5-1978

Symmetry versus asymmetry in paired-associate learning: A test of the dual coding theory

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SYMMETRY VERSUS ASYMMETRY IN PAIRED-ASSOCIATE LEARNING: A TEST OF THE DUAL CODING THEORY

A Thesis

Presented to the

Department of Psychology

and the

Faculty of the Graduate College

University of Nebraska

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

University of Nebraska at Omaha

by

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May 1978

Acknowledgements

The writer of this thesis wishes to express gratitude and thanks to the members of his thesis committee: Professors Kenneth Deffenbacher (Chairman), John Brickell, Gary Larsen, and Barbara Manning. Their insightful comments and criticisms were invaluable to the completion of this project.

Thanks are also extended to the writer's family and friends for their friendship and support during the course of this thesis. Without them, the motivation needed to complete the project would have expired prematurely.

THESIS ACCEPTANCE

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Symmetry versus Asymmetry in Paired-Associate Learning: A Test of the Dual Coding Theory

The dual coding theory of imagery (Paivio, 1975) holds that there are two independent coding processes: Imaginal processes and verbal processes. Imaginal processes, in effect, present information "all at once" to the organism. Verbal processes, according to the dual coding theory, are characterized by a sequential mode of organization. Sequentially organized information is processed temporally by the organism, with meaning contingent upon the order of processing. The proposed thesis seeks to test the validity of Paivio's dual coding theory of imagery through the paired-associate learning paradigm.

The Dual Coding Theory

Paivio considers images to be analogue representations of perceptual information. The image is not a static entity but, rather, a dynamic process. Without the contribution of dynamic imaginal processes, verbal thinking would be less flexible and creative. The imagery system processes nonverbal information stored in the form of images. The verbal system, though, is specialized to handle abstract linguistic units which by their very nature are discrete and sequentially arranged. According to Paivio, verbal units are only indirectly and arbitrarily related to veridical entities, whereas images can be said to mirror them. Images, then resemble perceptual objects; words only symbolize them.

The major dimension chosen by Paivio to differentiate imaginal and verbal processes is a temporal one. Information units contained in the image are simultaneously available to the organism for perusal and retrieval, even though retrieval itself may proceed serially because of the nature of the other systems that operate on the image. For example, the information contained in an image of a room is available all at once, but one, nevertheless, describes and lists its contents in a serial manner. When one describes the contents of his living room, he usually begins by describing the items to the left of the room's entrance and then proceeds in a clockwise manner to describe the rest of the room. Such a procedure could convince one that imagery possesses a sequential structure. Yet, as Paivio points out, if the same person is asked what is on the right as he enters the room, he will answer promptly and correctly. To Paivio, this indicates that the layout of the room is available simultaneously in memory. He regards the usual left to right processing as simply a descriptive habit common in our culture.

Paivio feels that information processing approaches to perception and memory are a recent expression of the organization distinctions of the dual coding theory. A major distinction in the information processing paradigm is between parallel and serial processing systems. These systems are subdivided into the spatially and operationally parallel processing systems and the serial and sequential processing systems. Spatially parallel processing is essentially characterized by simultaneity of functioning. Paivio presents the visual system as an example, because simultaneously given information can be processed over a large area of the retina. The defining property of operationally parallel systems is independence of operations rather than simultaneity. In other words, processing can be successive, but the functioning of any element in the system is not contingent on the result of the functioning of another. Serial processing is very similar to operationally parallel processing in that elements are activated one after another, free from any structural dependence between them. In this mode of processing, information units must flow through one at a time, but the order of flow is not subject to constraints within the system. Sequential processing, however, is not only successive, but the specific order is produced and determined by constraints within the system.

Paivio defines the imagery system as a parallel processing system which can function in both the spatial and operational modes. The verbal system, though, is primarily sequential but can also function in an operationally parallel mode. Paivio feels that the imagery system can not function directly as a sequential processor, whereas the verbal system can not function directly as a spatial processor.

Paivio's distinction is illustrated, again, by the living room example. The information was simultaneously available and free from sequential hindrances, thus, it was both operationally and spatially parallel. The sequential presentation of the information reflects motor and verbal mediation instead of an intrinsic sequential organization of the image. Verbal processes, Paivio adds, can be operationally parallel since one can substitute words of the same grammatical class into a particular grammatical frame. The substitutions will not be sequentially hindered in any strong sense. The word eventually used is determined, instead, by semantic considerations.

In an earlier study, Paivio (1971) compared visual and imaginal processes by having subjects generate images of the letters of the alphabet read in forward and backward directions. The sequential nature of the alphabet determines the order for the generation of the images of the specific letters but does not dictate the shape of, nor the order in which, one describes the characteristics of a particular letter. In other words, the order of the letters demands that the image of an A precede the image of a B, but the lines and angles of an A or a B are available in the image simultaneously.

Paivio (1975) put several other implications of his theory to empirical test. He reasoned that imagery would be increasingly favored over purely verbal thought as an associative mechanism, if subjects are asked to memorize an increasing number of words. This should occur because, theoretically, imagery is free from the sequential constraints that characterize verbal processes and, therefore, would be more conducive to the rapid encoding of discrete units into synchronously organized structure. The sequential constraints that do characterize linguistic processes should increasingly inhibit the encoding of words into higher-order structures as the number of words to be memorized increases. As Paivio said, "Things can be joined together in a variety of ways to form a meaningful image, but words do not enjoy a similar degree of freedom in sentences" (Paivio, 1975, p. 153).

Paivio (1975) tested his predictions by showing subjects two, three, or four unrelated nouns and asking them to produce either an image or a sentence that would interconnect the nouns or their imaged referents in a meaningful way. He also instructed the subjects to reveal their cognitive processes by writing the interconnected sentences or drawing pictures of the images. Paivio employed the time it took a subject to begin writing or drawing as a sign of the speed of the imaginal and verbal encoding.

It should be noted that Paivio used both concrete and abstract nouns. He reasoned that concrete nouns would more readily elicit images because unambiguous referents would be immediately available for those words. The word "chair" elicits an image more readily than the word "justice." Abstract nouns like "justice" do not directly refer to sensory objects. They are abstract concepts that represent ideas instead of perceptual objects. Consequently, abstract nouns do not readily elicit images.

Paivio's (1975) results supported his prediction to a large extent. As the number of words increased, the imagery subjects responded faster than the verbal subjects to concrete words. With abstract words, as the number of words increased, the difference in response latencies between the imagery and verbal subjects decreased, although the imagery subjects were never faster than the verbal subjects regardless of the number of words. The verbal subjects were faster in interconnecting abstract words in a sentence than were the imagery subjects in joining together the same abstract words in an image. Yet, the response latencies of the verbal and imagery subjects were less different as the number of items to be joined together increased. Paivio interpreted these results as indicating that verbal encoding is more sequentially constrained than imaginal encoding. With more items in a set, verbal encoding is more hindered than imaginal encoding since there are more sequential contingencies to deal with in the former.

In earlier research, Begg and Paivio (1969) examined concrete and abstract sentences which underwent either lexical or semantic transformations. They felt that a concrete sentence such as "The fat boy kicked the girl" can be imaginally represented as an action picture in which the meaning of the entire sentence is summarized as a single organized unit or complex image. On the other hand, the information contained in an abstract sentence such as "The proposition was illogical" depends on the sequentially organized verbal units and can be imaged only with great difficulty. From these determinations, Begg and Paivio deduced that the most efficiently coded, stored, and retrieved aspects of a concrete sentence will be those related to the sentence as a whole unit, such as its meaning. In abstract sentences, though, the specific words and not the meaning will be relatively better remembered.

