, in which words from all five of the DRM sub-lists are intermixed. Because this design aimed to discourage inter-item integration, we may observe a different pattern of results. Therefore, the purpose of the present experiment was to examine whether or not the impairment of false recall will be long-lasting in a subsequent free recall test using a random list. On the basis of Bäuml and Aslan's (2006) findings, we predicted that a part-set cueing effect on recall of list words, evident in the first test, should be long-lasting, namely unchanged, in a subsequent free recall test. With respect to the false recall, on the basis of the findings of our previous experiments and of previous research (Bäuml & Kuhbandner, 2003; Kimball & Bjork, 2002; Kimball et al., 2008; Takahashi & Kawaguchi, 2010a), which indicated that part-set cueing affects both recall of list words and critical non-presented words in the same manner, we expected that part-set cueing should have lasting detrimental effects on recall of both of these word types.

Method

Participants. The participants were 103 undergraduate students and 9 members of the community, all of whom had college degrees. They received either course credit or monetary compensation for participating in the experiment. Their ages ranged from 18 to 39 years (M=20.0, SD=3.2). They were randomly assigned to the two conditions with 56 participants in the no cue group and 56 participants in the cue group. Participants were tested either individually or in groups of up to 10. None had participated in any related memory experiments.

Design. A 2 (groups: no cue or cue) X 2 (word types: list words or critical non-presented words) X 2 (tests: first or second test) mixed factorial design was used, with groups manipulated between participants and word types and tests manipulated within participants.

Materials. As in our previous research (Takahashi & Kawaguchi, 2010a, b), we used a total list of 75 words, which comprised five shorter sub-lists, *devil, stairs, listen, electricity*, and *peace*, taken from Miyaji and Yama (2002). However, the words within the list were randomized, with the constraints that no more than three words from a given sub-list would appear in succession. We produced two randomly ordered lists, which was recorded by an audio tape player, designated list A and B, to avoid order effects. Half the participants were presented list A, the remaining half were presented list B.

Procedure. The participants were instructed to remember the words in a memory test that they would take. During the study phase, each of the 75 words was presented by an audio tape player at a rate of 2 seconds per word. Immediately following the study phase, participants were first given a three-digits number (i.e., 999) and asked to keep writing down every number (i.e., 999, 996, 993,…) obtained by counting backwards in threes as rapidly as possible, in 30 seconds. After this interpolated counting task to control the recency effect, the recall-test phase began.

In the recall phase, all participants were provided an answer sheet and pencil. The participants in the no cue group were simply asked to write down as many words as they could remember in any order. Those in the cue group were provided with 25 cue words composed of the five strongest associates from the original five 15-words sub-lists in their original order. That is, for the participants in cue group the answer sheet listed the 25 cue items in a left-hand column; these participants were told to check off all 25 cue items before starting to recall; then they should write down only non-cued words. All participants were instructed to write down only words that they were sure they had heard previously. They were given 5 minutes for the recall test.

Immediately after the first recall test, participants again were asked to write down a three-digits number obtained by counting backwards in threes as rapidly as possible, in 30 seconds. After this second interpolated counting task, all participants were given an unexpected free recall test. They were asked to write down, in any order, as many words as they could remember. In addition, the participants in the cue group were told that they could write down any cued words (i.e., 25 list words) from the preceding test as the words came to mind. After that the participants were debriefed.

Results

The dependent variable for all tests was the proportion of the 50 non-cued list words correctly recalled (i.e., 75 words minus 25 cued-words) and the proportion of falsely recalled 5 critical non-presented words. Non-critical intrusions, which occurred at a relatively low rate, were not analyzed because the data of interest were list and critical non-presented words. All analyses were considered significant at the $p=.05$ level, or lower, unless otherwise noted, and all post hoc comparisons were Tukey's honestly significant difference (HSD) in this article.

List and critical non-presented words. The proportions of recalled list items (i.e., the non-cued 50 words) and of critical non-presented words recalled in no cue and cue groups are shown in the Table 1. A 2 (groups) X 2 (word types) X 2 (tests) mixed factorial analysis of variance (ANOVA) was performed on recall scores. There was a significant interaction among the three factors, $F\ (1,\ 110)=13.20$, $MSE=.008$. There were also significant interactions between word types and tests, $F\ (1,\ 110)=9.17$, $MSE=.008$, and between groups and tests, $F\ (1,\ 110)=6.24$, $MSE=.01$. A main effect of test approached marginal significance, $F\ (1,\ 110)=6.51$, $MSE=.01$, $p<.10$. No other main effect or interaction approached significance.

