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RECOGNITION OF PICTURES AND WORDS: REACTION TIME AS A FUNCTION OF DEPICTION AND SIMILARITY OF DISTRACTORS

by

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A Dissertation Submitted to the Faculty of the

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I hereby recommend that this dissertation prepared under my direction by Armando Andres Bencomo

entitled RECOGNITION OF PICTURES AND WORDS: REACTION TIME AS A FUNCTION OF DEPICTION AND SIMILARITY OF DISTRACTORS

be accepted as fulfilling the dissertation requirement of the degree of Doctor of Philosophy

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After inspection of the final copy of the dissertation, the following members of the Final Examination Committee concur in its approval and recommend its acceptance:*

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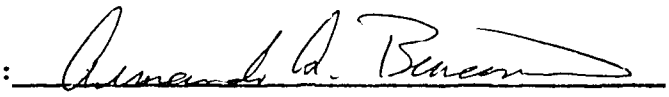
SIGNED: 

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ABSTRACT

Subjects were asked to recognize a test stimulus as same or different from a target stimulus presented 30 seconds earlier. Depiction of target and test stimuli was either pictorial or verbal. Distractors were selected to resemble the target along one of five possible dimensions: Acoustic-formal, Acoustic, Conceptual (functionally or categorically related to target objects), Schematic (similar in shape to target objects), or Neutral (minimally related to the target).

Same-different reaction times were found to vary systematically as a function of both mode of depiction and distractor type. ANOVA of RTs and of a TSD based analysis were consistent in showing that verbally related distractors were difficult to distinguish from targets only when the target object, the test object, or both appeared as a printed word. Schematic and Conceptual distractors were difficult to discriminate only when one of the stimuli or both appeared as a picture.

The results suggested that a simple Double Encoding Hypothesis could not adequately account for differences in memory for pictures and words. Rather, it appears that subjects encode and store several kinds of information about targets depending upon whether picture or word representations are used.

INTRODUCTION

Memory for pictured objects and their word names has been investigated within a variety of experimental paradigms, with the general finding that pictures are remembered better than words (Dilley and Paivio 1968, Paivio and Csapo 1969, Sampson 1970). Although differences in recall or recognition of pictorially or verbally depicted objects are rarely great in magnitude, they have proven reliable enough to demand serious theoretical consideration and interpretation. Most accounts of picture-word differences suggest that the individual with average competence in his language has learned to represent his experience in either or both of two possible ways: through an imaginal code which derives directly from the sensory experience itself, or through a verbal code which is a less direct or symbolic representation of the experience (e.g., Paivio 1969). Moreover, researchers often propose that differences in memory for pictures and words are mediated by the differential elicitation of such imaginal and verbal codes by picture and word stimuli (Paivio and Csapo 1969, Sampson 1970).

Perhaps the most frequently cited interpretation of picture-word differences in memory is a view which may be termed the Dual Encoding Hypothesis (DEH). The DEH proposes that pictures are remembered better than words because they elicit both imaginal and verbal codes, while words elicit primarily a verbal code (Paivio 1969, 1970;

Reese 1970). Although most of the evidence from studies comparing recall and recognition for pictures and words is generally consistent with the DEH, there is very little direct evidence regarding the specific role of coding systems in the processing of pictures and words.

The present study was designed to provide more direct evidence regarding the role of verbal and imaginal codes in recognition memory for verbal and pictorial stimuli. The recognition memory paradigm was chosen for its simplicity. Subjects were asked to recognize a test stimulus as being same or different from a target stimulus presented earlier. Depiction of target and test stimuli was either pictorial or verbal. Distractors were selected to resemble the target along one of five possible dimensions: Acoustic-formal, Acoustic, Conceptual (functionally or categorically related to the target object), Schematic (similar in shape to the target object), or Neutral (minimally related to the target).

In order to increase the precision of the experiment, Reaction time (RT) was adopted as the principal dependent measure. Long different RTs for a distractor indicate high confusability with the target, while short latencies reflect low confusability. If a target is primarily coded (or remembered) in terms of a verbal code, then verbal distractors should be highly confusible and yield long RTs. Conversely, if a target is primarily coded in terms of a visual (image) code, then Schematic distractors should yield long RTs. Depiction of the experimental stimuli as pictures or words should influence the code employed,

and thus influence RTs for distractor items as well. An experimental design was chosen in which depiction of target and distractor stimuli could be varied independently. The design permitted the interaction of depiction and distractor type to be examined as well.