Begg and Paivio tested their hypothesis by presenting abstract and concrete sentences to subjects and then changing the sentences semantically or in wording. The results supported their hypothesis. Semantic changes in concrete sentences were recognized better than the lexical changes. Conversely, lexical changes in abstract sentences were recognized better than the semantic changes. The results supported the notion that meaning and the words used to convey meaning are more closely intertwined in abstract sentences than in concrete sentences. Concrete sentences represent a perceptual arrangement or event which has a meaning that is not only linguistic.

Further support for the dual coding theory was obtained by Segal (Note 1). Subjects were presented two, three, or four items either as line drawings of objects or as their verbal labels. Segal predicted, as would Paivio, that the latency of verbal encoding of the items would increase more steeply with an increase in set size than would imaginal encoding. The dual coding theory would also predict, concerning the effect of pictures versus words, that pictures would have a more direct access to the imagery system, and imaginal encoding would be faster with pictures than words.

The prediction for verbal encoding of pictures relative to words depends upon one's theoretical orientation concerning the mechanism that generates verbal description. If one feels that a purely verbal associative mechanism generates a sentence that integrates spatial items, then verbal encoding latencies should be faster for words than for pictures because the words have direct access to the verbal system. If one assumes, as does Pylyshyn (1973), that the organized descriptive representation is in some kind of abstract propositional form that is neutral with respect to input modality, then the encoding time should be the same for pictorial and verbal presentations except for the initial time it takes to identify the items perceptually. A third possibility is that a concrete sentence describes perceptual information after it has been organized and represented in the imagery system. From this it follows that pictures would have the advantage over words even in sentence generation, especially so, when the number of items involved is large.

After being presented the line drawings or the words, Segal's subjects were asked to generate either meaningful sentences or meaningful images that would integrate the items of a set. When they had the image or sentence, subjects pressed a key and then wrote or drew on a piece of paper the sentence or picture that represented the image. Segal found that verbal encoding latencies increased much more steeply than imaginal coding latencies with more items in the set. This result held for the picture labels as well as for the picture items. Also, encoding latencies were faster for pictures than for words, especially for more items. This was expected for imaginal encoding, but the similar result for verbal encoding suggests that the pictures activated the processes necessary for producing a descriptive sentence more efficiently than did words.

Pylyshyn might argue that the pictures simply have the advantage in terms of initial scanning or reading time and that the organization and generation of the sentence is guided by an abstract propositional system which is neutral with respect to input modality. Paivio would reply that if Pylyshyn was correct then one would expect the same advantage for pictures even when only two items were involved. The results showed that this was not the case. With two items in a set, words were processed slightly more quickly than pictures. The data, in other words, are congruent with the interpretation that encoding into meaningful structures is more efficient with pictures as opposed to words. Thus, the simultaneously available pictures have direct access to an imagery system that changes them into synchronously integrated schemas; the verbal processes required to produce descriptive sentences are then activated. The differences between latencies for pictures and words seem to be due to processes that organize three or four units into information structures that generate linguistic descriptions. With more items in a set, words have an increasing disadvantage, for the images must be generated indirectly and sequentially from the separate items, retained in that form, and then transformed into imaginary scenes before sentences can be produced.

Imagery and Paired-Associate Learning

The studies of Paivio (1975), Paivio and Begg (1969), and Segal (Note 1) supported the notion that there are distinct differences between imaginal and verbal encoding. The dual coding theory holds that these differences are more than trivial in that the two processes constitute distinct yet interdependent trains of information coding. Language is more than a lexicon and syntax, and imagery is not merely an epiphenomenon of an abstract core of meaning. Since much of language refers to concrete entities, it is enriched by the imaginal concomitants of many words. In return, language gives order and logical direction to imagery. Yet, the essence of the dual coding theory is that images are different from words. Images contain information that is simultaneously available. Words convey information that is contingent upon order of processing. From this primary distinction, one can deduce that imaginal associations in paired-associate learning are synchronic whereas purely verbal associations are sequential in nature. Paivio has found support for this notion in the area of paired-associate learning.

Asch and Ebenholtz (1962) theorized that associations are always symmetrical, i.e., the association formed is bidirectional. "House" elicits "tree" with the same ease that "tree" elicits "house." Yet, Paivio (1975) feels their view is incorrect when one examines purely verbal associations that have been formed under conditions of unidirectional associative experience. Verbal associations are sequentially constrained in contrast with imaginal associations that are synchronously organized. This distinction lies at the core of the dual coding theory, and the paired-associate task provides a very adequate means for its empirical test.

A specific prediction generated by the dual coding theory is that image-mediated paired-associate recall, which is assumed to accompany picture and concrete noun-pairs, should be symmetrical regardless of which member of the pair is used as the retrieval cue. It is assumed, though, that picture and concrete noun-pairs elicit images that tie the paired items together. On the other hand, for pairs of abstract words, forward recall should be easier than backward recall, since the associations of abstract pairs are mediated by sequentially organized verbal processes.

Smythe (Note 2) tested these predictions. In his experiment, subjects were presented lists of pairs consisting of pictures, concrete words, or abstract words as items. With either the left-hand or right-hand item used as the retrieval cue, recall was subsequently tested by having the subjects respond verbally with the appropriate associate. In accordance with the symmetry hypothesis, differences in recall symmetry occurred as a function of pair type. Picture and concrete noun-pairs produced symmetrical backward and forward recall. Abstract noun-pairs resulted in higher forward than backward recall. These differences, though, were quite small. Smythe measured the latency of a subject's correct response as an additional dependent measure and found it to be more sensitive than recall measures to differences in associative directionality.

Other studies, though, have failed to unequivocally support Paivio's hypothesis. Wollen and Lowry (1971) found that there was virtually no difference between forward and backward recall when the imagery rating of noun-pairs was varied. Low-imagery noun-pairs resulted in symmetrical recall as did the high-imagery noun-pairs. Mondani and Battig (1973) found that when subjects were presented unmixed lists comprised of only abstract or only concrete noun-pairs, there were no significant forward-backward recall differences between concrete and abstract pairs. But, when subjects were presented mixed lists, significant differences in forward-backward recall resulted. In mixed lists, according to Mondani and Battig, subjects employed appropriate mnemonic strategies. As a result, abstract noun-pairs were recalled more efficiently in a forward rather than backward direction, while the recall of concrete noun-pairs was asymmetrical. These results supported Paivio's hypothesis.

Mondani and Battig attributed the nonsignificant differences between concrete and abstract pairs within unmixed lists to the subjects' meager usage of the appropriate (imagery and verbal) strategies in unmixed lists. Subjects in their study were instructed prior to their learning two unmixed and one mixed lists in the use of imaginal and verbal nmemonics. They were allowed to use those strategies or any others they considered effective in learning the pairs. Apparently, in unmixed lists, the subjects used inappropriate mnemonics. When subjects, though, were tested for <u>uncued</u> recall, they recalled many concrete pairs from the unmixed lists in a reverse direction. In other words, subjects recalled the pair "house-book" as "book-house," for example. Because of this result, Mondani and Battig felt that there was evidence from both types of lists showing that associative symmetry holds for concrete pairs processed by imagery.

