PICTURES AND WORDS AS STIMULUS ITEMS IN PAIRED ASSOCIATE LEARNING: A SUBPROCESS ANALYSIS¹

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The purpose of this study was to assess the effects of pictures and words as stimulus items in PAL by subprocess analysis. College students studied word-word pairs or picture-word pairs for 1 or 2 trials. They were then tested on the acquisition of stimulus items, response items, or S-R pairs by a recognition (Exp. I and II) and a recall methods (Exp. III). The results of three experiments were highly consistent in that the picture-word difference was found only in the stimulus acquisition process but not in the others. The results suggest that the superiority of picture stimuli in PAL is not in the process of S-R association.

It was commonly observed that *Ss* learned more easily a paired associate learning (PAL) task when stimulus items were presented as pictures rather than words. The superiority of picture or object has been explained in several ways. Wimer and Lambert (1959) found that intralist discriminability was greater among object stimuli than word stimuli, and this suggested that the picture-word difference in PAL was attributable to the difference in this discriminability. On the other hand, Paivio (1969, 1971) assumed that picture stimuli elicit images more easily than word, and that the imagery can serve a mediating function.

It has been considered that PAL consists of some subprocesses. For example, Martin (1967) and Underwood, Runquist and Shulz (1959) assumed two processes in PAL, and Morikawa (1965) and Wollen

and Lowry (1971) assumed three. The first attempt to analyze the effect of picture and word on these subprocesses was made by Wicker (1970). Employing a similar procedure to Martin (1967), he examined differential effects of picture and word stimuli upon stimulus recognition and S-R association. Following a study trial, *S* was first tested for recognition of the stimulus items and then asked to recall responses to the stimulus items. Wicker obtained the results that stimulus recognition and associative recall were better for picture stimuli than word, but that the picture-word difference in S-R association disappeared when associative recalls were counted only for correctly recognized stimuli. These results suggested that the locus of picture-word difference in PAL was only in the stimulus recognition process. His later studies reported almost similar results (Wicker, 1971; Wicker & Everston, 1972).

Lynch and Rohwer (1971), relying on the assumption by Underwood, et al. (1959), tested the hypothesis that sentential elaborations of lists would affect only associative learning process in PAL and pictorial elaborations only response learning process. Following a study trial, half the *Ss* were first asked to recall or recognize

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the response items, and then to perform the matching task in which all stimuli and responses were presented at the test trial. The remaining *Ss* were tested in the reverse order. The matching task was assumed to assess associative learning independent of response learning. The hypothesis was partially supported.

The effects of picture and word stimulus items upon PAL can be more specified by the use of subprocess analysis. The *Ss* in the previous studies were first tested for one of the two processes and then for the other. So the performance on the latter process should be affected by testing the former one. In order to assess the pure picture-word difference, therefore, an *S* was tested only for one process in the present study. The three processes tested in this study were named stimulus acquisition, response acquisition, and S-R association. Three experiments are reported. Two processes, stimulus acquisition and S-R association, were tested in Experiment I and three process in Experiments II and III.

EXPERIMENT I

Method

Design and subjects. A 2×2 factorial design was used. The first factor was two kinds of stimulus items in PAL task (picture vs. word), and the second factor was two processes tested in the test trial (stimulus acquisition vs. S-R association). The *Ss* were 40 female college students. They were divided into four groups of 10 *Ss* each.