To further understand the interactions, separate 2 (groups) X 2 (word types) ANOVAs were conducted on the data from the first and second tests. In the first cued test, there was only a significant main effect of group, $F\ (1,\ 110)=4.78$, $MSE=.02$. Neither the main effect of word type nor the interaction between these two factors approached significance. The results confirmed that, when using a random list, the presence of part-set cues significantly reduced recall of both list and critical non-presented words relative to giving no cues. Whereas, in the second (non-cued) recall test, there was only a significant interaction between groups and word types, F (1, 110)=7.58., MSE=.02. There were no significant main effects of group and word type. The post hoc test confirmed that the mean of the cue group (M=.16) was different (with marginal significance) from that of the no cue group (M=.21), thus showing that providing part-set cues still reduced recall of list words. On the other hand, recall of critical non-presented words showed the different pattern. Contrary to our prediction, recall by participants in the cue group (M=.23) was significantly higher than that in the no cue group (M=.17). The latter finding reveals a boost in false memories, i.e., of critical non-presented words.

Relations between the first and the second recall test. Visual inspection from the first to second recall tests of Table 1 shows that recall of list words does not change much whereas recall of critical non-presented words does. Therefore, to further understand the increase (i.e., release from the part-set cueing effect), separate 2 (groups) X 2 (tests) ANOVAs were conducted on the data from the list and critical non-presented words. In the list words, there was only a significant main effect of group, F (1, 110)=9.65, MSE=.01. Neither the main effect of word type nor the interaction between these two factors approached significance. That is, the release from the part-set cueing effects were absent both for the no cue group (1%) and the cue group (−1%). The absence of release from part-set cueing is consistent with the findings of Bäuml and Aslan's (2006) low degree of inter-item associations. However, in the critical non-presented words, there were significant main effect of test, F (1, 110)=6.95, MSE=.01, and significant interaction between these two factors, F (1, 110)=11.05, MSE=.01. But there was no significant main effect of group. The post hoc test confirmed that the release from the part-set cueing effect was present for the cue group (9%), but not for the non cue group (−1%). Thus, when the part-set cues were given on first recall, participants recalled less critical non-presented words than when the cues were removed on second recall.

Subjective organization. Since participants could divide a total list of 75 words into five sub-lists, it seems reasonable that participants may have encoded the words in an organized fashion. According to the retrieval-strategy disruption account, chunking based on inter-item associations formed during learning may contribute to an individual's retrieval-strategy. To examine whether part-set cueing disrupts participants' retrieval strategies, we calculated the adjusted ratio of clustering (ARC) scores (Roenker, Thompson, & Brown, 1971) of the 50 non-cued words as an indicator of subjective organization. The ARC scores range from −1.00 to 1.00, with 1.00 representing perfect organization and zero indicating no tendency beyond chance for recall in an organized fashion. We calculated ARC scores of 50 non-cued list words as an indicator of subjective organization. A 2 (groups) X 2 (tests) mixed ANOVA was performed on the ARC scores. There were no significant main effects of group and test. No interaction between these two factors approached significance. These results indicated that the cue group (M=.12) showed no lower ARC scores than the no cue group (M=.15) in the first test. On the other hand, although the cue group (M=.25) showed higher ARC scores than the no cue group (M=.16) in the subsequent free recall test, this difference did not reach significance.

Cue words recalled in the second recall test. As noted in the method section, the participants in the cue group were told that they could write down any of the 25 cue words, presented in the first free recall test, during the second free recall test (where they were not presented). It is interesting to compare these cued words with the comparable list words that were not cued for the no cue group. According to the retrieval inhibition account, these cued words should be recalled with greater frequency than comparable list words, because their memory traces are stronger. In contrast, according to the retrieval-strategy disruption account, there should be no significant differences between these words for two groups, as there are no changes in stored memory traces. Therefore we calculated the proportions of cue words (i.e., 25 list words) recalled in the second recall test. The result indicated that cue words were recalled at a significantly better rate for the cue group (M=.55) than for the no cue group (M=.32), t (110)=9.38, SE=.02. These results indicate that the memory traces of cue words are stronger, thereby resulting in favor of the retrieval inhibition account.

Table 1 *Mean Proportion of List and Critical Non-Presented Words Recalled in No Cue and Cue Group.*

	List words		Critical non-presented words	
	No Cue	Cue	No Cue	Cue
First recall				
	.20	.17	.18	.14
	(.01)	(.01)	(.02)	(.04)
Second free recall				
	.21	.16	.17	.23
	(.01)	(.01)	(.02)	(.03)

Note. Standard errors are in parentheses.