Mondani and Battig attributed the contrary results obtained in the Wollen and Lowry (1971) study to the fact that Wollen and Lowry's subjects learned only a concrete or abstract list but not both. Mondani and Battig speculated that many subjects use the same mnemonic strategy (usually imagery) in learning abstract or concrete pairs from an unmixed list. When the pairs are the same within a list, i.e., all concrete or all abstract, subjects fail to use the appropriate mnemonic strategy. A subject, in learning a list of abstract pairs, may attempt to image all of them. Mondani and Battig feel that experience with both types of pairs within a single list leads to an increased use of differentiated imaginal and verbal strategies for concrete and abstract pairs. The symmetrical recall of low-imagery noun-pairs in Wollen and Lowry's experiment was presumably due, according to Mondani and Battig, to the subjects' use of imaginal strategies in learning abstract pairs. The Wollen and Lowry subjects, however, were not instructed to use imaginal or verbal mnemonics. The subjects were not instructed in the use of any mnemonic; they were just presented noun-pairs and, in addition, pictures which corresponded with the pairs. For example, accompanying the noun-pair "table-gun" was a picture of a gun and table. It was most likely this procedure and not inappropriate mnemonics that led to the symmetrical recall of low-imagery noun-pairs, since pictures would be processed, presumably, in the nonverbal imaginal code. And if pictures did accompany the low-imagery noun-pairs, then the noun-pairs could not have been very abstract. It would be impossible to present a picture of the noun-pair "theory-idea."

The findings of Smythe (Note 2), Wollen and Lowry (1971), and Mondani and Battig (1973) did not unequivocally support Paivio's hypothesis. The present thesis was designed to produce more decisive evidence for the asymmetry hypothesis which is an integral implication of the dual coding theory. The dual coding theory emphasizes the differences between imaginal and verbal processes in terms of the associations the two processes produce. Imaginal associations contain synchronously organized information with the associated items available simultaneously. Verbal associations, free from any imaginal mediation, are sequential in regards to their intrinsic structure.

This thesis, then, used Paivio's dual coding interpretation of imagery as a theoretical base and the paired-associate task as its experimental paradigm. Subjects were presented abstract and concrete noun-pairs under either imagery or rote-memory instructions. The subjects were tested for forward and backward recall in the study-test method of paired-associate learning. It was hoped that the present experiment would provide a more direct test of the asymmetry hypothesis than the aforementioned studies. The imagery and rote-memory instructions were used to provide control for mnemonics used by the subjects. In addition, mixed lists of abstract and concrete noun-pairs were presented in order to prevent the unmixed list confounding of the Wollen and Lowry and Mondani and Battig studies.

Predictions

In terms of specific predictions, the dual coding theory leads one to expect an overall main effect for concrete versus abstract noun-pairs. Concrete noun-pairs should be recalled more frequently and faster than abstract noun-pairs. Also, imagery instructions should lead to more frequent and faster recall than the rote-memory instructions. Both of these predictions have been supported many times in the literature, (e.g., Paivio & Foth, 1970). In addition, the left-hand members of each pair should evoke a greater number of correct recalls and faster latencies than the right-hand members. There is usually a forward bias in paired-associate learning but no backward bias due to the left-to-right scanning and reading habits common in our culture.

It was predicted that instrcutions would interact with the concreteness rating of the noun-pairs. In the recall of concrete noun-pairs, imagery instructions should lead to far greater correct recall and faster latencies than rote-memory instructions. The difference, though, between the instructions should be negligible in the recall of abstract noun-pairs. This was expected because, theoretically, the imagery instructions subjects should have great difficulty in imaging abstract noun-pairs, so any mnemonic advantage they have over the rote-memorizers should be lost in the recall of abstract noun-pairs.

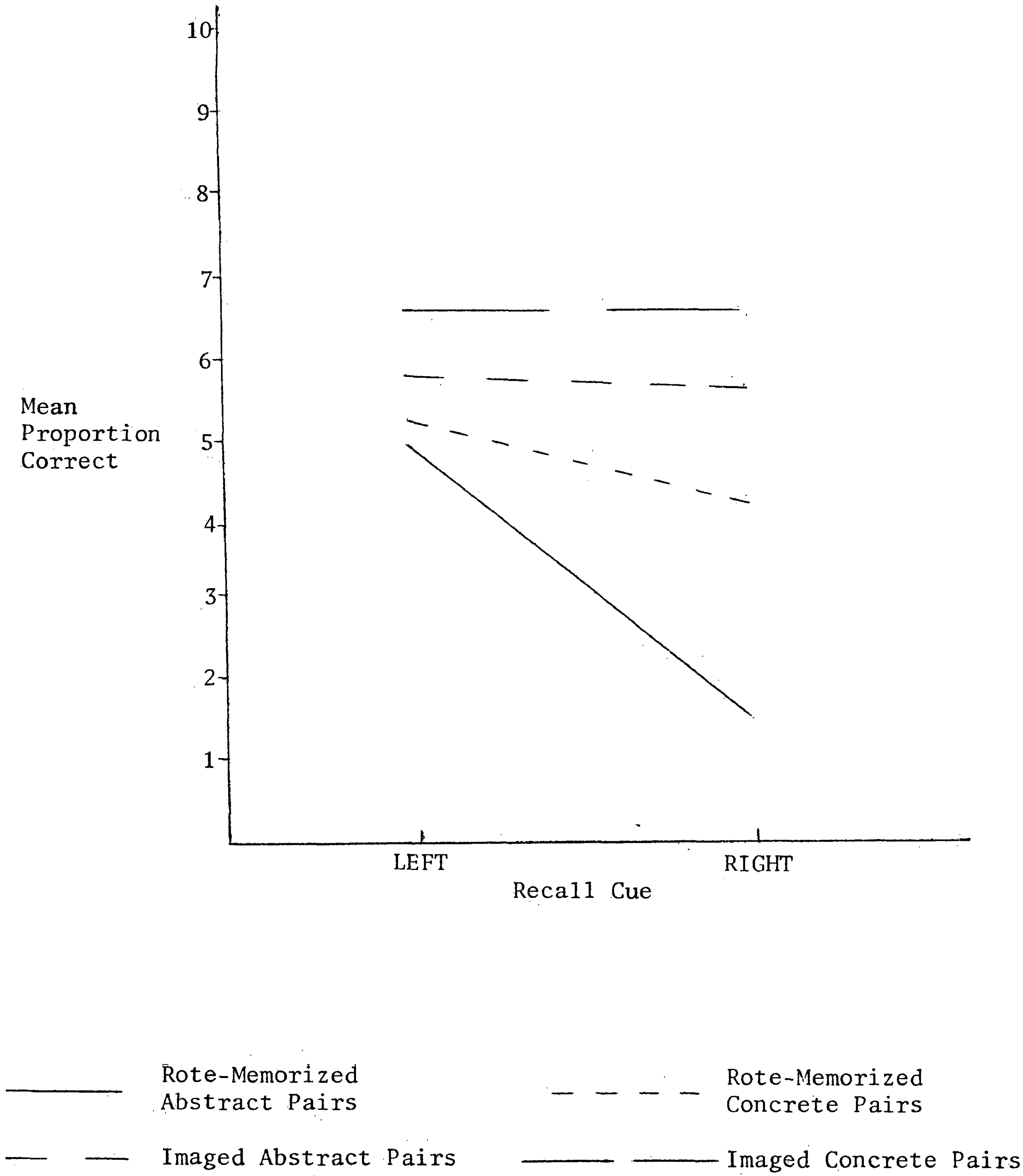
Concerning the main hypothesis, it was predicted that for the imagery instructions subjects, forward and backward correct-recall-frequency and response latency will be equivalent, indicating associative symmetry. There should be an advantage for forward recall over backward recall for the rote-memory subjects. That is, for the rote-memorizers, left-hand cues should lead to greater correct recall and shorter latencies than the right-hand cues. This amounts to an interaction between instructions and cue direction. In terms of an interaction between concreteness and cue direction, left-hand members and concrete words should evoke greater recall and shorter latencies than right-hand members and abstract words. Yet, more importantly, concrete noun-pairs should display more associative symmetry than abstract noun-pairs. The difference between left and right-hand members for concrete noun-pairs should be very small, while the difference between left and right-hand members for abstract pairs should be large. For abstract noun-pairs, the left-hand members should evoke larger correct-recall-frequencies and shorter latencies than the right-hand members.

