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BUILDUP OF PROACTIVE INTERFERENCE IN JAPANESE *KANJI* LEARNING

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The discriminative assumption on buildup of proactive interference in short-term memory predicts that when intertrial similarity of items is high, the proactive interference is built up while interlist similarity of items is low, the proactive interference is not built up. To test the discriminative assumption in Japanese *Kanji* learning, intertrial similarity was changed by the acoustic, the radical (as one of the figurative properties), and the radical plus semantic properties in *Kanji*. For the acoustic and the radical plus semantic properties, the proactive interference was built up in the non-discriminative list with high intertrial similarity but not built in the discriminative list with low intertrial similarity, which supported the prediction. The prediction was not supported for the radical property. The findings were discussed with reference to the discriminative function of these properties as memory cues.

Since Keppel and Underwood (1962) found proactive interference in short-term memory by using the Brown-Peterson paradigm, many experiments have been performed on buildup and release of proactive interference (e.g., Kikuno, 1983; Mori, 1979; Radtke & Grove, 1977; Radtke, et al., 1982; Watkins & Watkins, 1975; Wickens, 1970). In the typical research paradigm on buildup of proactive interference, subjects are given successively three or four trials of three items in each trial. When the subjects' performances decrease with increasing trials, buildup of proactive interference is documented. Among several factors affecting buildup of proactive interference, intertrial similarity of items is assumed to be one of the most important determinants.

Fujita (1985) examined effects of the interlist similarity on buildup of proactive interference by using the items of taxonomic categories. Each list had four trials of three items in each. For the non-discriminative list all trials had three items of the same category (e.g., flower) and for the discriminative list each trial had three items of four different categories (e.g., four-footed animals, fruits, fish, and carpenter's tools). The percent correct recall decreased significantly with increasing trials for the non-discriminative list, whereas the percent did not change with trials for the discriminative list. Since the discriminative list has the items of quite different categories in each trial, the items in each trial are encoded and retrieved distinctively by using the different category names as memory cues. Thus the proactive interference is not built up. Since the non-discriminative list has the items of the same category in all trials, on the other hand, only one category name is used as the

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memory cue. Thus it is difficult to encode and retrieve dintinctively the items in each trial and the proactive interference is built up. These suggest that decrease in discriminative function of memory cues is important for the buildup of proactive intereference.

The purpose of this study is to examine buildup of proactive interefence in Japanese *Kanji* lists in stead of the category lists. To our knowledge, there has been no study on *Kanji* lists. As is already indicated, every *Kanji* has acoustic, figurative, and semantic properties (e.g., Kaiho & Nomura, 1983). To examine the effects of intertrial similarity in *Kanji*s' properties on proactive interference, the discriminative and the non-discriminative lists are provided for the acoustic (Experiment 1), the figurative (Experiment 2), and the figurative plus semantic (Experiment 3) properties. If the discriminative assumtion proposed by Fujita (1985) is true for learning the *kanji* lists, it is predicted in the three experiments that proactive interference is built up for the non-discriminative lists but not built up for the discriminative lists.

Experiment 1

Method

Design and subjects: A2 (list) × 3 (trial) factorial design was used. The subjects were 48 college students with a mean age of 19:8 (18:3–24:4) and were divided into two groups for the discriminative and the non-discriminative lists, respectively.

Items and lists: Table 1 shows the items and lists used in Experiment 1. The non-discriminative and the discriminative lists had two types of list in each For the non-discriminative lists the three items in all trials had the same acoustic property: all items in List 1 had an acoustic property of "kan" and those in List 2 had "tou" For the discriminative lists the three items in each trial had quite different acoustic properties: List 1 had "kan", "you", and "kei" in the first, the second, and the third trials, respectively, and List 2 had "tou", "kai", and "sin" in the same order of trials

Procedure: The items were presented by Kodak Ektagraphic Slide Projecter with the time regulation system by Sanwa Digital Time Regulator. The subjects were given List 1 and List 2 (or List 2 and List 1) and the interlist interval of 120 sec. The three items in the first trial were presented simultaneously during 2.5 sec. After that a three-digit number (e.g., 986) was presented during 20 sec. and the subjects was required to count backward by three from the number and to verbalize them. After that the subejct was required to recall the items by writing in the first trial during 15 sec. After the intertrial interval of 2.0 sec., the second trial was started. Thus each trial had presentation of the items, the count backward task, and recall of the items

Table 1. List items used in Experiment 1

List condition	trial	List 1			List 2		
		1	2	3	1	2	3
Discriminative		刊	曜	景	当	解	信
		漢	用	警	等	回	新
		館	容	系	統	械	臣
Non-Discriminative		刊	観	感	当	燈	糖
		漢	完	簡	等	投	討
		館	幹	看	統	党	登

Results Since the performances in the two types of list were about the same for the discriminative and the non-discriminative lists, respectively, these were pooled for statistical analyses. Fig. 1 shows the mean percents of correct recall for the two lists.