Materials. Two lists of 16 pairs were constructed, which differed only in the mode of stimulus items. The stimulus items for one list consisted of concrete nouns written in Japanese Hiragana and their line drawings for the other list. These nouns were three- or four-letter words, and were selected from the concreteness-value table of 247 nouns by Sugimura and Kuriyama (1972). Concreteness was referred to persons, objects, or materials and its value was defined by the percent of *Ss* who

judged a noun as concrete. The values of 16 nouns were 80% or above, with the mean of 91.5%. The response items were consisted of 16 two-letter nonsense syllables in Japanese Katakana selected from the nonassociation-value table by Umemoto, Morikawa and Ibuki (1955). Their values ranged from 50% to 54%. Stimulus and response items were so paired that no association due to meanings and pronunciations would occur for any pairs. Some examples of pairs were Rōsoku (candle)—Tsunu (nonsense syllables), Sakura (cherry)—Hiho, Ribon (ribbon)—Mewa, etc. The stimulus and response items of each pair were put on the white tape, side by side, with black felt pen and presented through a frame of 5 cm $\times$ 16 cm by Tayōto Learning Apparatus, Sanwa K. K. Two different presentation orders were provided for each list.

Two lists of 32 nouns were constructed for stimulus recognition test. The items of one list consisted of words and those of the other list their drawings. 16 of 32 nouns were identical to the stimulus items of original pairs, and the remaining nouns served as distractors which were selected from the concreteness-value table. Each item was given on a 6 cm $\times$ 12 cm white card with black felt pen. The original items and distractors were arranged in random order.

Procedure. The *Ss* were run individually. Sitting on the chair faced to the apparatus, they were instructed to remember several word (or picture and word) pairs which would appear on the apparatus one by one. They were also instructed that the same pairs would appear twice but in different orders. Each pair was presented for 5 sec and the interlist interval was 10 sec.

Immediately following these study trials, the *Ss* were tested the recognition memory of stimulus items or S-R pairs. The *Ss* tested the stimulus recognition were given the instruction that they were presented some words (or pictures) to which they had to respond by saying "Yes" if they thought to have seen it before, and "No" if they thought not. The stimulus recognition cards were shown at a 5-sec rate, one by one. The *Ss* tested the S-R association

were given an answering sheet on which all stimulus items (words or pictures) were printed on the top half of the sheet and all response items (nonsense syllables) on the bottom half. The stimulus and response items were arranged in a 4×4 matrix, respectively. The Ss were asked to reconstruct the previously learned pairs. The testing time was a maximum of 3 min.

Results

The mean numbers of correct identifications of the stimulus items were 15.5 for the picture stimuli and 13.1 for the word stimuli, respectively. The difference was significant at the 1% level with $t(18)=4.35$. The mean number of correct pairings of stimulus and response items was 4.4 and 4.6 in the same order. The obtained results indicated that the superiority of picture over word stimuli was found only in the process of stimulus acquisition but not in that of S-R association.

EXPERIMENT II

The purpose of this experiment was to assess the effect of picture and word stimuli upon the acquisition of stimulus items, response items, and S-R pairs, under a different experimental setting from Experiment I.

Method

Design and subjects. A 2×3 factorial design was used. The first factor was two kinds of stimulus items in PAL (picture vs. word), and the second factor was three processes assessed in the test trial (stimulus acquisition, response acquisition, and S-R association). The Ss were 180 freshmen of a women's junior college. They were assigned to one of the six groups and were run in groups of 9 to 11. The number of Ss in each group is shown in Table 1.

Materials. Two lists of 14 three-letter noun pairs were constructed. The stimulus items were concrete nouns for one list, and their line drawings for the other. The response items for both lists consisted of abstract nouns. All

nouns were selected from the table by Sugimura and Kuriyama (1972). The concreteness values were 80% or above ($\bar{X}=91.4\%$) for concrete nouns and 30% or below ($\bar{X}=16.4\%$) for abstract nouns. Stimulus and response items were randomly paired with the restriction that no association due to meanings and pronunciations would occur for any pairs. Some examples of pairs were Ribon (ribbon)—Kūki (air), Nezumi (rat)—Jikan (time), Basketsu (bucket)—Fushigi (wonder), and so on. Additional two pairs were constructed for practice trials. The stimulus and response items in each pair were put on the white tape, side by side, with black felt pen and presented through a frame of 10 cm×22 cm by Tayōto Learning Apparatus.