Finally, a three-way interaction between instructions, concreteness and cue direction was predicted. Figure 1 depicts the predicted interaction. Rote instructions, abstract noun-pairs, and right-hand members should yield a smaller number correctly recalled and longer latencies than imagery instructions, concrete noun-pairs, and left-hand members. The difference between left and right-hand members for imagery instructions and concrete pairs should be small, while the difference between left and right-hand members for rote-memory instructions and abstract pairs should be large. This amounted to the prediction that rote-memorized abstract noun-pairs would show far less associative symmetry than imaged concrete noun-pairs. In addition, it was predicted that rote-memorized concrete pairs would show less symmetry than imaged abstract pairs. The reasoning behind this

Figure 1

Predicted Interaction between Instructions,

Concreteness, and Cue Direction



prediction holds that the instructions will override the inherent differences between noun-pair types. An abstract noun-pair united in an image should display more associative symmetry than a concrete pair memorized by rote.

Method

Subjects

There were 88 subjects in the present experiment. All the subjects, 34 males and 54 females, were students in an introductory psychology course at the University of Nebraska at Omaha. Subjects were either called by the experimenter or enlisted themselves through a signup sheet. All subjects received extra credit towards their final grade by participating in the experiment.

Materials

Sixteen noun-pairs were constructed from words taken from Paivio, Yuille, and Madigan's (1968) list of 929 nouns that were rated by subjects for imagery, concreteness, and meaningfulness. Eight noun-pairs were composed of words rated high in concreteness and imagery; the remaining noun-pairs were composed of words rated low in concreteness and imagery. Both the concrete and abstract noun-pairs were equated for meaningfulness. The mean imagery and concreteness ratings differed significantly for abstract and concrete nouns, $t(15) = 4.49$, $p < .01$, and $t(15) = 4.27$, $p < .01$. The mean meaningfulness ratings, though did not significantly differ for the abstract and concrete words, $t(15) = .64$, $p > .01$. Both the abstract and concrete words included 8 words of AA frequency and 8 words of A frequency in English print (Thorndike & Lorge, 1944).

The pairs randomly constructed from the concrete nouns were: automobile-breast, factory-garden, pipe-beast, mother-nail, rock-string, flag-tower, body-newspaper, and girl-building. The abstract noun-pairs were: necessity-soul, effort-position, evidence-style, chance-duty, amount-theory, safety-moral, answer-justice, and quality-knowledge.

Design

The present experiment utilized a mixed design with two between-group and one within-group variables. All subjects were presented the same abstract and concrete noun-pairs. Half of the subjects were instructed to image the pairs; the others were told to rote-memorize the pairs. Of the imagers, upon recall, half of the subjects received the right member of each pair as the recall cue, and the other half received the left member. The rote-memory subjects were also divided into right-cue and left-cue conditions. In all, there were four groups in the present experiment: imagery-right recall (IR), imagery-left recall (IL), rote-right recall (RR), and rote-left recall (RL).

Procedure

Subjects were randomly assigned to the four groups. Each subject was run individually and received appropriate instructions before the beginning of the experiment (see Appendices A and B for instructions). Each subject was then shown four practice pairs and recall cues. After all questions had been answered, the experiment began.

The noun-pairs were randomly separated into two sets of 8 pairs each. Pretests had revealed that subjects correctly recalled approximately half of the pairs from an 8 pair set. With a 16 pair set, only a fraction of the items were correctly recalled. The 8 pair sets offered the optimal amount of variance for the manipulations of the present experiment to take effect.

Each subject was presented first one set of 8 noun-pairs and then the recall cues for that set. Immediately after the recall for the initial set was completed, the second set of noun-pairs was presented. The order of the noun-pairs and recall cues was individually randomized for each subject.

The pairs were presented at the rate of one every 6.5 seconds. There was a .75 sec. projector slide change time between successive presentations of noun-pairs. In recall, subjects were permitted up to 6 seconds to recall the correct word. This was timed with a stop-watch. The pairs and cues were shown on a wall with a Kodak Ektagraphic Model AF-2 slide projector. Subjects were seated approximately five feet from the wall.

Results

The means of the proportion of items correctly recalled under the imagery and rote-memory instructions, respectively, were .61 and .45. The mean proportion of concrete pairs correctly recalled was .74, and the mean proportion for abstract pairs was .33. Left recall cues yielded a mean proportion of items correctly recalled of .50; right recall cues resulted in a mean proportion of .56. An analysis of variance revealed significant effects for instructions, $F(1,84) = 17.23$, $p < .001$, concreteness, $F(1,84) = 269.58$, $p < .001$, and the interaction of instructions and concreteness, $F(1,84) = 6.46$, $p < .05$. These results supported the predictions that imaging subjects would perform better than rote-memorizing subjects, concrete noun-pairs would result in easier recall than abstract noun-pairs, and that the instructions would interact with concreteness. The significant interaction, depicted graphically in Figure 2, revealed that the difference in recall performance between imagers and rote-memorizers was greater with concrete than with abstract noun-pairs.

Contrary to the predictions, though, there was not a significant effect for the direction of recall cues, $F(1,84) = 2.76$, $p > .05$. In addition, this nonsignificant effect was in a direction opposite of the one predicted since it was predicted that right recall cues would result in poorer recall than left recall cues. The interaction between instructions and recall direction (left vs. right) was also nonsignificant, $F(1,84) = 1.85$, $p > .05$, as was the interaction between recall direction and concreteness, $F(1,84) = .12$, $p > .05$. Not only was the interaction between instructions and recall direction non-significant, in addition, the rote-memory subjects actually performed slightly better in right recall rather than left recall. It was predicted that an asymmetry in favor of left cue (forward) recall would exist for rote-memorizing subjects. It was also predicted that a similar asymmetry would exist for abstract as opposed to concrete noun-pairs. Neither prediction was borne out by the results. Also, the three-way interaction between instructions, concreteness, and recall direction was nonsignificant, $F(1,84) = 2.26$, $p > .05$. This result failed to support the hypothesis that imaged concrete pairs would show the most symmetry while rote-memorized abstract pairs would show the least.