METHOD

Materials and Design

Stimuli were 24 common objects represented both by simple line drawings and by printed words. Transfer letters were used to print the name of each object, and a simple line drawing depicting each object was also constructed. Both picture and word stimuli were photographed, and transparencies prepared. The word labels for the objects, concrete nouns, were presumed to have high imagery values. Ten of the stimulus words were scaled by Paivio, Yuille, and Madigan (1968) and did indeed rate high on these measures (mean C = 7.04, mean I = 6.60). Four different objects served as targets, and a set of five distractors related to each target stimulus was constructed. A pilot study determined that the picture stimuli were reliably labelled with the corresponding object names used as verbal stimuli in the study. A complete listing of the objects used in the study can be found in Table 1.

Two sets of target objects were prepared. Each contained the four target objects, with two presented as pictures and two as words. The two sets mirrored each other: an object represented as a word in one set was represented as a picture in the other set. Test lists contained 24 objects, four target stimuli and 20 distractors. Two test lists were prepared, with 12 of the 24 objects represented in each mode.

Table 1

List of Experimental Stimuli and Number of Pilot Subjects Responding to Picture Stimuli with the Word Labels Used in the Study

Item Type	Objects			
	I	II	III	IV
		(N = 44)		
Target	NAIL(44)	WHEEL(44)	PEAR(44)	RAKE(44)
Acoustic-formal	TAIL(40)	HEEL(39)	BEAR(44)	CAKE(44)
Acoustic	WHALE(44)	SEAL(42)	CHAIR(44)	STEAK(41)
Conceptual	HAMMER(44)	CAR(43)	APPLE(43)	HOE(42)
Schematic	PENCIL(43)	FLOWER(42)	BELL(44)	BROOM(43)
Neutral	DRESS(44)	FLAG(44)	KEY(44)	THUMB(41)

These two lists also mirrored each other. Sets of target stimuli were combined with test lists to yield four different sets of target and test items. The List (L) variable refers to these four sets, and consequently has four levels.

Four independent variables were combined in a 4x(2x2x5) mixed design. List was a between subjects variable, each subject being exposed to only one of the four sets of stimuli. Presentation Mode (PM), Test Mode (TM), and Distractor Type (DT) were all varied within subjects. PM and TM each had two levels, target and test items being presented both as pictures and words. The DT variable referred to the relationship of the distractor to the target stimulus, and included five levels:

1. Acoustic-formal (AF). These distractors were objects whose names, as spoken words, were acoustically similar to the names of target objects. They also resembled target stimuli as printed words, differing only in the initial consonants (e.g., NAIL- TAIL).
2. Acoustic (A). These were objects whose names shared the acoustic but not formal properties of the named target objects (e.g., NAIL-WHALE).
3. Conceptual (C). These objects were either categorically or functionally related to the target objects (e.g., PEAR-APPLE, NAIL-HAMMER).
4. Schematic (S). These were objects which shared schematic (shape) attributes with the target objects (e.g., NAIL-PENCIL).
5. Neutral (N). These distractors were minimally similar to targets (e.g., NAIL-DRESS).

Figure 1 shows one target and its related distractors.

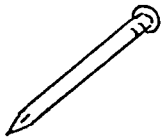
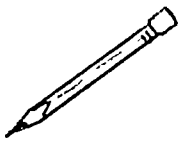
Target(or same test stimulus)		NAIL
Acoustic-formal		TAIL
Acoustic		WHALE
Conceptual		HAMMER
Schematic		PENCIL
Neutral		DRESS

Fig. 1. Sample Drawings used in the Study: One Target and Its related Distractor Items.

Each type of distractor could be presented in four ways with respect to depiction. The target and test objects could both appear as words (condition WW); they could both appear as pictures (condition PP); the target could be a picture and the test item a word (condition PW); or the target could be a word and the test item a picture (condition WP). Each subject was tested once on each type of distractor at every combination of representational formats (WW, PP, PW, WP).

Subjects and Apparatus

Twenty-four undergraduates from introductory psychology classes at The University of Arizona volunteered to participate in the study.

Stimuli were presented by a Carousel Projector (Kodak Model 800) programmed by a Hunter interval timer. Response latencies were measured by a Hunter Kwic-Kloc started by the same pulse which presented the stimulus. Latency was terminated by the subject's response on two microswitches labelled alternately "Same" and "Different" for each subject.

Procedure

Subjects were familiarized with the apparatus and procedure by practicing a recognition task with upper and lower case letters. They were told that they would see a single letter of the alphabet, which they must remember. They were instructed to expect a second letter 15 seconds later. Their task was to signal whether the second letter was the same or different from the first. If the same letter appeared both times, but differed in case, subjects were to still respond "Same."