A 2 (list) × 3 (trial) analysis of variance was performed by the use of arcsin transformed scores. The main effect of list was significant ($F=4.72$, $df=1/46$, $p<.01$), which showed that the mean percent was larger for the discriminative than for the non-discriminative lists. The main effect of trial was significant ($F=22.18$, $df=2/92$, $p<.01$), which showed that the mean percent decreased with trials. Since the interaction was significant ($F=9.07$, $df=2/92$, $p<.01$), several simple effects were examined. For the discriminative list the percent did not change with trials. For the non-discriminative list, on the other hand, the percent decreased significantly with increasing trials ($p<.01$ for Trial 1 vs. Trial 3). Although the percents of the two lists were about equal in the first trial, the discrepancy between the two lists became larger with increasing trails and was significant ($p<.01$) in the third trial. As was predicted, the findings showed that proactive interference was built up for the non-discriminative list but not built up for the discriminative list.

Experiment 2

Method

Design and subjects. A 2 (list) × 3 (trial) factorial design was used. The subjects were 48 college students with a mean age of 19·5 (18:6–21:11) and were divided into two groups

Items and lists. Table 2 shows the items and lists used in Experiment 2 The non-discriminative and the discriminative lists had two types of list in each. For the non-discriminative lists the three items in all trials had the same radical as one of the figurative properties all items in List 1 had a *tehen* (a left part of *Kanji*) and those in List 2 had a *gyoninben* (a left part of *Kanji*) For the discriminative lists the three items in

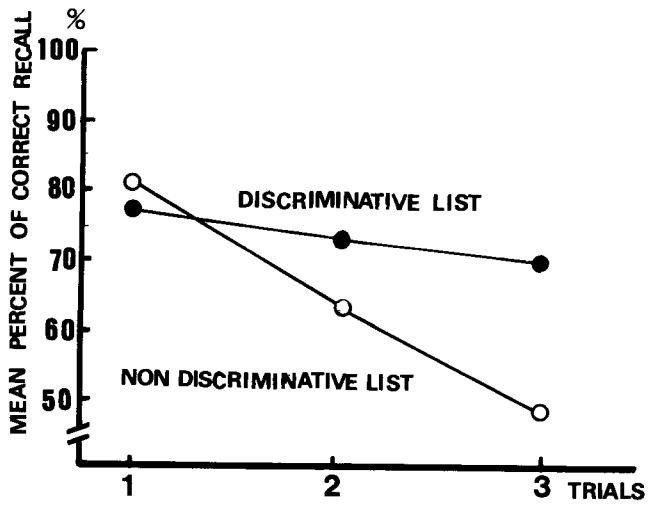

Fig. 1. Mean percents of correct recall in each trial (Exp 1).

Table 2. List items used in Experiment 2

list condition	trial	list 1			list 2		
		1	2	3	1	2	3
discriminative		拡	宣	連	徒	陽	忠
		授	宗	退	役	陛	恩
		批	実	造	復	険	念
nondiscriminative		拡	拝	担	徒	径	往
		授	採	技	役	得	後
		批	接	推	復	律	従

each trial had quite different radicals. List 1 had a *tehen* (a left part), a *ukanmuri* (a top part), and a *shinnyo* (a left-bottom part) in the first, the second, and the third trials, respectively, and List 2 had a *gyoninben* (a left part), a *kozatohen* (a left part), and a *shitagokoro* (a bottom part) in the same order of trials.

Procedure. The procedure was the same as Experiment 1.

Results

Since the performances in the two types of list were about the same for the discriminative and the non-discriminative lists, respectively, these were pooled for statistical analyses. Fig. 2 shows the mean percents of correct recall for the two lists.

