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#### NOTES

1. While this research was in progress, the first author was receiving stipend support from PHS Training Grant No. MH08528 from the National Institute of Mental Health to the Department of Psychology. The study also was supported, in part, by a research grant from the National Institute of Child Health and Human Development, No. HD03083, to the second author.

2. Duchnowski, A. J., Nunnally, J. C., and Faw, T. T. *Acquired reward value in discrimination learning: Methodological developments and effects of reward magnitude and reward schedules*. In preparation.

3. The authors wish to express their appreciation to Dr. Ed Binkley, Director of the Division of Educational Research for Metropolitan Nashville Public Schools, Mrs. James Cannon of Andrew Jackson School, and Mr. Willie Nixon of Glengarry School for their cooperation and assistance in making subjects available.

of detail in pictorial stimuli might affect the size of obtained picture-word differences. In the present study, concrete nouns, simple line drawings, and color photographs were compared as stimulus items. Photographs were chosen to be as rich in detail as possible, and line drawings were constructed to be as barren as possible of incidental detail, consistent with the requirement that both could be easily labeled with the corresponding concrete noun. More recall was predicted with color photographs than with line drawings (which have been more often employed in picture-word comparisons). Also, postexperimental questionnaires were given to determine whether or not the two types of pictorial stimuli differed in reported use of mnemonic aids to mediate associations.

#### METHOD

All Ss learned a list of 20 paired-associates by the study-test procedure. In the word group, Ss were presented 20 pairs of concrete nouns. The 40 nouns were chosen to achieve minimum interitem association and a broad range of Thorndike-Lorge frequency. They were paired randomly. The same pairs were used in drawing and photograph groups, except that stimulus nouns were replaced by simple line drawings and by color photographs, respectively. Informal pilot data indicated that drawings and photographs were nearly always labeled by the noun they replaced.

Pairs and test stimuli were presented manually on white 5 x 8 cards. A nonsystematically different order of presentation was used on each trial. All Ss performed to a criterion of one perfect trial or to completion of nine trials. Responses were given orally by S and recorded on an answer sheet by E. Cards were presented for 2.5 sec on study trials and 5 sec on test trials; each exposure accompanied the clicking of an electric timer. An intertrial interval of approximately 30 sec was employed.

After reaching criterion, Ss in drawing and photograph groups were asked to label the stimuli. They were then given a sheet that presented the 20 pairs with space in which they were to write a brief description of any "mnemonic devices or memory tricks" they may have used to learn each pair. Examples of the use of imagery and verbal mediation were given with these instructions. For pairs learned without any mediational device, they were asked to write the word "rote."

The Ss were 63 introductory psychology students at Pennsylvania State University who participated for class credit. They were tested individually and were assigned nonsystematically to one of the three

## Photographs, drawings, and nouns as stimuli in paired-associate learning<sup>1</sup>

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*Color photographs and simple line drawings were compared with corresponding concrete nouns as stimulus items in paired-associate learning. Greater recall was found with pictorial stimuli, but a predicted difference between photographs and drawings was not significant. The two types of pictorial stimuli did differ, however, in proportion of intralist intrusion errors and in reported use of mediation. Both surpassed word stimuli whether rote learning or a mnemonic strategy was reported. These results do not support theories that attribute picture superiority to incidental cues or to implicit mediational strategies.*

Studies by Kopstein & Roshal (1954), Paivio & Yarmey (1966), and others have

demonstrated greater acquisition with pictorial stimuli than with corresponding verbal stimuli in paired-associate (PA) learning. In the attempt to explain this effect, it has been suggested that the picture stimuli of these studies consistently evoked implicit labeling responses and were thus encoded both verbally and visually (Kaplan, Kaplan, & Sampson, 1968). According to what has been called the incidental-cues hypothesis (Jenkins, 1968), a picture is therefore functionally equivalent to its noun label and, in addition, presents a number of incidental, perceptual cues to the S. Such cues may facilitate learning by retarding a leveling process in memory images (Reese, in press), by enabling additional bonds between stimulus and response features, or by increasing the probability of discovering an effective functional stimulus.

This hypothesis implies that manipulation of the complexity or degree

experimental conditions to achieve 11 males and 10 females in each.

### RESULTS AND DISCUSSION

Averages on several measures are given for each experimental condition in Table 1. Differences between drawing and photograph groups in trials and errors to criterion were in the predicted direction. Orthogonal comparisons indicated, however, that these two picture conditions differed significantly from the word condition ( $F = 42.44$ ,  $df = 1/60$ ,  $p < .001$ ) but not from each other ( $F < 1$ ) in trials to criterion. Because of significant heterogeneity of variance (Cochran's  $C = .820$ ,  $df = 20$ ,  $p < .01$ ) and a high correlation between treatment means and variances in errors to criterion, the latter measure was subjected to square-root transformation before analysis. Again there was a large difference between picture and word conditions ( $F = 33.31$ ,  $df = 1/60$ ,  $p < .001$ ) but not between the two picture conditions ( $F < 2$ ). Four Ss, all in the word group, failed to reach criterion in nine trials. Therefore, picture-word differences were reduced somewhat by scoring these Ss as if they had reached criterion.