The subjects were reminded that stimuli were always presented in pairs, and that judgments were to be made about the second stimulus with respect to the first. Finally, they were instructed to respond by pressing the appropriate button as soon as they had reached an accurate judgment. Stimuli were exposed for a duration of 1 second. Ample practice was allowed in order that RTs could stabilize before the experiment proper.

The experimental procedure was identical to the warm-up task, with the following exceptions. First, subjects were told that they would see pairs of objects rather than pairs of letters. They were instructed to give a same response when target and test stimuli represented the same object, regardless of depiction mode. This point was strongly emphasized, with reference made to the analogous situation in warm-up when the same letter was presented in both upper and lower case. Second, subjects were told to expect a longer inter-item interval. This was lengthened to 30 seconds. Exposure duration remained at 1 second. The experimenter recorded subjects' RT and decision for each test stimulus. Prior to each trial, he reminded subjects that each pair of objects was to be judged independently. He also alerted the subject with the word "Ready" 1 second prior to exposing each target and test stimulus.

RESULTS

All subjects produced error-free performances, correctly recognizing each test item as either the same or different from the target stimulus. Reaction time scores did, however, vary systematically with the independent variables.

Mean Reaction Time

Latencies for same and different judgments were analyzed separately. Results are presented in Table 2 and Table 3, respectively.

Same Judgments

Analysis of variance revealed only two significant effects: PM ($F = 16.59$, $p < .001$) and the PMxTM interaction ($F = 12.29$, $p < .005$). Reaction times were significantly longer when the target item was a word rather than a picture. The longest RTs occured under the WP treatment, and the shortest appeared under the PP condition. Latencies for conditions WW and PW were of intermediate length and approximately equal.

Different Judgments

The four way ANOVA indicated that two interactions involving the List variable were significant: LxDT ($F = 2.46$, $p < .025$) and LxPMxTMxDT.($F = 2.17$, $p < .025$). Since the lists differed with respect

Table 2

Same Judgments: Mean RT for Each Cell in the Factorial Design

Presentation Mode	Test Mode	
	Word	Picture
	all values in milliseconds	
Word	840	889
Picture	818	730

Table 3

Different Judgments: RT for Each Level of Each Variable

Variable	Level				
	all values in milliseconds				
List	I	II	III	IV	
	813	601	970	1042	
Presentation Mode	Word	Picture			
	859	854			
Test Mode*	Word	Picture			
	841	872			
Distractor Type**	AF	A	C	S	N
	874	794	937	926	751

*$p < .05$

*$p < .001$

to which of the four target objects appeared in each combination of PM and TM, these interactions indicate that within each combination (i.e., WW, PP, PW, WP) the effect of the DT variable depended upon which of the four target objects was presented. While there is no theoretical basis for predicting specific performance differences as a function of the target object used, it is not surprising that individual subjects may have responded idiosyncratically to a particular word or picture used in the study. An examination of the form of the interactions revealed that the curves generally showed rather small departures from parallelism, with a number of exceptions directly traceable to subjects who gave an unusually long RT to a particular test item. Although such deviant responses influenced two of the complex interactions involving the List variable, it did not appear that they unduly influenced mean RTs when the data were pooled over all 24 subjects. Thus it is felt that the significant interactions involving List neither invalidate the other findings nor merit further theoretical interpretation in themselves.

The main effect for TM was significant ($F = 5.40$, $p < .05$), with words producing shorter RTs than pictures. DT was also significant ($F = 23.35$, $p < .001$). Conceptual distractors yielded the longest RTs, while neutral items yielded the briefest. AF and S distractors also led to rather long RTs, but A distractors did not.

The PMxDT interaction also attained significance ($F = 14.78$, $p < .001$). When the target object was depicted as a word, AF distractors generated the longest latencies. Conversely, when the target object was