Figure 2

Interaction between Instructions and Concreteness

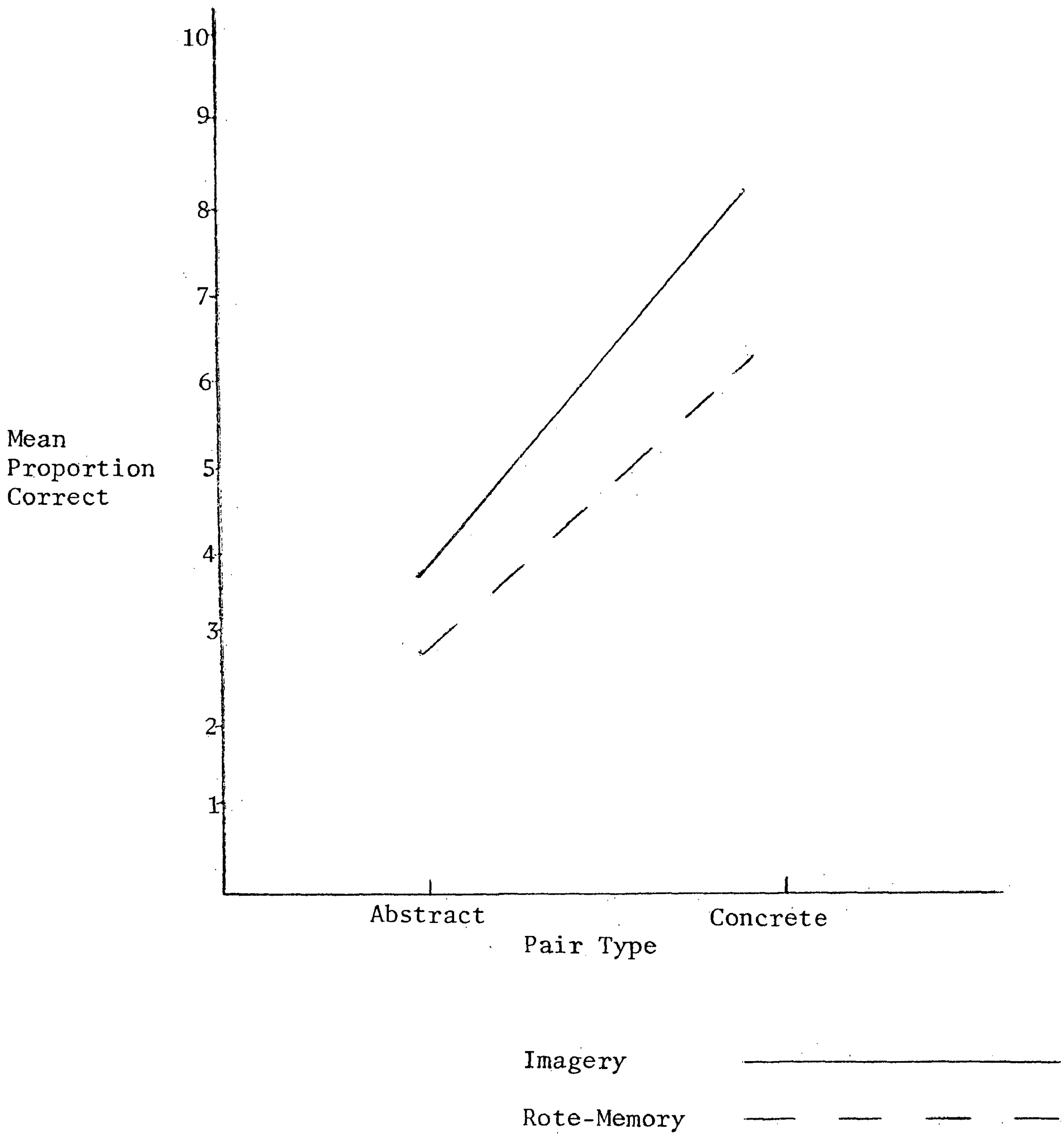


TABLE 1

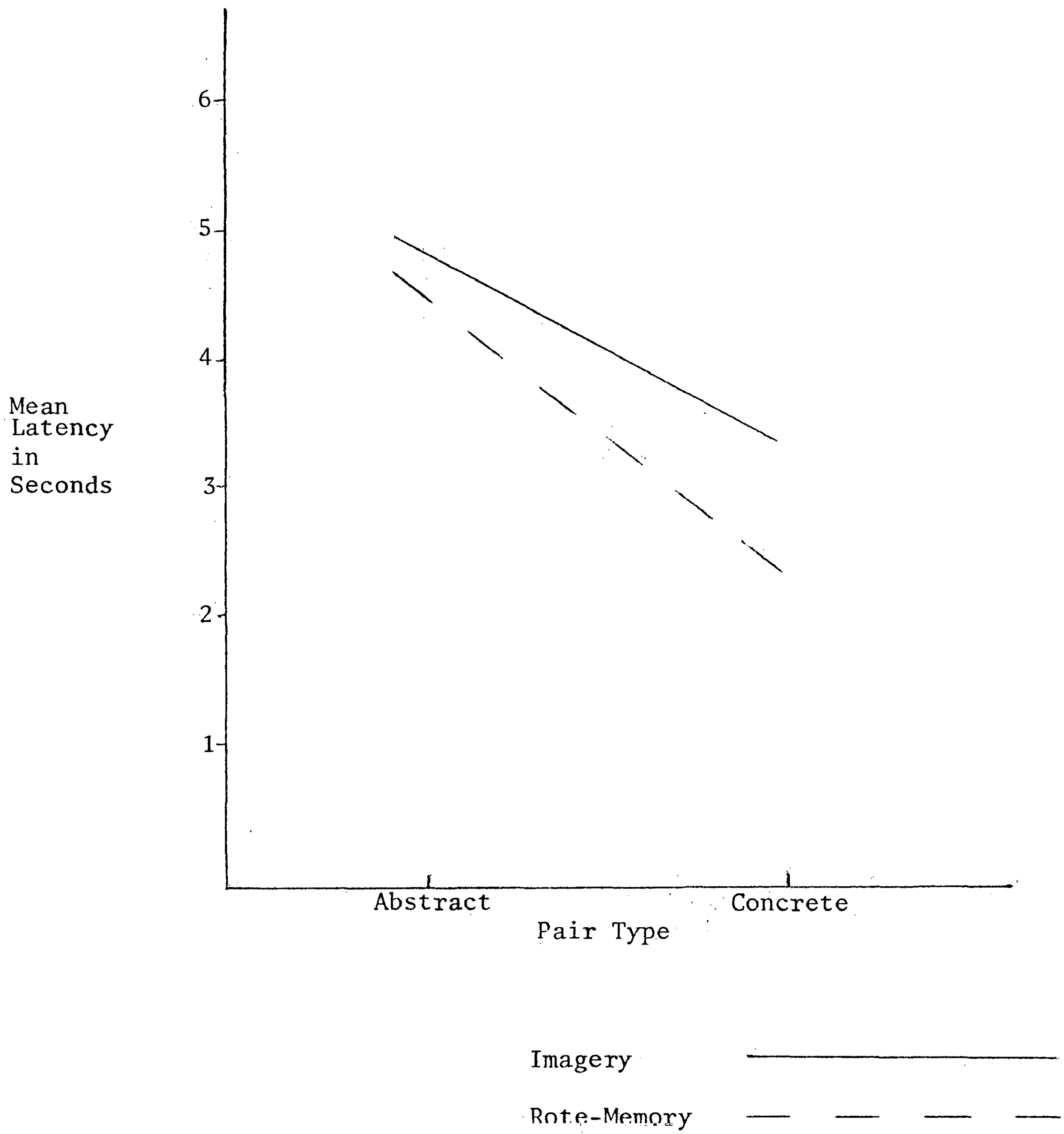
Mean Latencies in Seconds for Different Noun-Pair Types, Mnemonic Instructions, and Recall Cues in Paired-Associate Task