For recognition test two lists of 36 three-letter nouns were constructed, one of which was for the stimulus recognition test and the other for the response recognition test. 14 words of the stimulus recognition list were the stimulus items of original pairs and additional 22 were concrete nouns as distractors. Similarly, 14 words of the response recognition list were the response items of original pairs and additional 22 abstract nouns served as distractors. The presentation order and its corresponding word were given on a 10 cm×27 cm white card with black felt pen, side by side. The original items and distractors were arranged in random order.

Procedure. The Ss were run in groups of 9 to 11 by E and an assistant. They were seated at the table in front of the apparatus. A practice pair was presented and Ss were asked to learn this word (or picture and word) pair. After the presentation of another practice pair, they were given the instruction that several pairs as these would be presented one by one and that they must remember them as many as possible. Pairs were presented at a 2-sec rate.

Immediately following this study trial, answering sheets were distributed to Ss, one for each, to test the recognition memory of stimulus items, response items, or S-R pairs. The same answering sheets were employed both for stimulus recognition and response recognition tests. On this sheet, the numbers 1 through 36 were printed in three columns. The Ss

TABLE 1
Number of Ss and mean number of
correct responses (Exp. II)

Stimulus item		Recognition test		
		Stimulus	Response	S-R pair
Picture	<i>N</i>	30	28	30
	$\bar{X}$	12.5	10.5	3.2
	<i>SD</i>	2.4	2.2	2.1
Word	<i>N</i>	30	31	31
	$\bar{X}$	10.5	10.3	3.3
	<i>SD</i>	2.1	2.7	2.8

tested the stimulus recognition were presented 36 words one by one, and were instructed to circle the number of the word they thought to have seen before on the left side of the apparatus, and to cross it they thought not. The Ss tested the response recognition were presented 36 words, and were given the same instruction as that of stimulus recognition test except that they were asked about the words on the right side of the apparatus. Each word was presented for four seconds for both recognition tests.

The answering sheet for S-R recognition test involved 14 stimulus items printed on the left side of the sheet and 14 response items on the right side. These words were randomly arranged in such a way that there was no cue for matching as were in the original pairs. The Ss were asked to recall the previously learned pairs as many as possible and to match the words on the left side with the corresponding words on the right side. 90 sec were allowed for this pairing test.

Results

Table 1 shows the number of Ss and the mean number of correct responses for the six groups. The correct responses for stimulus recognition and response recognition were defined as the correct identifications of them in the original pairs. For the S-R recognition, the correct response was defined as the correct matching of stimulus and response items in the original pairs.

It is evident from Table 1 that the performance difference due to picture and word stimuli was found only in the stimulus recognition and there was no difference for the other tests. Separate *t* tests were performed, which revealed that only the difference in stimulus recognition was statistically significant at the 1% level with $t(58)=3.49$.

Several analyses were attempted for the other performance measures. Correct identifications of 22 distractor words were calculated on stimulus recognition and response recognition tests. The mean numbers on the stimulus recognition were 21.6 of picture stimuli and 19.5 of word stimuli, respectively. Those of the response recognition were 17.8 and 18.0 in the same order. The picture-word difference was significant only for the stimulus recognition ($t=5.40$, $df=58$, $P<.01$). For the S-R recognition, incorrect matchings and response omissions were calculated separately. The mean numbers of incorrect matchings were 5.3 for picture stimuli and 6.0 for word stimuli, respectively. The mean numbers of response omissions were 5.6 and 4.7 in the same order. The number of incorrect matchings tended to be larger than that of response omissions on word stimuli, although the difference was not significant.

EXPERIMENT III

The purpose of this experiment was to test whether the results obtained in Experiment II could be expanded to other testing method. Recall rather than recognition tests were used in this experiment.

Method

Design and subjects. A 2×3 factorial design was used, which was identical to that in Experiment II. The Ss were 109 college students, 40 males and 69 females. They were assigned to one of the six groups of approximately equal number of males and females, respectively.