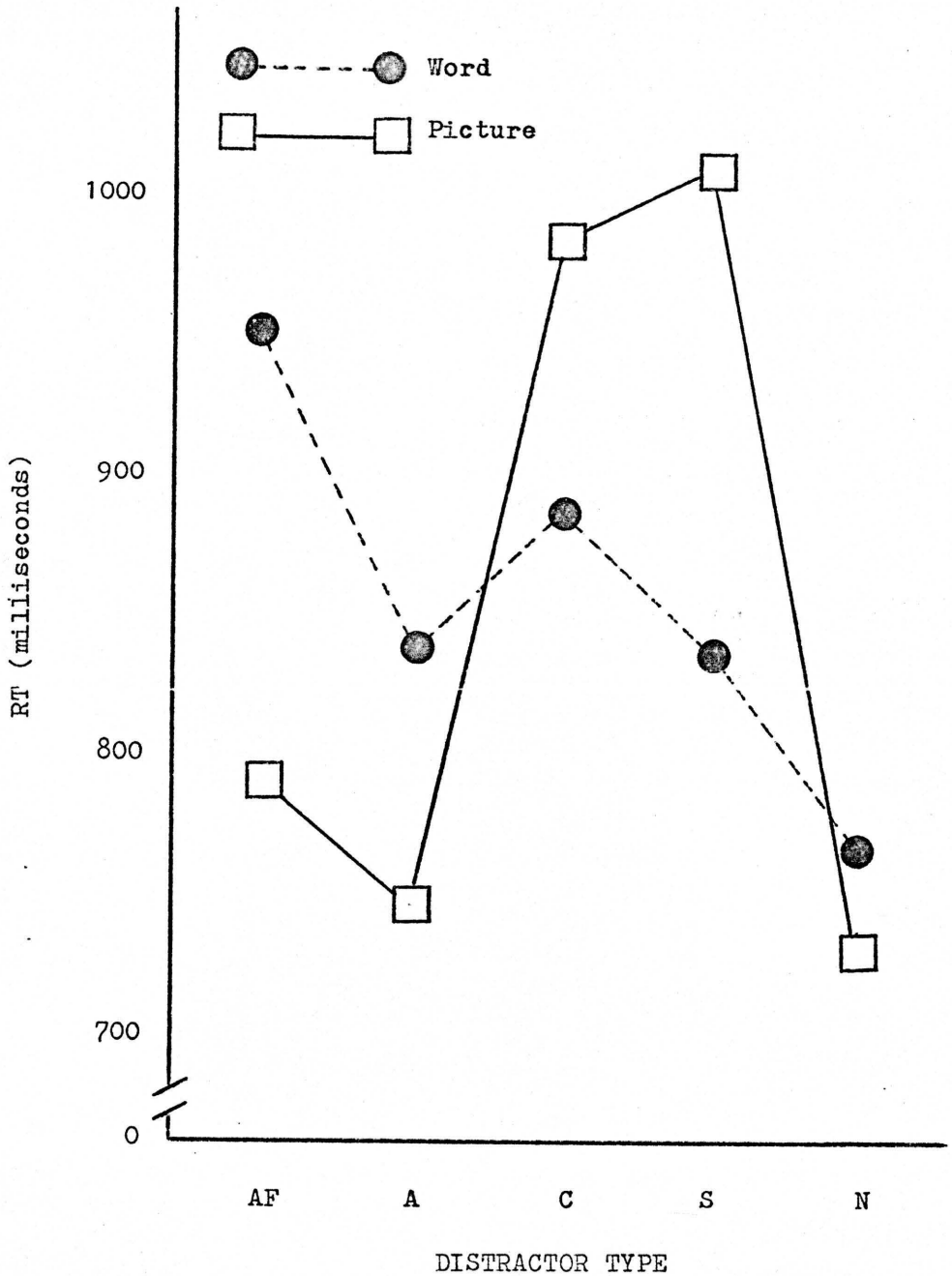


Fig. 2. RT as a Function of Presentation Mode and Distractor Type.

depicted as a picture, S and C distractors yielded longest RTs. This interaction is illustrated in Fig. 2, in which RTs for each type of distractor are plotted as a function of mode in which target object was depicted.

Test Mode and DT also interacted significantly ($F = 14.41$, $p < .001$). When the test stimulus was a word, AF distractors produced the longest RTs. Schematic and Conceptual distractors generated longest latencies when the test object was pictured. The interaction can be examined more closely in Fig. 3.

It is evident from Fig. 2 and Fig. 3 that a distractor related verbally to the named target object leads the subject to delay longer in reporting his decision when either the target or the test object is presented as a word, and less when either is pictured. On the other hand, a distractor which resembles the target object in shape increases RTs when the target or test objects are pictures, but has a much weaker effect when they are words. It is interesting that C distractors yielded relatively long latencies under both kinds of depiction and for both presentation and test modes, although the effect was greater for pictorial representation. In all cases, the N items produced the fastest responding.