Errors were classified as omissions, intralist intrusions, or extralist intrusions, and the percentage of each type was calculated for each S. Table 1 indicates no difference in extralist intrusions but suggests that the word group was greater, not only in number of intralist intrusions, but also in the proportion of total errors which were of this type. The large-sample Mann-Whitney U test yielded significant differences in percentage intralist intrusions between word and picture groups ( $p < .01$ , two-tailed) and between photograph and drawing groups ( $p < .01$ , two-tailed). This finding is in disagreement with data reported by Deno (1968) and Dominowski & Gadlin (1968), who did not find picture-word differences in error type. Any number of procedural differences could account for this discrepancy in results, but two that most readily suggest

themselves are length of list and type of response item. The use of noun responses in the present study probably increased the picture-word effect, relative to the number responses used by Dominowski and Gadlin and the Japanese words used by Deno, because of greater difficulty of differentiating stimulus and response terms with word stimuli. This factor, and the shorter list length in the earlier studies (10 and 12 pairs), probably affected picture-word differences in intralist confusion.

Table 1 also presents the average number of pairs for which rote learning was reported in the postexperimental questionnaire. Some mediational device was described for all others. It can be seen that the word condition fell between photograph and drawing in number of times rote learning was reported, but the two picture conditions differed from each other on this measure ( $F = 4.77$ ,  $df = 1/60$ ,  $p < .05$ ). An attempt to classify subjective reports suggested that this difference was based on the more frequent use of stimulus selection with photographs to isolate functional stimuli which had preexperimental associations with the response term (e.g., a dark patch on the photograph of a mountain was often singled out in the pair MOUNTAIN-INK).

For 57 Ss, it was possible to classify pairs according to whether rote learning or a mediational strategy was reported and to compute an average number of errors for each type (the other six Ss reported either all rote learning or none). Averages of these values are presented in Table 2. Reports of rote learning were associated with greater incidence of errors ( $F = 49.34$ ,  $df = 1/54$ ,  $p < .001$ ), but more errors were made in the word group for either type of report. The picture-word contrast was significant for both rote ( $F = 29.79$ ,  $df = 1/54$ ,  $p < .001$ ) and mediational ( $F = 27.18$ ,  $df = 1/54$ ,  $p < .001$ ) pairs. This result is consonant with data by Dominowski & Gadlin (1968) and by Wicker (in press) in its failure to support theories which link picture-word differences to the use of imagery or other mediational devices.

Although the second orthogonal contrast (between drawing and photograph groups) was not significant for either rote pairs ( $F < 1$ ) or mediational pairs ( $F = 2.62$ ,  $df = 1/54$ ,  $p > .05$ ), a two-way analysis treating only these two picture groups yielded a significant interaction between stimulus type and reported strategy ( $F = 6.22$ ,  $df = 1/36$ ,  $p < .05$ ). This interaction reflected the fact that the nonsignificant trend in support of the incidental-cues prediction could be localized in pairs for which mediation was reported. Thus, reported mediation was

Table 2  
Average Number of Errors Per Pair as a Function of Stimulus Type and Reported Learning Method

Report	Stimulus Type		
	W (N = 19)	D (N = 18)	P (N = 20)
Rote	2.82	1.13	1.15
Mediational	1.94	.85	.59

both more frequent and more likely to reduce errors in the photograph groups than in the drawing groups. It must be emphasized again, however, that this strategy difference did not produce a significant overall increase in recall.

In summary, this experiment confirmed previous studies by Jenkins (1968) and Paivio, Rogers, & Smythe (1968) in that addition or deletion of incidental cues did not substantially alter the magnitude of the picture-word effect. The color and fine-grain detail in photographic stimuli did not significantly increase learning relative to simple line drawings. Differences in intrusion errors and in the effectiveness of mnemonic mediation suggested, however, that drawings and photographs should not be considered equivalent PA stimuli, and that different combinations of factors may account for the superiority of each.

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### NOTE

1. This study was conducted in the Laboratory for the Study of the Symbolic Processes, Pennsylvania State University. It was supported by Public Health Service Postdoctoral Research Fellowship MH-36970-01A2 and by National Institute of Child Health and Human Development Training Grant HD-00151.

Table 1  
Averages on Several Dependent Measures for Each Experimental Condition

Measure	Stimulus Type		
	W*	D*	P*
Trials to Criterion	6.1	3.5	3.3
Errors to Criterion	44.6	19.9	15.2
Percentage Intra-list Intrusions	18.5	9.8	13.5
Percentage Extra-list Intrusions	2.2	3.3	3.8
Number Reported Rote Pairs	9.0	10.4	7.2

\* W = word. D = drawing. P = photograph