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Pictorial Superiority Effect

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Pictures generally show superior recognition relative to their verbal labels. This experiment was designed to link this pictorial superiority effect to sensory or meaning codes associated with the two types of symbols. Paired-associate stimuli consisted of simple pictures or of their labels, with list items selected either from the same conceptual category or from different conceptual categories. In addition, schematic or visual similarity among the pictures was either high or low. At two rates of presentation equal amounts of conceptual interference were produced for pictures and their labels. High schematic similarity eliminated the pictorial superiority effect at the slow rate and completely reversed it at the fast rate. These results suggest that the meaning representations for simple pictures and their labels may be identical, and that the pictorial superiority effect is related to the qualitative superiority of the sensory codes for pictures.

Memory for pictorial stimuli generally exceeds memory their concrete labels. This finding has been explained by the assumption that pictures are more likely to be dually encoded as both imaginal and verbal representations, a conceptualization that presupposes that code redundancy facilitates retention (Paivio, 1969, 1971). One implication of this dual-code hypothesis is that the superiority effect should be eliminated when the pictures are not labeled or verbally encoded. Nelson and Brooks (1973) tested this possibility using pictures or their labels as paired-associate stimuli and unrelated words as responses. Sensory similarity *among the labels* was varied. If the pictures were being named, high label similarity was expected to disrupt performance. The results indicated that high label similarity impaired acquisition when the stimuli were labels and when they were pictures that had to be named. However, label similarity failed to generate any interference when the instructions made no reference to naming. Similar results were obtained when the responses were associatively related to their stimuli, a finding that suggests that pictorial meaning can be conveyed without naming (Nelson & Reed, 1976, Experiments 1 and 2). Thus, in conjunction with corroborative verbal reports, these studies indicated that the pictures were not labeled, not dually encoded, and yet the typical pictorial superiority effect was obtained.

The results of the label similarity experiments suggested that the superiority effect, at least in certain tasks, cannot be explained by a dual picture–name encoding. Alternatively, as suggested by Paivio and Csapo (1973), the pictorial image code may be qualitatively superior to its verbal code. Nelson and Reed (1976, Experiment 4) extended this line of reasoning in suggesting that the potential qualitative differences could be conceptualized within a levels-of-processing framework. Although there are different ways of expressing this idea, a common assumption is that the features of a word can be classified into sensory and meaning attributes and that both types of features are processed and can be represented in memory (Craik & Lockhart, 1972; Nelson, Wheeler, Borden, & Brooks, 1974; Posner & Warren, 1972). If applied to pictorial stimuli the superiority effect could be

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related to potential differences at either or at both levels of processing. The sensory representation for a simple picture, its visual configuration, may provide a more differentiating mnemonic than the sensory or graphic representation provided by its label (cf. Nelson, Brooks, & Borden, 1974). Similarly, the meaning code for a pictorial stimulus may be more effective than that associated with its label. To test the feasibility of the levels notion in this context, Nelson and Reed (1976, Experiment 4) used pictures or their labels as paired-associate stimuli and varied amount of conceptual similarity. The stimuli all belonged to the same taxonomic category (animals or articles of clothing), or each came from a different category. Interest was focused upon the relative amounts of conceptual interference produced as a function of type of stimulus. Equivalent amounts of interference would have suggested that similar meaning codes were contacted for the two types of stimuli, and differential interference would have implied that the meaning codes may have been different. The results indicated that equivalent interference was generated, suggesting that pictures and their labels contacted comparable semantic representations and, therefore, that the pictorial superiority effect may not be the result of more effective meaning codes.

The present experiment was designed to replicate the conceptual similarity results under differing conditions and to determine if the superiority effect could be attributed to differences in the efficacy of the sensory codes. In addition to manipulating type of stimulus and conceptual similarity, schematic similarity among the pictorial was either high or low. When schematic similarity was high all of the pictures appeared similar, sharing a common configuration; when it was low, the pictures were drawn to share a minimum of physical features. If the picture–word difference is primarily related to differences in sensory codes, then high schematic similarity should eliminate and possibly reverse the usual pictorial superiority effect. Alternatively, schematic similarity among the pictures should have little effect if their visual configurations are not processed or if the resulting sensory codes are highly transitory. Since it seemed plausible that all variables might vary in effectiveness with encoding time, rate of presentation also was manipulated in this experiment.