Signal Detection Analysis

In any single-stimulus recognition experiment, response biases may confound the data. For example, in the present procedure the

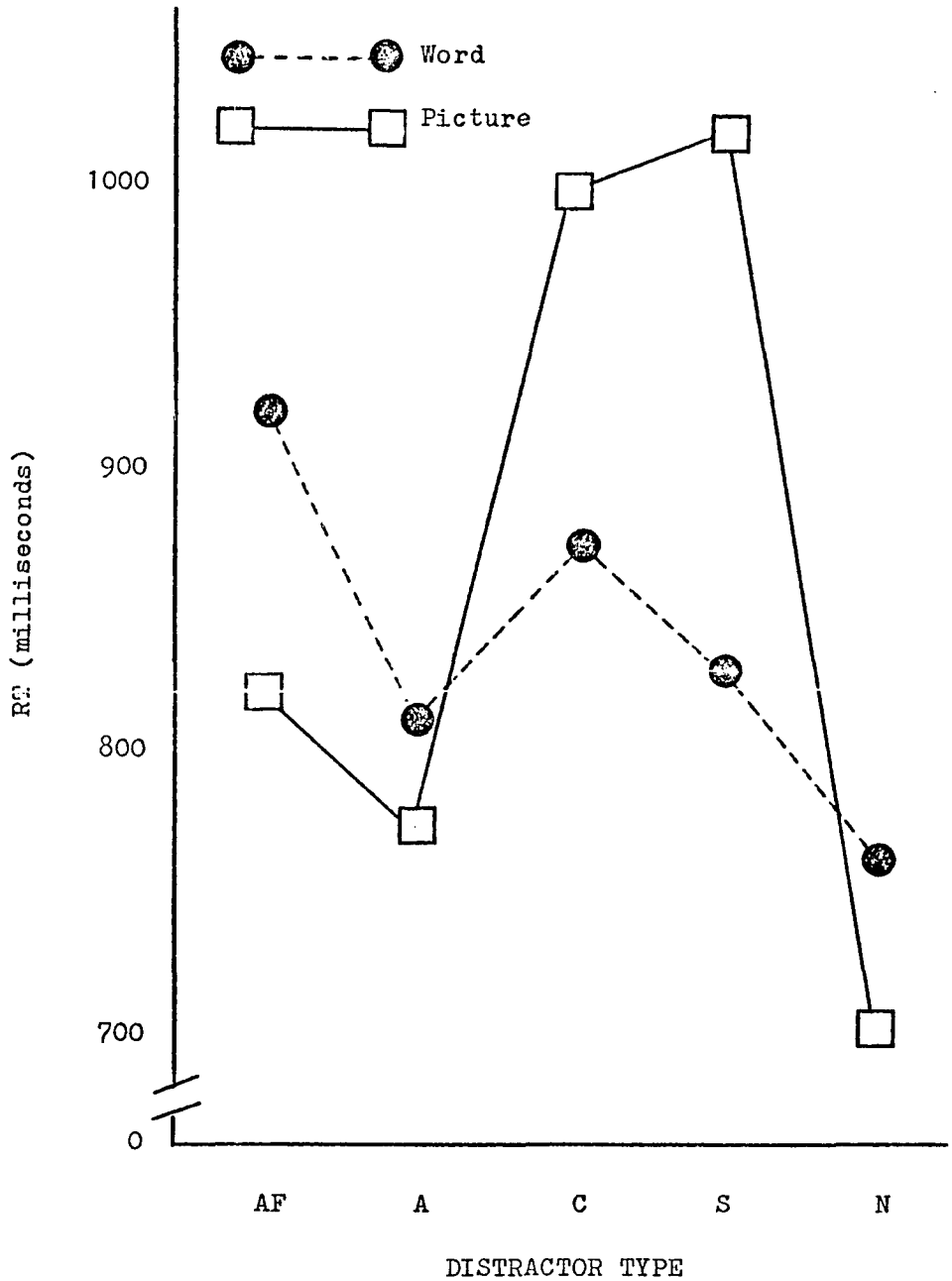


Fig. 3. RT as a Function of Test Mode and Distractor Type.

high ratio of distractor to matching items among the test stimuli may have biased some subjects toward making different judgments. In such situations, analytical methods derived from the theory of signal detectability (TSD) are helpful. They can provide a means for distinguishing an observer's response bias from his ability to discriminate between target and non-target test items. Thus a TSD analysis of the data could provide a more sensitive and valid index of performance.