TABLE 2
Number of *Ss* and mean number of
correct responses (Exp. III)

Stimulus item		Recall test		
		Stimulus	Response	S-R pair
Picture	<i>N</i>	18	19	17
	$\bar{X}$	7.1	5.1	4.2
	<i>SD</i>	1.5	2.1	1.8
Word	<i>N</i>	18	19	18
	$\bar{X}$	5.8	5.3	4.1
	<i>SD</i>	1.7	1.8	2.4

The number of *Ss* in each group is shown in Table 2.

Materials and procedure. Learning materials were almost identical to those in Experiment II but the recognition lists were not employed.

The *Ss* were run in groups of 17 to 19 by *E* and an assistant. The only difference between Experiments II and III was in the testing method. Immediately after a study trial, answering sheets were distributed to *Ss*, one for each, to test the recall memory of stimulus items, response items, or S-R pairs. The *Ss* tested the stimulus recall were asked to remember the stimulus items as many as possible and to write them down on the sheet. The *Ss* under the other conditions were instructed to recall the response items or the S-R pairs. In all tests the *Ss* were informed that they could neglect the presentation order and write down as they would occur in mind. A maximum of three minutes was allowed.

Results

Table 2 shows the number of *Ss* and the mean number of correct recalls. Separate *t* tests were performed, which revealed that only the difference in stimulus recall was significant at the 2% level with $t(34)=2.25$.

DISCUSSION

The results obtained from the three experiments are highly consistent in that the

differential effect of picture and word stimuli upon PAL was found only on the stimulus acquisition process but not on the others. Pictures as stimulus items were acquired more easily by *Ss* than words, but no performance difference between pictures and words was found both in response acquisition and S-R association. These results hold true when the performance was assessed by recognition test as well as recall test.

The finding that the stimulus acquisition was facilitated by picture stimuli may be explained in several ways. (a) It has generally been assumed that pictures facilitate learning by appealing directly to sensory reactions of *Ss*. Contrary to this common sense, Bourisseau, Davis and Yamamoto (1965) obtained the results that sense-impression responses to pictures occurred less than those to words. They suggested that pictures are less ambiguous stimuli than words and that pictures present more restrictive and compressed informations than words. Gropper (1966) also found less associative responses to pictures than words, and argued that competitions among the associative responses may be related to learning and memory. Thus, the picture superiority may be due to its restricting function of the associative power of stimuli. (b) An alternative explanation was attempted by several writers (Jenkins, Neale & Deno 1967; Scott, 1967). They assumed that the discriminability among stimuli is greater on pictures than on words, and that recall and recognition is positively related to this discriminability. The picture superiority may be due to greater intralist discriminability. (c) On the other hand, Paivio (1971) assumed in his dual-coding hypothesis that picture stimuli are coded in both imagery and verbal systems but word stimuli are mainly coded in verbal system. The picture acquisition may be facilitated by this difference in the coding system.

It was assumed that the matching task used in Experiments I and II provides the

pure assessment of S-R association because all stimulus and response items are presented at the test trial and Ss do not necessarily need to remember them. The obtained results revealed that the process of S-R association is entirely independent of the presentation mode of stimulus items. The same results were found when Ss were given the recall test which any stimulus and response items were not presented at the test trial. As far as the present study is concerned, it is concluded that picture stimuli do not facilitate the formation of S-R association in PAL. This conclusion is in line with Wicker (1970), although he used a somewhat different technique from the present study. As Paivio (1969, 1971) assumed, if the imagery elicited by picture stimuli can serve as a potential mediator, the facilitative effect of this mediator should occur in the process of S-R association. The obtained results are not consistent with this prediction. However, the present conclusions might have some limitations: (a) A standard method of PAL was not involved in the present design, and (b) Ss were tested only after one or two study trials and were not examined for further trials. The facilitative effect of picture stimulus items upon the subprocesses may be dependent upon stages of PAL.

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