Pair Type	Instructions	Left Cue	Right Cue
Concrete	Imagery	2.25	2.38
	Rote	3.90	2.89
Abstract	Imagery	4.82	4.69
	Rote	5.12	4.88

Table 1 presents the mean response latencies for correct recall in the paired-associate task. A failure to correctly recall was recorded as 6 seconds. Overall mean latencies, not recorded above, were 2.55 for concrete pairs and 4.88 for abstract pairs, 3.54 for imagers and 4.02 for rote-memorizers, and 4.02 for left cue recall as opposed to 3.71 for right cue recall. An analysis of variance showed imagery instructions to lead to significantly faster recall than rote-memory instructions, $F(1,84) = 15.03$, $p < .001$. Concrete noun-pairs were recalled significantly faster than abstract noun-pairs, $F(1,84) = 268.22$, $p < .001$. There was a significant interaction between instructions and concreteness, $F(1,84) = 11.31$, $p < .01$. This interaction is depicted in Figure 3. In addition, a three-way interaction between instructions, concreteness, and recall direction was found

Figure 3

Interaction between Instructions and Concreteness



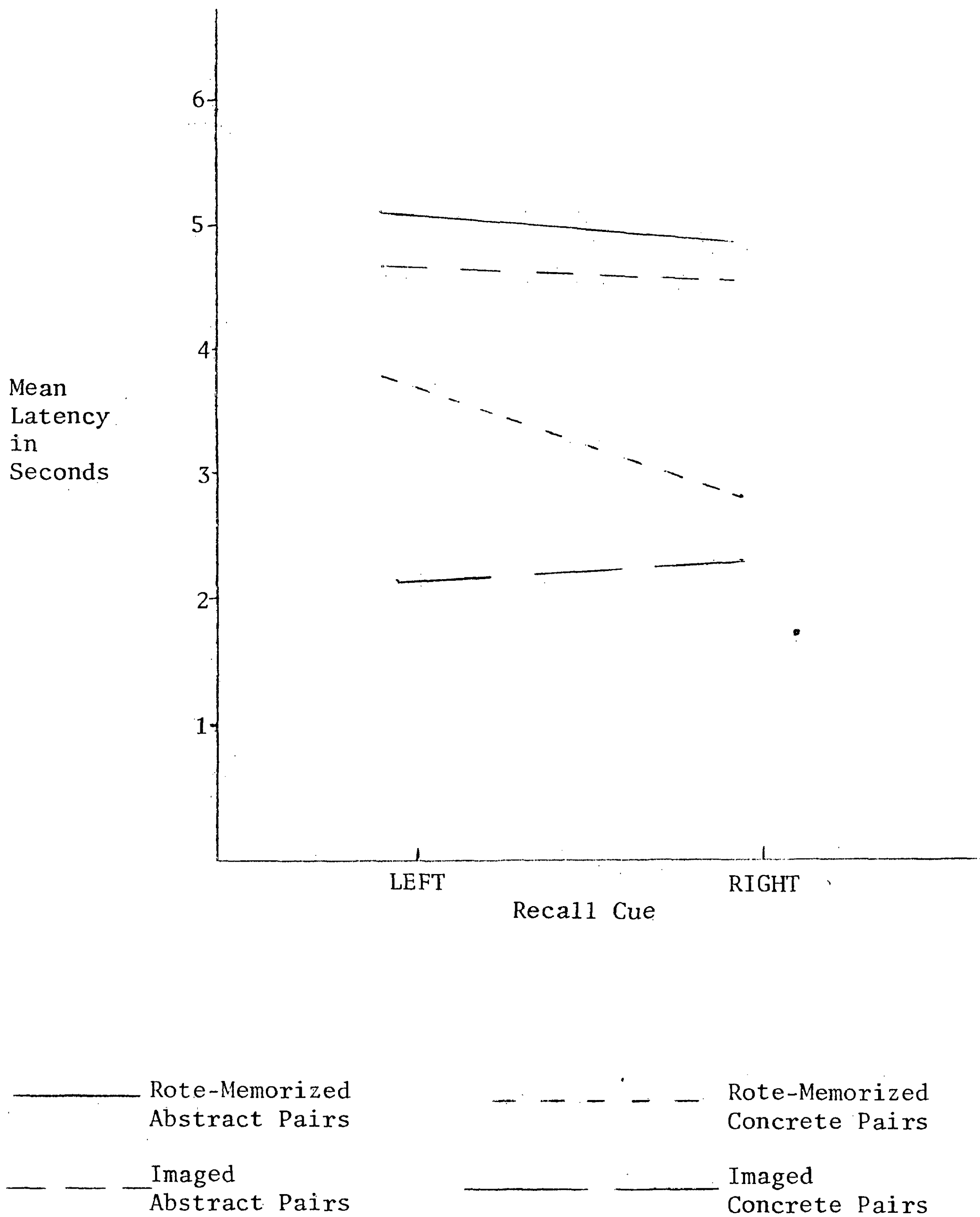
significant, $F(1,84) = 4.25$, $p < .05$. All of the above effects were congruent with the predictions and the proportion correct measure except for the three-way interaction shown in Figure 4. A three-way interaction was predicted with rote-memorized abstract pairs to show the greatest difference (and therefore largest asymmetry) between left cue and right cue recall. The graph shows that rote-memorized concrete pairs produced the greatest asymmetry while it had been predicted that rote-memorized abstract pairs would. Also, the asymmetry favors right cue recall over left cue recall, whereas it has been predicted that the resulting asymmetry would favor left over right recall. The graph shows, though, imaged abstract noun-pairs recalled relatively symmetrically compared to rote-memorized concrete pairs--and relative symmetry for the recall of imaged concrete pairs. These specific findings within the interaction support the predictions.

Contrary to the predictions, there was a nonsignificant main effect for recall cue direction, $F(1,84) = 3.39$, $p > .05$. The difference between the means showed right recall to be faster than left recall. Although this difference was nonsignificant, it had been predicted that left recall would be faster than right recall. Instructions and recall direction failed to significantly interact, $F(1,84) = 3.42$, $p > .05$. As in analyses of the proportion correct measure, this nonsignificant interaction showed asymmetry for rote-memorized noun-pairs--but in a direction opposite of the one predicted. Under rote-memory instructions, right cues led to faster recall than left cues. It had been predicted that rote-memory instructions would lead to faster left as opposed to right recall.

Figure 4

Interaction between Instructions, Concreteness

and Cue Direction



Concreteness and recall direction also failed to significantly interact, $F(1,84) = 1.18$, $p > .05$. It had been predicted that symmetry would hold for concrete but not for abstract noun-pairs. The results did not support this prediction.

Discussion

The results of the present experiment did not support Paivio's hypothesis of associative asymmetry. His hypothesis holds that imaged and concrete noun-pairs will display symmetry while rote-memorized and abstract noun-pairs will not. The hypothesis is derived from the dual coding theory of imagery which states that imagery is defined by synchronic processing whereas linguistic processes involve sequential processing. All except one of the crucial interactions thought to directly test Paivio's hypothesis were nonsignificant. The one significant interaction was significant in the wrong direction. On the basis of the face value of the results, one would have to question the validity of Paivio's hypothesis.