A TSD analysis essentially involves a comparison of false alarm rate to hit rate. In a single-stimulus recognition paradigm, the hit rate (HR) is the tendency of the subject to correctly judge a target repeated during the test phase as being the same as the target item originally presented during the study phase. The false alarm rate (FAR) is the tendency for the subject to incorrectly identify a distractor as being the same as the originally presented target. For a given set of observation conditions, HR and FAR can be compared by constructing a "receiver operating characteristic" (ROC function) for each particular type of distractor.

In the present experiment, RTs for same judgments were used to estimate HR; while RTs for different judgments were used to estimate FAR. Each of the four possible combinations of PM and TM (i.e., WW, PP, PW, WP) was considered to constitute a separate set of observation conditions within which the effect of Distractor Type could be assessed by TSD methods. Specifically, within each combination of depiction modes long different RTs for distractors were compared to short same RTs for target stimuli. In effect, an ROC function was generated.

In TSD methodology, the distance from the ROC to the positive diagonal indicates the observer's sensitivity, or in this case the subject's ability to quickly and accurately distinguish a repeated target from a distractor among the test stimuli. Although $\underline{d}'$ and $\underline{d}_s$ are the distance parameters most frequently used, $\underline{d}_m$ was chosen for this analysis. The $\underline{d}_m$ index is the average distance of all points on the standardized ROC curve from the positive diagonal. It should therefore reflect actual observations better than the two more common measures. The rationale and statistical procedures involved in using $\underline{d}_m$ have been presented elsewhere (Wheeler, Daniel, Seeley, and Swindell 1971).

Results of the TSD analysis are presented in Fig. 4. Mean $\underline{d}_m$ values are plotted separately under WW, PP, PW, and WP conditions as a function of Distractor Type. Low $\underline{d}_m$ values indicate that the observer had difficulty discriminating distractors from target objects. High $\underline{d}_m$ values indicate that subjects quickly and accurately judged distractors as being different from target stimuli. If a particular type of distractor was difficult to discriminate under a given combination of PM and TM, it is likely that the observer percieved the distractor as similar to the target item under those conditions of depiction. Conversely, higher $\underline{d}_m$ values reflect more easily made discriminations and suggest that percieved similarity was low for the type of distractor in question. Thus the TSD analysis can be used as a sensitive and relatively unbiased estimate of the way the discriminability of different distractor types varies with the conditions of depiction.