Discussion

In the random presentation format, we found that the typical impairment of list word recall, which appeared in the cued recall test, lasted when cues were removed in a subsequent free recall test. These results are consistent with the findings of Bäuml and Aslan (2006), which have demonstrated that the detrimental effects of part-set cueing for list words lasts longer in subsequent free recall tests with low degree of inter-item associations whereas the effect disappears when high degree inter-item associations are involved. As Takahashi and Kawaguchi (2010b) demonstrated, the absence of detrimental effects of part-set cueing on a subsequent free recall test has been interpreted as support for the retrieval-strategy disruption account. This is because this account implies that removal of the part-set cues should enable participants to return to their optimal retrieval strategy (Basden & Basden, 1995). In contrast, the retrieval inhibition account predicts that the detrimental effects of cues should be relatively long-lasting even if the cues are removed. This is because the cues should continue to impair the related items more than the non-cues.

Results of the present experiment clearly support the retrieval inhibition account. Therefore, together with results from our previous research (Takahashi & Kawaguchi, 2010b), these findings support Bäuml and Aslan's

(2006) claim that the part-set cueing effect is mediated by retrieval-strategy disruption in situations where high associative encoding is possible, but the part-set cueing effect is mediated by retrieval inhibition in situations where low associative encoding is involved.

A remaining issue concerns the unexpected finding involving false recall of critical non-presented words in the second recall test. In the first recall test, we replicated the results of Takahashi and Kawaguchi (2010b), which showed that part-set cues impaired recall of both list and critical non-presented words. However, in the second free recall test, the cue group produced more false recalls than the no cue group. Recall of critical non-presented words did not parallel that of words actually presented in a study list. These results are consistent with some previous research using the immediate recall tests (Marsh, McDermott, & Roediger, 2004; Reysen & Nairne, 2002). For example, Marsh et al. (2004) found a detrimental effect of part-set cueing for list words, with randomly selected cues having no effect on the recall of the critical non-presented words. Further, Reysen and Nairne (2002) found that presenting consistent cues, which comprised the even numbered list words form the original list, reduced the part-set cueing effect for the list words, but not for the critical non-presented words. It should be noted that the types of cues used differ across experiments. In the present study, the cue words were always strongly associated to critical-non presented words. In contrast, these associations were weaker in the previous research (Marsh et al., 2004; Reysen & Nairne, 2002). Therefore, it remains unclear whether the present result using strongly associated cues can be generalized to a wide range of cuing scenarios.

It should also be noted that the overall level of recall of critical non-presented words in present experiment was lower than that of Takahashi and Kawaguchi (2010b). This pattern of the results is consistent with the previous study showing lower false recall rates occur with random than with blocked presentations (McDermott, 1996; Toglia, Neuschatz, & Goodwin, 1999). However, given the low level of false recalls (M=.17) for the non cue group in the second recall, this result should be treated with caution, as a genuine release effect may have been masked with some unknown factors.

Why does part-set cueing reduce false memories using a random list? One possible explanation for the reduction of false recalls might derive from the retrieval inhibition hypothesis. Providing part-set cues presumably induces the retrieval inhibition. A key feature of the retrieval inhibition hypothesis is that the practiced and non-practiced items share the same associations prior to the experiment. As noted in the introduction, list words used in the DRM paradigm are all semantically associated with the critical non-presented words. Therefore, a retrieval inhibition explanation would contend that part-set cueing, in this case cueing that provides the opportunity for retrieval practice, should decrease the activation levels of both non-cued list words and the critical non-presented words that are semantically activated by the list. This explanation suggests that both list and critical non-presented words will be inhibited by the presence of part-set cueing. This pattern was obtained in the present study as well as in previous studies (Bäuml & Kuhbandner, 2003; Kimball & Bjork, 2002; Kimball et al., 2008; Reysen & Nairne, 2002). Furthermore, as noted earlier, Bäuml and Aslan (2006) demonstrated that the detrimental effects of part-set cueing for list words persisted to affect subsequent free recall tests with a low degree of inter-item associations. This result too favors the retrieval inhibition account.

On the basis of previous findings (Bäuml & Kuhbandner, 2003; Kimball & Bjork, 2002; Takahashi & Kawaguchi, 2010a, b), which indicate that part-set cueing affects recall of both list words and non-presented critical words in the same manner, one might predict that the impairment of critical non-presented words should also persist to affect subsequent recall tests. We tested this prediction about cueing effects using a random item presentation. However, we failed to confirm the predicted pattern, although the impairment effect on recall for list words lasted during the second free recall. In addition, we used only one kind of list word (i.e., strong associates) as part-set cues. Accordingly, it is possible that the predicted pattern of results will emerge with another type of part-set cues. Future research should examine if the detrimental effects of the critical non-presented words, as well as those of the list words, could have lasting effects in another type of cueing.

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Notes

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