There were, perhaps, certain artifacts of the instructions and experimental design in this experiment that could have confounded a valid test of the associative asymmetry hypothesis. Paivio (1971) stated his hypothesis as such: "To the extent that associations involve visual imagery, they will be symmetrical; to the extent that they involve the verbal symbolic system they will tend to be directed, with the degree of directional asymmetry depending on the relative asymmetry of associative experience involving two or more events" (p. 278). Because of the left to right reading disposition in our culture, one expects the left term of an abstract noun-pair to elicit the right term in recall more readily than the right term eliciting the left. Yet, in the present experiment, subjects were allowed in the rote-memory condition to repeat noun-pairs to themselves in both directions. This could have neutralized the inherent asymmetry of the abstract and rote-memorized noun-pairs.

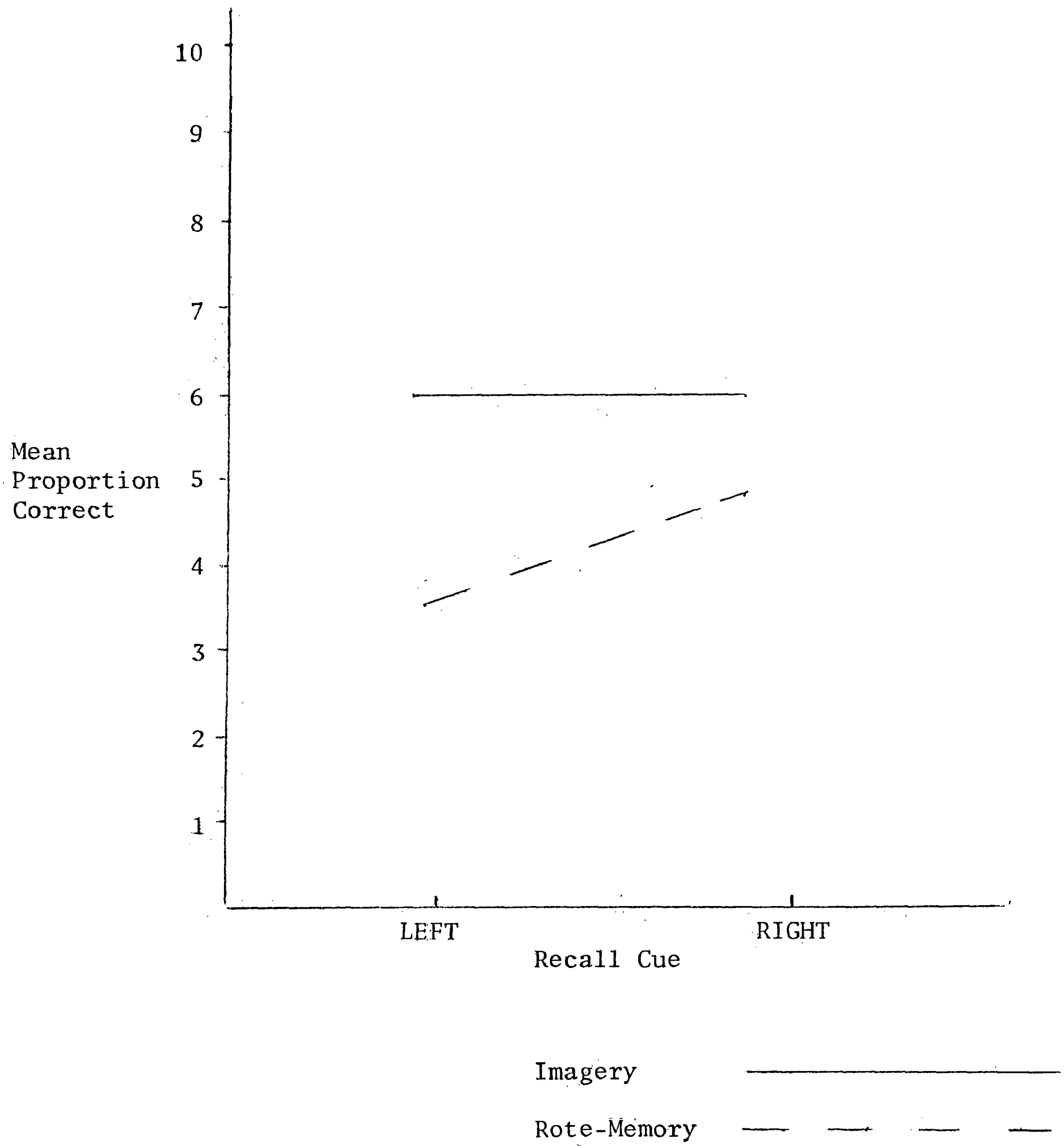
Figure 5 shows a graph of the nonsignificant interaction between instructions and recall cues for the measure of proportion correct. The imaged noun-pairs show almost perfect symmetry while the rote-memorized noun-pairs favor backward recall over forward recall. Since the interaction, itself, was nonsignificant, all one can do is speculate; yet, the backward asymmetry could have been attributed to the subjects' overpractice of the noun-pairs in a reverse direction. The point is that the asymmetry Paivio refers to for imageless noun-pairs can be in either direction. The direction the asymmetry takes may well depend on the conditions governing the learning of the noun-pairs.

It is plausible that the reverse rehearsal might have cancelled out the predicted forward asymmetry. It is also plausible, though, on the basis of the results, to challenge Paivio's associative asymmetry hypothesis. The results supported Asch and Ebenholtz's (1962) proposal that "When an association is formed between two distinct terms, a and b, it is established simultaneously and with equal strength between b and a" (p. 136). In the present experiment, the effect for cue direction was nonsignificant for both measures.

Paivio's dual coding theory can be challenged since a hypothesis derived from his theory failed to acquire support. Pylyshyn (1973)

Figure 5

Interaction between Instructions and Cue Direction



proposed that there is an underlying abstract propositional system rather than separate imaginal and verbal codes. He feels that imagery is epiphenomenal rather than emergent in its role in thinking and memory. Paivio's view that imagery is emergent is to a great extent related to his assumption that imaginal thinking is defined by parallel processing. Linguistic thinking, then, is defined by sequential, order-contingent processing. The overall significant effects for imagery instructions and concreteness support the view that imagery is emergent. But, Paivio's leap from emergence to parallel processing was not supported by the results. The interactions which tested the parallel-sequential processing assumption did not support Paivio's notions.

Other studies, e.g., Wollen and Lowry (1971) and Mondani and Battig (1973), failed to conclusively support Paivio's hypothesis of associative asymmetry. Paivio feels that one reason for the negative studies could be that simulatneous visual presentation of the noun-pairs could result in the subjects storing visual-spatial copies of the pairs. Thus, visually stored abstract noun-pairs would also be processed in the imagery system and demonstrate symmetry in paired-associate tasks. But, how does that relate to the experiments that supported Paivio's theory, if, in fact, the conditions in those studies were similar to those in the negative studies? What prevented those subjects from succumbing to the visual-spatial storage of abstract noun-pairs? In addition, carrying Paivio's argument a little further, if abstract pairs can be visually stored, so can concrete pairs. Therefore, there is really no such thing as the parallel processing imaginal system but only the parallel perceptual processing of stored percepts. Paivio's argument can not stand on logical grounds alone.

It may be that the paired-associate paradigm does not provide a clear test of the associative asymmetry hypothesis. An effort was made in the present experiment to institute adequate controls on mnemonic instructions and the composition of the list of noun-pairs presented to the subjects. An effort was made to cancel out the "surprise effect" (Wollen & Allison, 1968) which results from an unexpected shift from forward learning to backward recall. A "surprise effect" would confound the true differences between imaginal and verbal associations. Also, a mixed list of abstract and concrete pairs was used to prevent any confounding arising from the use of unmixed lists. There are, perhaps, even more subtle confounding conditions in the paired-associate task which few researchers take notice of. The differences between studies supporting Paivio's hypothesis and those studies nonsupportive of Paivio may have been due to the variable conditions governing paired-associate learning. The number of pairs presented, the nature and types of instructions used, and the number of study trials allowed are all potential variables influencing any test of the asymmetry hypothesis in the paired-associate paradigm.