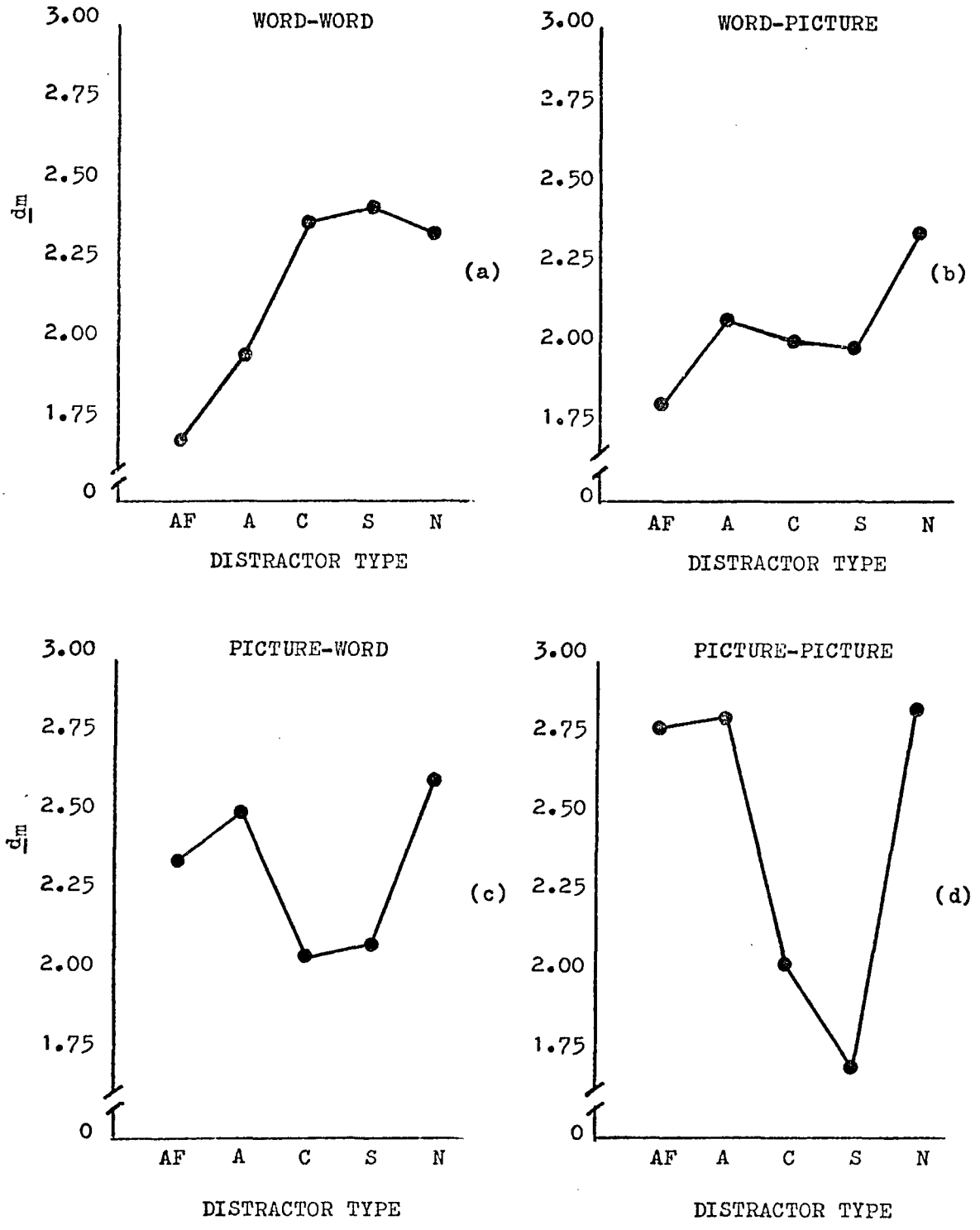


Fig. 4. The Signal Detection Index, d_m , as a Function of Presentation Mode and Distractor Type.

WW Depiction

When target and test objects both appeared as printed words, mean $\underline{d}_m$ was lowest for AF and A distractors and highest for N items. Subjects accurately judged C and S distractors as quickly and easily as they did N distractors. Evidently, subjects perceived distractors as similar to targets only along dimensions represented by AF and A items. This was the only condition of depiction in which C distractors did not reduce the observer's sensitivity relative to his performance on neutral items. Notably, mean $\underline{d}_m$ values for AF distractors were lower than for A distractors.

PP Depiction

When both target and test objects were pictured, subjects were able to distinguish easily between target objects and the AF, A and N distractors. Values of $\underline{d}_m$ for these distractor types were high and about equal. As expected, lowest mean $\underline{d}_m$ occured for S items. Subjects apparently perceived these stimuli as more similar to the target objects when both were pictured. Conceptual distractors were also found to be considerably less discriminable than N items.

WP Depiction

When the target stimuli were presented as printed words and the test items as pictures, mean $\underline{d}_m$ was highest for N and lowest for AF. A, C and S distractors yielded intermediate values of $\underline{d}_m$. AF stimuli were less discriminable than A distractors, suggesting that subjects perceived AF items to be more similar to target stimuli than were A

items. Apparently, formal similarity was involved in the subjects' decision making process even when the AF distractors appeared only as pictures and were not viewed as words.

PW Depiction

When the target stimuli were presented as pictures and the test objects as printed words, mean $\underline{d}_m$ was highest for N and lowest for C and S distractors. A items were hardly less discriminable than N, although subjects seemed to find AF distractors less discriminable than A items. It is also interesting that subjects perceived S distractors as similar to target objects even though the distractor appeared as a printed word rather than a picture.

DISCUSSION

The recognition task proved to be easy, and all subjects responded with perfect accuracy. A more sensitive RT measure proved to be effective and indicated systematic variations in memory for the object stimuli employed. Specifically, subjects responded differentially to the distractor types as a function of the depiction mode (picture vs. word) of the target and test stimuli. TSD procedures were also applied to the RT data in order to provide a less biased and more sensitive estimate of subjects' ability to distinguish target from non-target test stimuli.

Results of the TES analysis were generally consistent with the ANOVA of different-judgment RTs. Both analyses indicated that subjects perceived verbally related distractors (AF, A) as being more similar to target items when the target stimulus, the test stimulus, or both appeared as printed words. Conversely, subjects perceived visually related distractors (S) as more similar to targets when one or both of the stimuli were pictured.

As expected, AF and A distractors were most difficult to discriminate under condition WW, and they were most easily and quickly discriminated under PP. The reverse held true for S distractors. These results are consistent with predictions based on the DEH. Similarly, it was not surprising that subjects perceived verbally related distractors

as similar to targets under condition WP. According to the DEH, subjects would have verbally labelled the pictured object and could have used that information in making their decisions.