A 2 (list)×3 (trial) analysis of variance was performed by the use of arcsin transformed scores. The main effect of list was significant ($F=4.61$, $df=1/46$, $p<.01$), which showed that the mean percent was larger for the discriminative than for the non-discriminative lists. The main effect of trial was also significant ($F=19.11$, $df=2/92$, $p<.01$), which showed that the mean percent decreased with trials. The percent decrement tended to be larger for the non-discriminative than for the discriminative lists. Since the interaction was not significant ($F=1.44$, $df=2/92$,

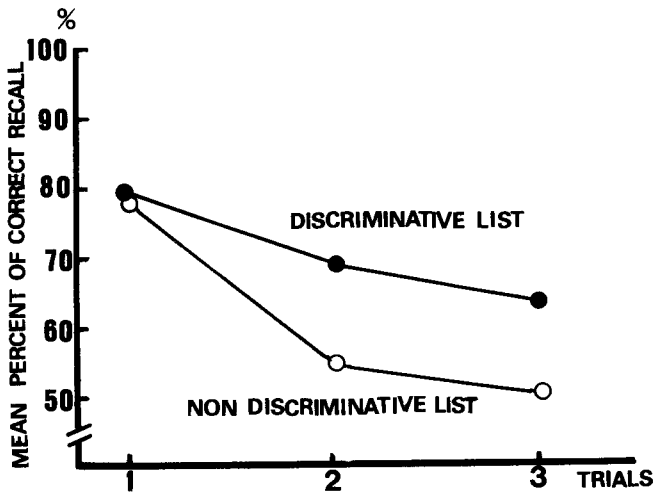

Fig. 2. Mean percents of correct recall in each trial (Exp. 2).

$p > .10$), however, our prediction was not supported.

EXPERIMENT 3

Method

Design and subjects: A 2 (list) × 3 (trial) factorial design was used. The subjects were 42 college students with a mean age of 19:3 (18:3–23.7) and were divided into two groups.

Items and lists: Table 3 shows the items and lists used in Experiment 3. The non-discriminative and the discriminative lists had two types of list in each. For the non-discriminative lists the three items in all trials had the same radical and the same meaning represented by the radical. all items in List 1 had a *sanzui* (a left part of *Kanji*) as a radical and the same meaning about "water" represented by the *sanzui*, and those in List 2 had a *gonben* (a left part of *Kanji*) as a radical and the same meaning about "word and speech" represented by the *gonben*. For the discriminative lists the three items in each trial had quite different radicals and meanings represented by the radicals. List 1 had a *sanzui* (a left part) and the meaning "water" represented by the radical, a *gonben* (a left part) and the meaning "word and speech" represented by the radical, and a *kihen* (a left part) and the meaning "tree" represented by the radical in the first, the second, and third trials, respectively. List 2 had a *itohen* (a left part) and the meaning "cloth" represented by the

Table 3. List items used in Experiment 3

list condition	trial	list 1			list 2		
		1	2	3	1	2	3
discriminative		海	説	材	絹	葉	投
		河	評	植	結	菜	拾
		港	詞	板	綿	花	指
nondiscriminative		海	波	流	説	話	談
		河	湖	泳	評	講	論
		港	洋	漁	詞	訓	訳

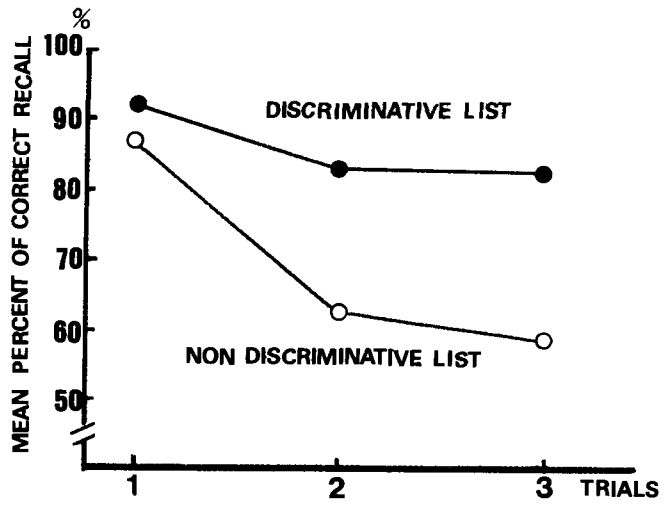

Fig. 3. Mean percents of correct recall in each trial (Exp. 3).

radical, a *kusakanmuri* (a top part) and the meaning "plant" represented by the radical, and a *tehen* (a left part) and the meaning "hand" represented by the radical in the same order of trials.

Procedure. The procedure was the same as Epxeriment 1.

Results

Since the performances in the two types of list were about the same for the discriminative and the non-discriminative lists, respectively, these were pooled for statistical analysis. Fig. 3 shows the mean percents of correct recall for the two lists.