Paivio (1971) feels that meaningfulness is a variable that needs to be more fully explored. In the present experiment, meaningfulness was held constant while concreteness and imagery were varied. Highly meaningful abstract noun-pairs might have been integrated into associative compounds, thereby nullifying the predicted asymmetry. The pair "theory-justice" might have been stored by subjects as the phrase "a theory of justice." A pair integrated into a meaningful phrase could show symmetry in subsequent recall. Future research should aim at systematically varying meaningfulness and examining its effects on symmetry and asymmetry.

The strong effects for concreteness and imagery instructions in the present experiment support the notion that imagery is an emergent cognitive construct. The dual coding theory provides a simple and parsimonious explanation of these results. Pairs rated high in imagery or processed by imagery are stored in both the imagery and verbal systems. Therefore, in recall, there are two codes to call upon for retrieval. The storage redundancy explains the relative greater recall for imagery noun-pairs compared to purely verbal noun-pairs. The nonsignificant interactions between imagery and recall direction do not support Paivio's claim that imagery is essentially characterized by parallel processing while verbal processes are not. Yet, Pylyshyn's notion of an abstract propositional system was, also, not supported by the results. His theory does not explain the strong effects for imagery when meaningfulness is held constant. The conclusion of the present thesis is that imagery is a useful scientific construct. Paivio's treatment, though, of imagery in his dual coding theory calls for theoretical refinement and elucidation over and above the parallel processing versus sequential processing dichotomy.

Reference Notes

1. Segal, A. Untitled research, reported in Paivio (1975).

2. Smythe, P. C. Pair concreteness and mediation instructions in forward and backward paired-associate recall. Unpublished doctoral dissertation, University of Western Ontario, 1970. Cited in Paivio (1975).

References

Asch, S. E., & Ebenholtz, S. M. The principle of associative symmetry. Proceedings of the American Philosophical Society, 1962, 106, 135-163.

Begg, I., & Paivio, A. Concreteness and imagery in sentence meaning. Journal of Verbal Learning and Verbal Behavior, 1969, 8, 821-827.

Bourne, L., Ekstrand, B., & Dominowski, R. The psychology of thinking. New Jersey: Prentice-Hall, 1971.

Mondani, M. S., & Battig, S. R. Imaginal and verbal mnemonics as related to paired-associate learning and directionality of associations. Journal of Verbal Learning and Verbal Behavior, 1973, 12, 401-408.

Paivio, A. Imagery and verbal processes. New York: Holt, Rinehart, and Winston, 1971.

Paivio, A. Imagery and synchronic thinking. Canadian Psychological Review, 1975, 16, 147-163.

Paivio, A., & Foth, D. Imaginal and verbal mediators and noun concreteness in paired-associate learning: The elusive interaction. Journal of Verbal Learning and Verbal Behavior, 1970, 9, 384-390.

Paivio, A., Yuille, J. C., & Madigan, S. A. Concreteness, imagery, and meaningfulness values for 925 nouns. Journal of Experimental Psychology Monograph Supplement, 1968, 76, No. 1, Part 2.

Pylyshyn, Z. W. What the mind's eye tells the mind's brain: A critique of mental imagery. Psychological Bulletin, 1973, 80, 1-24.

Thorndike, E. L., & Lorge, I. The teacher's word book of 30,000 words. New York: Columbia University Press, 1944.

Wollen, K. A., & Allison, T. S. Latency and frequency of S-R and R-S associations as a function of recall time. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 895-899.

Wollen, K. A., & Lowry, D. H. Effects of imagery on paired-associate learning. Journal of Verbal Learning and Verbal Behavior, 1971, 10, 276-284.

APPENDIX A

Instructions for Imagery Subjects

You are about to participate in a psychology experiment that was designed to examine certain aspects of memory. You will be presented word-pairs, like ruler-watch or apple-table for example, which you will have an opportunity to briefly study. After you have studied the word-pairs, you will then be tested for recall. In recall, one of the two words which made up a pair will be shown to you, and your job is to tell me the other word of the pair. For instance, if I had shown you the pair ruler-watch, then, in testing recall I would display ruler or watch alone and you would tell me the word that goes with it.

In this experiment I am requesting that you memorize the words in a certain way. I would like you to use <u>visual</u> <u>imagery</u>. Visual imagery simply refers to those "pictures" in your head. Right now, try to picture your living room at home. Do you have it? You see, that'a all an image is. In memorizing the pair ruler-watch you could picture a watch wrapped around a ruler or a ruler with a watch built into it, and many other things. Most psychology research on memory has indicated that making visual "pictures" is one of the best ways to memorize. Warning--some of the pairs you will be presented may be very difficult to produce images for. Don't let that bother you. Simply try your best to form some image. This experiment has nothing to do with your grades or intelligence. Just relax and try your best.

You will have an opportunity to practice with a few word-pairs. You will then be presented 8 word-pairs and, following that, a test for recall. After that, you will be given another 8 word-pairs and another test for recall. Remember, you will have a few seconds to memorize each pair (roughly 6 seconds). In recall, you will have about 6 seconds to recall each pair.

A slide-projector will be used to display each pair on the screen. Each pair will be displayed for the same amount of time. You can study each pair until the next pair is shown. In recall, time is up--right when the next recall cue is displayed. Try a few practice pairs. If you have any questions whatsoever, please ask me now, before the experiment begins.

APPENDIX B

Instructions for Rote-Memory Subjects

You are about to participate in a psychology experiment that was designed to examine certain aspects of memory. You will be presented word-pairs, like ruler-watch or apple-table for example, which you will have an opportunity to briefly study. After you have studied the word-pairs, you will then be tested for recall. In recall, one of the two words which made up a pair will be shown to you, and your job is to tell me the other word of the pair. For instance, if I had shown you the pair ruler-watch, then, in testing recall I would display ruler or watch alone and you would tell me the word that goes with it.

In this experiment I am requesting that you memorize the words in a certain way. I would like you to use <u>rote-memorization</u>. Rote-memorization simply refers to a certain way of memorizing that involves repeating a word to yourself over and over again. In memorizing the pair ruler-watch you would repeat ruler-watch to yourself maybe five times, or, switch the order around and say watch-ruler a few times. Most psychology research on memory has indicated that rote-memorization is one of the best ways to memorize. Warning--some of the word-pairs may be difficult to memorize. Don't let that bother you. Simply try your best to rote-memorize. This experiment has nothing to do with your grades or intelligence. Just relax and try your best.

You will have an opportunity to practice with a few word-pairs. You will then be presented 8 word-pairs and, following that, a test for recall. After that, you will be given another 8 word-pairs and another test for recall. Remember, you will have a few seconds to memorize each pair (roughly 6 seconds). In recall, you will have about 6 seconds to recall each pair.

A slide-projector will be used to display each pair on the wall. Each pair will be displayed for the same amount of time. You can study each pair until the next pair is shown. In recall, time is up--right when the next recall cue is displayed. Try a few practice pairs. If you have any question whatsoever, please ask me now, before the experiment begins.