Method

Materials

In individual sessions each subject acquired a single list of eight paired associates. The stimuli consisted of concrete words taken from the Battig and Montague (1969) norms, or they consisted of corresponding pictorial referents for these words. Two different but apparently comparable lists were constructed for each condition of schematic and conceptual similarity. All lists were equated for rank within each category, for frequency, and for apparent concreteness. The high schematic, high conceptual similarity stimulus sets were SCREWDRIVER, WRENCH, CHISEL, RULER, HAMMER, SAW, NAIL, and PENCIL; and ORANGE, APPLE, STRAWBERRY, PINEAPPLE, CHERRY, GRAPES, LEMON, and PEACH. For high schematic, low conceptual similarity, the sets were KNIFE, BAT, NAIL, ZIPPER, OAR, CLARINET, BRANCH, and PENCIL; and WHEEL, PIE, FLOWER, NECKLACE, BALLOON, GLOBE, CLOCK, and DRUM. The stimuli representing the low schematic, high conceptual similarity lists were DRESS, SHIRT, PANTS, SOCK, TIE, HAT, GLOVE, BELT; and DOG, HORSE, CAT, SHEEP, MOUSE, RABBIT, PIG, and COW. In the low schematic, low conceptual similarity conditions the stimuli were CAR, LAMP, SHEEP, HAND, SPOON, BANJO, PEACH, and TIE; and BOAT, FORK, HEART, WHEEL, SUIT, VIOLIN, MOUSE, and SAW.

When schematic similarity was high the line drawings were represented in nearly rectangular or

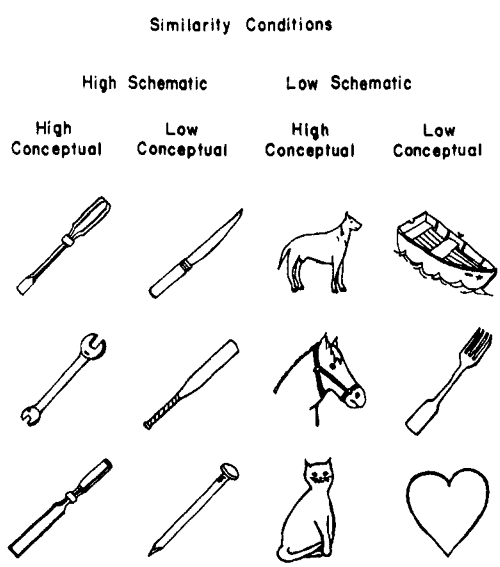

FIGURE 1. Representative pictures for similarity conditions.

TABLE 1

Mean Errors as a Function of Schematic Similarity, Type of Stimulus, Conceptual Similarity, and Rate of Presentation

Presentation rate and conceptual similarity	Schematic similarity: High — Picture	High — Label	Low — Picture	Low — Label	*M*
Fast (1.1 sec)					
High	54.50	33.56	24.88	36.44	37.34
Low	26.19	25.94	16.75	30.69	24.89
M	40.34	29.75	20.81	33.56	
Slow (2.1 sec)					
High	21.19	14.31	9.19	17.13	15.45
Low	10.75	14.63	8.19	12.63	11.55
M	15.97	14.47	8.69	14.88	
M	28.16	22.11	14.75	24.22	

nearly circular form, depending upon the list. In the former case, each picture subtended an angle of approximately 45–50°. When schematic similarity was low the pictures were drawn to be as distinct as possible. Furthermore, as determined by judgments of colleagues, the drawings were equally similar or equally distant within each condition of conceptual similarity. The area circumscribed by each picture was carefully equated within any given condition and was approximately equated across conditions. Representative examples of pictures for each condition are presented in Figure 1. Of course, as should be clear from the stimuli, schematic similarity was effectively manipulated only among pictures. The labels for all pictures were formally dissimilar and served only as appropriate baseline controls for their corresponding pictorial referents. Thus, schematic similarity was not expected to affect performance in the label conditions unless, as an unlikely event, the subjects spontaneously generated similar referents for the verbal stimuli.

Responses were concrete words that were associatively unrelated to their stimuli and other items in the list. The same response set was used within each condition of schematic and conceptual similarity. For the initially listed stimulus set in each similarity condition the responses were EARTH, COOKIE, FILM, GHOST, JET, LAKE, DAISY, and NUN; and, for the stimulus set listed second they were MAGNET, BANJO, LAMP, FLAG, RULER, TANK, ALTAR, and WINDOW.

Procedure

Using the recall method, slides (negatives) of all items were presented via a Kodak Carousel slide projector. Rate of presentation during study was 1.1 sec for half of the subjects in each stimulus condition, and it was 2.1 sec for the remaining half of the subjects. In all conditions a test trial immediately followed each study trial, with recall being paced by the subject. Study and recall alternated in this manner for a total of 20 trials after the initial presentation or for 4 consecutive errorless trials, whichever came first. Sequences of pairs and test stimuli were presented in four unsystematically varying orders, with the restriction that at least four items had to intervene between the presentation of a given pair and its test. This sequencing was changed for each subject.