A 2 (list) $\times 3$ (trial) analysis of variance was performed by the use of arcsin transformed scores. The main effect of list was significant ($F=9.85$, $df=1/40$, $p<.01$), which showed that the mean percent was larger for the discriminative than for the non-discriminative lists. The main effect of trial was significant ($F=14.45$, $df=2/80$, $p<.01$), which showed that the mean percent decreased with trials. Since the interaction was significant ($F=2.25$, $df=2/80$, $p<.10$), several simple effects were examined. For the discriminative list the percent did not change with trials. For the non-discriminative list the percent decreased significantly with increasing trials ($p<.01$ for Trial 1 vs. Trial 3). Although the percents of the two lists were about the same in the first trial, the discrepancy between the two lists became larger with increasing trials and was significant in the second ($p<.05$) and the third ($p<.01$) trials. As was predicted, the findings showed that proactive interference was built up for the non-discriminative list but not built up for the discriminative list.

Discussion

According to the discriminative assumption on buildup of proactive interference in short-term memory which proposed by Fujita (1985), intertrial similarity of items has an important role in buildup of proactive interference. When the intertrial similarity of list items is high, the discriminative function of memory cues decreases and then the items in each trial are not encoded and retrieved distinctively. Therefore, the proactive interference is built up easily. When the intertrial similarity of list items is low, the discriminative function of memory cues increases and then the items in each trial are encoded and retrieved distinctively. Therefore, the proactive interference is not built up. Fujita (1985) found by using the items of taxonomic categories that the proactive interference was built up for the non-discriminative list with high intertrial similarity while the interference was not built up for the discriminative list with low intertrial similarity. The findings were interpreted as supporting the discriminative assumption.

In the present study a new attempt was made to apply the discriminative assumption of proactive interference to Japanese *Kanji* learning. The non-discriminative list with high intertrial similarity and the discriminative list with low intertrial similarity were provided for the acoustic (Experiment 1), the figurative (Experiment 2), and the figurative plus semantic (Experiment 3) properties. According to the discriminative assumption, it was predicted that the proactive

interference was built up for the non-discriminative lists but not built for the discriminative lists. That is, correct recall of the items decreases with increasing trials significantly for the non-discriminative list, whereas that does not change with trials for the discriminative list.

When the intertrial similarity of items was changed by the acoustic properties of *Kanji*, the percent correct recall decreased with trials significantly for the non-discriminative list, whereas the percent did not change with trials for the discriminative list. Thus the findings supported the discriminative assumption. Since for the non-discriminative list only one acoustic property is used as a memory cue in all trials, the discriminative function of the memory cue decreases with trials. Thus the proactive interference is built up. Since for the discriminative list the quite different properties are used as memory cues in each trial, on the other hand, the discriminative function of the memory cues does not decrease with trials. Thus the proactive interference is not built up.

When the intertrial similarity of items was changed by the figurative properties of *Kanji*, the percent correct recall decreased with trials for the non-discriminative and the discriminative lists. These findings are not consistent with the discriminative assumption. In this experiment the radicals of *Kanji* were used as one of the figurative properties. Since the radicals are only one portion of each *Kanji*, however, the radicals are assumed not to serve as the distinctive memory cues for the discriminative list, which may result in the recall decrement. Although the interaction was not significant, the recall decrement tended to be larger for the non-discriminative than for the discriminative lists. This finding suggests that for the discriminative list some subjects may notice the differences of radicals in the three trials and use each radical as the memory cue. Before we draw a definite conclusion on the figulative properties of *Kanjis* in general, further studies on the other figurative properties than the radicals are needed.

When the intertrial similarity of items was changed by the multiple (radical and semantic) properties of *Kanji*, the results supporting the discriminative assumption were obtained. That is, for the non-discriminative list the percent correct recall decreased significantly with trials and the proactive interference was built up. For the discriminative list the percent correct recall did not change with trials and the proactive interference was not built up. The comparison of Fig. 2 with Fig. 3 reveals the effects of semantic properties on correct recall. First, the percent recall is larger for Fig. 3 than for Fig. 2 as a whole. This suggests that encoding and retrieving in memory processes are facilitated by the semantic cues. Second, the percent decrement for the non-discriminative list and the percent non-decrement for the discriminative list are more evident for Fig. 3 than for Fig. 2. This suggests that the memory cues of *Kanji* become more clear by adding the semantic properties. In this study, however, the effects of the semantic property only on buildup of proactive interference are not known. So, further studies are needed on this point.

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