On the other hand, several unexpected findings proved to be inconsistent with the DEH. According to the DEH, shape related distractor items should have been easily distinguished from targets under condition WP, since subjects would have encoded and stored very little visual information about the target object when it was represented by a printed word. However, under condition WP mean $\underline{d}_m$ for S distractors was considerably lower than for N items. In fact, it was about as low as for A items.

The DEH also implies that S items should be easily discriminated under condition PW, since subjects would have encoded very little shape or visual information from the distractor items when they were presented as printed words. However, mean $\underline{d}_m$ was again unexpectedly low for shape distractors under this condition of depiction. Contrary to the predictions of the DEH, it would seem that almost as much visual information about an object may be spontaneously encoded from the word label for the object as from the picture of the object.

Another unexpected finding was that C distractors produced low and approximately equal $\underline{d}_m$ values under PP, PW and Wp conditions of depiction, but had no comparable effect under WW. It appears that under WW depiction subjects make their decisions entirely on the basis of the verbal properties of the word label for the stimulus objects. That is,

subjects ignored information about the non-verbal properties of the objects. Yet when a picture is presented, subjects may process and use information about the object itself, including its categorical or functional relationship with other objects.

Several further findings emerged when the effect of the four conditions of observation upon a single type of distractor was considered. AF distractors were least discriminable under WW and WP, more discriminable under PW, and most discriminable under PP. This suggests that the depiction mode (picture or word) tends to "set" the subject to perceive similarities along certain dimensions, since mean $\underline{d}_m$ for AF under WP was almost as low as for WW, but was much higher under PW. This same pattern of results was found for A distractors.

As indicated above, C distractors yielded relatively low and about equal $\underline{d}_m$ values for all conditions except WW, which yielded a high value. Evidently, the presentation of a picture may induce subjects to encode or use a wider range of information about the stimulus object. As expected, S distractors yielded lowest $\underline{d}_m$ values under PP and highest values under WW. Neutral distractors were most easily discriminated under PP, less easily discriminated under PW, and least easily discriminated under WW and WP. The discriminability of N items in the present study was similar to the results reported by Wicker (1970) in a combination paired-associate and recognition paradigm using pictures and words.

The present study indicates that subjects extract and use several kinds of information from both verbally and pictorially depicted objects.

In a single stimulus recognition experiment, subjects were found to use the formal properties of written words, the acoustic properties of the spoken word, and the figural or shape properties of the object itself. They also considered the functional and categorical relationship between target and test objects in making their decisions. Since these kinds of information were extracted from both pictures and words, it is possible that picture-word differences in memory are not in fact mediated by the automatic arousal of particular coding systems as suggested by the DEH (cf. Paivio and Csapo 1969). Rather, it would appear that representational formats may influence subjects' information processing and decision making strategies and not simply their spontaneous encoding of information. This conclusion is consistent with the increasingly popular view that human cognitive processes involve active operations on incoming stimuli rather than passive reception and processing of input.

REFERENCES

Dilley, M. G. and Paivio, A. Pictures and words as stimulus and response items in paired-associate learning of young children. Journal of Experimental Child Psychology, 1968, 6, 231-240.

Paivio, A. Mental imagery in associative learning and memory. Psychological Review, 1969, 76, 241-263.

Paivio, A. On the functional significance of imagery. In H. W. Reese (Chm.), Imagery in children's learning: A symposium. Psychological Bulletin, 1970, 73, 385-392.

Paivio, A. and Csapo, K. Concrete image and verbal memory codes. Journal of Experimental Psychology, 1969, 80, 279-285.

Paivio, A., Yuille, J. C., and Madigan, S. A. Concreteness, imagery and meaningfulness values for 925 nouns. Journal of Experimental Psychology, 1968, 76(1, Pt. 2).

Reese, H. W. Imagery and contextual meaning. In H. W. Reese (Chm.), Imagery in children's learning: A symposium. Psychological Bulletin, 1970, 73, 404-414.

Sampson, J. R. Free recall of verbal and non-verbal stimuli. Quarterly Journal of Experimental Psychology, 1970, 22, 215-221.

Wheeler, L., Daniel, T., Seeley, G., and Swindell, W. Detectability of degraded visual signals: A basis for evaluating image-retrieval programs. (Technical Report 73), Optical Sciences Center, The University of Arizona, Tucson, Arizona, 1971.

Wicker, F. On the locus of picture-word differences in paired-associate learning. Journal of Verbal Learning and Verbal Behavior, 1970, 9, 52-57.