For the study periods the subjects were instructed to "learn what word goes with each picture" or to "learn what words go together." During test all subjects were instructed to vocally anticipate the correct response, but no mention of naming the test stimuli was ever made. Depending upon assignment to condition, all subjects learned a three-item list consisting of picture–word or word–word pairs before beginning the experimental task.

Subjects

With manipulations of stimulus type, schematic similarity, conceptual similarity, and rate of presentation, the principal conditions of the experiment conformed to a 2^4 between-subjects design. Sixteen subjects were assigned to each of these treatment combinations, with 8 assigned to each list. Thus, there were a total of 256 subjects in the entire experiment. These subjects were assigned to conditions in blocks of 32, with 1 from each condition and list per block. Assignment within blocks was determined by a table of random numbers. All were selected from courses in Introductory Psychology and received points toward their grades for participating. Four experimenters, two male and two female, collected the data and were balanced with respect to conditions and lists.

Results

Table 1 presents the means of total errors for each subject as a function of the principal conditions of the experiment. An analysis of variance of these values ($\alpha = .05$) indi-

TABLE 2

MEAN ERRORS AS A FUNCTION OF TYPE OF STIMULUS, CONCEPTUAL SIMILARITY, AND SCHEMATIC SIMILARITY

Stimulus and conceptual similarity	Schematic similarity	
	High	Low
Picture		
High	37.84	17.03
Low	18.47	12.47
Label		
High	23.94	26.78
Low	20.28	21.66

cated that high schematic similarity, high conceptual similarity, and the faster rate all reliably disrupted performance, the respective Fs(1, 240) being 9.50, 19.94, and 92.48, with $MS_e = 214.79$. Type of stimulus was not significant ($F < 1$). However, as expected, schematic similarity did interact with type of stimulus, $F = 17.93$. Fisher's two-tailed least significant difference (LSD) for this interaction was 5.13. As shown in the bottom row of Table 1, the usual pictorial superiority effect was obtained when schematic similarity among the pictures was low. Reliably fewer errors were made on the pictorial stimuli. However, when schematic similarity was high the effect was completely reversed. Performance associated with the pictures was significantly worse than that associated with their labels. High schematic similarity among the pictures produced nearly twice as many errors while, among the label conditions, it had no effect. This reversal of the pictorial superiority effect depended upon the rate of presentation, as the Schematic Similarity × Type of Stimulus × Rate interaction also was reliable, $F = 4.56$. This interaction is displayed in the third and sixth rows in Table 1. At both fast and slow rates the pictorial superiority effect was obtained when schematic similarity was low. However, the reverse effect, pictorial inferiority, was obtained only at the fast rate. At the slow rate, performance on the two types of stimuli was not different when schematic similarity was high. Fisher's LSD for this interaction was 7.25.

The results of this analysis of variance also revealed interactions involving conceptual similarity with rate, $F = 5.44$, and with schematic similarity, $F = 4.28$. The interaction with rate, shown in the last column of Table 1, indicated that high conceptual similarity among the stimuli was more disruptive at the fast than at the slow presentation rate. Thus, the deleterious effects of both kinds of similarity were attenuated at the slower rate. The interaction with schematic similarity was qualified by a higher order interaction between Type of Stimulus × Schematic Similarity × Conceptual Similarity, $F = 4.94$. For convenience, this interaction is displayed in Table 2. Comparison of these means indicated that schematic similarity among the pictorial stimuli produced a relatively greater disruption of performance when conceptual similarity was high than when it was low. Of course, schematic similarity had essentially no effects when stimuli were labels. Thus, in the entire experiment poorest performance was obtained when pictures served as the paired-associate stimuli and interference was present at both the sensory and meaning levels. Incidentally, when schematic similarity was low, as shown in the last column of Table 2, conceptual interference engendered by pictures and by their labels was essentially equivalent. This finding replicates the results of the Nelson and Reed (1976) study under somewhat different conditions. None of the remaining interactions in this analysis were reliable, nor did they even approach the criterion for significance. The F for the four-way interaction among these variables was less than unity.

Immediately following acquisition, the subjects receiving pictorial stimuli were shown each picture and asked to label them. An average of 7.00 out of the 8 stimuli were correctly named, a value that did not appear to vary with the similarity conditions. Most labeling errors consisted of appropriate substitutions such as RAT for MOUSE, and LAMB for SHEEP. When asked if the name for the picture was used during learning, the subjects named an average of 3.25 items, with the remaining 5.75 items either never named or named inconsistently. There was a slight tendency for naming to be less likely when schematic similarity was high relative to when it was low, and more likely when conceptual similarity was high than when it was low. When asked how each pair was learned, the subjects in both picture and word conditions learned approximately four items by rote, three by verbal mediation, and less than one item by interaction imagery.

Discussion

Research in the areas of human memory and human performance has converged upon the idea that both the sensory and meaning features of words are activated in a variety of encoding tasks (cf. Craik & Lockhart, 1972; Posner & Warren, 1972). The results and theoretical impetus of the present experiment incorporate pictorial stimuli into this trend. Both pictures and their concrete verbal labels have forms of sensory expression in the physical world and both types of stimuli can possess content, that is, both can signify meaning. On logical and intuitive grounds, it seems reasonable to suppose that memory representations can be established or activated for both the expression and the implied content of these visual symbols. The present findings are entirely consistent with this supposition. Thus, greatest difficulty of acquisition is encountered when a given pictorial stimulus shares both configurational and conceptual attributes with other stimuli in the list. As with the recognition of a verbal stimulus, recognition of a pictorial stimulus as a subprocess in paired-associate acquisition appears to involve the activation of previously encoded sensory and meaning codes (cf. Bencomo & Daniel, 1975; Frost, 1971, 1972).

Given that both types of codes can be established or activated for both types of visual stimuli, the pictorial superiority effect can logically be attributed to the differential effectiveness of either code. The results of manipulations of schematic and of conceptual similarity indicate that the principal difference between simple pictures and their labels is inherent in their expression as physical stimuli. The sensory code for a picture is apparently more differentiating and less susceptible to interference from successively occurring items. Reducing this normally available distinctiveness by increasing schematic similarity among the pictures generates substantial interference, despite the fact that each picture is subject to a unique semantic interpretation. This finding is completely analogous to comparable manipulations of graphic similarity among words (Nelson, Brooks, & Borden, 1974). Thus, the pictorial superiority effect can be reversed by the simple operation of drawing the pictures to look similar.

The results of manipulations of conceptual similarity in this and the earlier study (Nelson & Reed, 1976, Experiment 4) indicate that, when schematic similarity is low, high conceptual similarity among pictures or among their labels produces interference. Most importantly, however, this interference is equivalent. If embedded in a list containing articles of clothing, a picture of a HAT generates the same amount of conceptual interference as the word HAT. Meaning interference appears to be independent of the type of stimulus producing it, whether a picture or its label. This finding is consistent with either of two alternative interpretations: It is possible that meaning codes linked to pictures are wholly independent of and superior to those linked to their labels, and that conceptual similarity among the two types of stimuli fortuitously generated the same amount of interference among both types of meaning codes. This alternative is plausible but appears overly complex. Alternatively, although semantic access appears faster for pictures (Potter & Faulconer, 1975; Rosch, 1975; Pellegrino, Rosinski, & Siegel, Note 1), identical meaning codes appear to be contacted by both types of stimuli. The generality of this inference across other coding tasks and conditions remains to be established. Obviously, it may be limited to simple pictures and to conceptual meaning. Nevertheless, the findings relating to variations in conceptual similarity are consistent with the general class of models assuming that meaning codes are abstractly represented in memory without regard to the form of the input (Anderson & Bower, 1973; Pylyshyn, 1973). Of course, the processes involved in extracting meaning may be highly dependent upon the type of stimulus (Paivio, 1971, 1975). If both of these assumptions are correct then a distinction needs to be made between memory codes and the processes by which these codes are established.

One final comment deserves mention. The findings associated with manipulations of schematic similarity do not deny the dual code hypothesis (Paivio, 1975; Paivio & Csapo, 1973). In fact, they are consistent with expectations derived from it. The levels-of-processing conceptualization expressed here takes issue only with the hypothetical role given to the labeling or verbal encoding of meaningful, simple pictures. In this and in other experiments involving pictorial recognition, the pictures do not appear to be consistently labeled and, therefore, they are apparently not dually encoded (Nelson & Brooks, 1973; Nelson & Reed, 1976). The persistence of the pictorial superiority effect under these conditions must be explained by some other means. The present findings suggest that pictorial stimuli provide a qualitatively superior sensory code and that, at least for simple pictures, the semantic representations for pictures and their corresponding labels may be identical. The levels conceptualization does not exclude the possibility that labeling can play a facilitating or even a necessary role. Labels or verbal descriptions may be redintegrated from information associated with meaning, and these verbal codes may in turn serve to affect performance. Accordingly, pictorial labeling is viewed as an ancillary process under the control of the information processor, to be used primarily in certain tasks and under certain conditions of encoding (cf. Nelson, Brooks, & Borden, 1973; Nelson & Reed, 1976, Experiments 1–4; Paivio & Csapo, 1971).

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